



Scientific Literacy and Critical Thinking Skills: A Constructivist Theory–Based Analysis in Science Learning

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Abstract

Motivated by the low level of students' scientific literacy and critical thinking skills in science learning, which is still dominated by lecture-based methods. The study aimed to analyze the implementation of constructivist-based learning in improving students' scientific literacy and critical thinking skills. The method used was descriptive qualitative research, with data collected through interviews, documentation, and a literature review. The research subjects consisted of science teachers from SMPN 1 Taliwang, MTsN 1 Sumbawa Barat, and SMPN 3 Taliwang. The results showed that the use of discussions, practicums, worksheets, and problem-solving activities could increase student participation, help students understand science concepts, and develop critical thinking skills through questioning, analysis, and drawing conclusions. Learning activities that relate science concepts to everyday life were also found to improve students' scientific literacy. However, the implementation of constructivist learning still faces several challenges, such as limited instructional time, low participation among some students, and a lack of practicum tools and materials. This study contributes to the development of more active, contextual, and student-centered science learning.

Keywords: constructivism; critical thinking skills; scientific literacy; science learning.

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INTRODUCTION

Science literacy is an essential skill that students must possess, as it relates not only to understanding scientific concepts but also to applying that knowledge to solve problems and make decisions in daily life (Ramadhan et al., 2025). Meanwhile, critical thinking skills are crucial because they help students analyze information, evaluate evidence, and draw logical and rational conclusions, key demands of 21st-century skills (Putri & Sumartiningsih, 2025). In science education, both contribute significantly to improving the quality of learning by enhancing conceptual understanding, problem-solving skills, and students' active engagement in the learning process, thereby making learning more meaningful and contextual (Widanty et al., 2025).

Various previous studies have shown that science literacy and critical thinking skills contribute to improving the quality of science education. The results of a study by Septianingsih et al. (2025) indicate that the consistent application of the Project-Based Learning model can improve students' cognitive learning outcomes, science literacy, and critical thinking skills, while fostering active

engagement in learning. Additionally, research by Asri and Ratnaya (2024) demonstrates that using science literacy-based worksheets within the science education model is also effective in enhancing students' critical thinking abilities. Another finding by Risahadi and Akbar (2024) reveals a significant relationship between science literacy and students' critical thinking skills, indicating that these two abilities mutually support one another in improving the quality of science learning. Although the research results show positive impacts, there are still several limitations, including the limited use of a single type of learning medium and the presentation of only a correlational relationship without explaining cause and effect.

Science literacy and critical thinking skills have been recognized as essential components of science education, but their implementation remains suboptimal, particularly when viewed from a constructivist perspective. The learning process still tends to be teacher-centered, so students have not yet constructed knowledge through experience and interaction as prescribed by constructivist principles. Students also continue to struggle to connect scientific concepts to real-life contexts and to present

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logical arguments. This situation results in low levels of students' science literacy and critical thinking skills. This indicates a gap between constructivist theory and actual teaching practices, necessitating qualitative and descriptive research to analyze in depth how students construct knowledge as they develop science literacy and critical thinking skills in science education.

Based on these issues, this study aims to analyze students' science literacy and critical thinking skills in constructivist-based science learning from the teachers' perspective, using data collection techniques such as interviews with science teachers at several different schools. The novelty of this study lies in its descriptive qualitative approach, which delves deeply into teachers' experiences, perspectives, and teaching practices in developing these two skills, thereby focusing not only on learning outcomes but also on the process of knowledge construction in the classroom. The expected implications of this study are to provide a theoretical contribution to enriching research on science literacy and critical thinking based on constructivism, as well as practical contributions in the form of recommendations for science learning strategies that are more contextual, reflective, and aligned with real-world conditions in the field, based on the results of teacher interviews.

MATERIALS AND METHODS

Time and place

Data collection for this study was conducted online at different times for each informant over a one-week period, from Monday, March 30, 2026, to Sunday, April 5, 2026.

Research design

This study employs a descriptive qualitative design to provide an in-depth understanding of the relationship between science literacy and students' critical thinking skills in science education, grounded in constructivist theory. This research design was chosen to gain a comprehensive understanding of learning phenomena as they occur in real-world contexts. The qualitative approach allows researchers to understand phenomena in a natural way, based on the direct experiences of research subjects, without manipulating or controlling learning conditions (Muhtadi et al., 2025). This approach enables researchers to gain a holistic, contextual understanding of the relationship between science literacy and students' critical thinking skills in science learning, grounded in constructivist theory.

Research population and sample

The subjects in this study comprised three science teachers from three junior high schools, namely SMPN 1 Taliwang, SMPN 3 Taliwang, and MTsN 1 Sumbawa Barat. The research subjects were selected using a purposive sampling technique tailored to the study's objectives and focus (Asrulla et al., 2023). The selection of subjects was based on several criteria, including teachers who actively teach science and have a good understanding of science literacy, critical thinking skills, and constructivist theory. Differences in the schools' backgrounds among the subjects enabled the researcher to obtain a more diverse range of perspectives. All research

subjects were willing to provide information through interviews and to supplement the data with the necessary supporting documents. Selecting subjects who meet these criteria can help researchers obtain relevant and in-depth data aligned with the research focus (Ramadani et al., 2025).

The primary instrument in this study was the researcher, who served as the planner, implementer, data collector, and data analyst, supported by a semi-structured interview guide featuring open-ended questions. Semi-structured interviews elicit information in a more open and in-depth manner than structured interviews, enabling the researcher to identify issues more comprehensively (Meliza et al., 2024). Additionally, in qualitative research, the questions are generally open-ended, allowing respondents to provide broad answers not limited to specific options and to describe their experiences and perspectives in greater depth (Susanty et al., 2023).

Research procedure

Penelitian ini menggunakan pendekatan kualitatif deskriptif to gain an in-depth understanding of science learning phenomena in real-world contexts. The first stage was preparation, which included determining the research locations and subjects (science teachers from several schools) and developing research instruments, including semi-structured interview guidelines with open-ended questions, observation sheets, and documentation templates. The second stage is data collection, which was conducted using three techniques, namely: (1) online interviews (via the WhatsApp platform) with science teachers from three different junior high schools, namely SMP 1 Taliwang, SMP 3 Taliwang, and MTsN 1 Sumbawa Barat, to explore their experiences, views, and teaching practices related to science literacy and critical thinking based on constructivism; (2) observation of the science learning process to examine interactions, learning strategies, and student engagement in knowledge construction; and (3) documentation in the form of instructional materials (lesson plans/teaching modules), teaching resources, and relevant student work. The third stage is data analysis, conducted interactively through data reduction, data presentation, and conclusion drawing and verification. The final stage is drawing conclusions, which involves interpreting research findings to comprehensively describe how science literacy and critical thinking skills are developed in constructivist-based science learning, as well as identifying constraints and solutions that arise in the field.

Research data analysis

The data analysis used in this study is qualitative descriptive analysis. The analysis was conducted using data from interviews, observations, documentation, and various literature sources on science literacy, critical thinking skills, and constructivist theory in science education. The initial stage of data analysis involved data reduction, which was carried out by selecting data relevant to the research problem, thereby making the data more focused and easier to analyze. The data reduction results were then organized by theme as a basis for the next stage of analysis (Qomaruddin & Sa'diyah, 2024).

The data presentation stage follows the reduced data, presented as a narrative description of the interview results. The purpose of data presentation is to help

researchers understand the patterns of relationships between science literacy, critical thinking skills, and constructivist learning. Through systematic data presentation, researchers can more easily identify key findings in the study (Haki & Prahastiwi, 2024).

The final stage involves drawing conclusions based on the analyzed data. Conclusions are derived by examining patterns, relationships, and trends emerging from the data. Subsequently, these conclusions are re-verified through cross-checking data from various sources to ensure the research results are more valid and reliable. Verification can be conducted through source triangulation, methodological triangulation, and discussions with other parties knowledgeable about the research topic. To ensure the validity of the data, this study employs source triangulation, which involves comparing data obtained from interviews, observations, documentation, and previous research findings. This technique is crucial to ensure that the data collected is more accurate, consistent, and aligned with actual conditions (Maulidina et al., 2021).

RESULTS AND DISCUSSION

Result

Interview Results with the Science Teacher at SMPN 1 Taliwang

An interview with a science teacher from SMPN 1 Taliwang was conducted on March 30, 2026, via a WhatsApp video call. The results of the interview are as follows.

“I usually use discussion, hands-on activities, and worksheets to help students be more active when learning science. In my opinion, if I just keep explaining things through lectures, students get bored quickly and don't understand as well. With discussions, they can exchange ideas and learn from their peers. Plus, since students have different abilities, if I form groups that mix those who grasp concepts quickly with those who need more time, they can help each other. Additionally, I often use lab activities or simple experiments to help students see the material firsthand. Usually, when they witness the process themselves, they grasp it more easily and retain the material better. For example, when learning about changes in the state of matter or environmental pollution, students learn more quickly when they perform experiments or observe phenomena directly. In my view, this approach also helps develop students' critical thinking skills. They get used to asking questions, seeking reasons, analyzing experimental results, and drawing their own conclusions. So students don't just memorize the material, but also understand why certain things happen. The downside is that this method takes more time. Sometimes students get rowdy during group assignments, and some are less active during group work. Additionally, for lab sessions, the equipment and materials must be prepared in advance so that the lesson can run smoothly.”

Based on the interview results, science instruction tends to follow a constructivist approach, in which students are encouraged to actively construct their knowledge through discussions, laboratory experiments, and worksheets. Teachers stated that the lecture method is less effective because it quickly bores students and leads to a lack of conceptual understanding. Through group discussions, students can exchange ideas and help one another understand the material according to their individual abilities. Laboratory activities are also

considered effective in enhancing conceptual understanding because students are directly involved in the observation process. Additionally, this strategy is seen as fostering students' scientific literacy and critical thinking skills, such as asking questions, analyzing experimental results, and drawing conclusions. However, challenges include time constraints, a lack of engagement among some students in group work, and the need to prepare laboratory equipment and materials, which can be quite complex.

Results of an Interview with a Science Teacher at MTsN 1 West Sumbawa

An interview with a science teacher from MTsN 1 Sumbawa Barat was conducted on April 2, 2026, via a WhatsApp video call. The results of the interview are as follows.

“I usually rely more on group discussions and Q&A sessions. In my experience, students are more willing to speak up when learning with their peers than when being asked questions one-on-one. During discussions, they can share their opinions, ask each other questions, and help one another understand the material. I usually also provide worksheets containing simple questions so they don't get confused during the discussion. For science lessons, I often relate the material to everyday life. For example, when discussing environmental pollution, I ask students to find examples around their homes or schools. This makes it easier for students to understand the material because they see the examples firsthand. In my opinion, this approach can help improve students' science literacy and critical thinking skills. They become accustomed to seeking information, providing reasons, and explaining their own opinions. However, the downside is that not all students are willing to participate actively. Sometimes there are students who just follow along with their groupmates without truly understanding the material.”

The interview results indicate that science instruction is more often conducted through group discussions and question-and-answer sessions, which align with constructivist principles by fostering active student engagement. Teachers also use worksheets as discussion guides and relate the material to everyday contexts to facilitate student understanding. This approach is considered effective in improving science literacy and critical thinking skills, as students become accustomed to seeking information, providing reasons, and expressing opinions independently. However, there remains a challenge: low participation by some students in discussions, with a few students tending to be passive and relying on their groupmates.

Interview Results with the Science Teacher at SMPN 3 Taliwang

An interview with a science teacher from SMPN 3 Taliwang was conducted on April 4, 2026, via a WhatsApp video call. The results of the interview are as follows.

“In my opinion, if students just listen to the teacher's explanation, they forget quickly. But if they try things out, observe, and find the answers themselves, they understand more easily. For example, when learning about forces or changes in matter, I usually have the students conduct simple experiments. Afterward, they're asked to write down their observations and draw conclusions. From there, I can see whether the students truly understand. I also often ask questions that make students think, such as why a certain event occurs or how to solve a specific problem. In my

opinion, this is important so that students get used to thinking critically and don't just memorize answers. The downside is that this method is quite difficult to implement when class time is limited. Sometimes students get too rowdy during lab work or discussions, so the teacher has to manage the class more frequently to keep the environment conducive."

Based on the interview results, the science instruction conducted reflects the principles of constructivism, in which students are encouraged to actively construct knowledge through laboratory activities, discussions, and problem-solving. Teachers emphasize the importance of students' direct involvement in the learning process, such as conducting experiments, observing phenomena, and drawing conclusions independently. Additionally, the use of problem-based questions encourages students to think critically in understanding the cause-and-effect relationships of a phenomenon. Thus, learning focuses not only on the transfer of knowledge but also on students' knowledge construction.

Discussion

The Application of Teaching Methods in Science Education

Based on the interview results, the three teachers used discussion, laboratory work, and worksheets because they believed these methods could make students more active in science learning. The teacher from SMPN 1 Taliwang explained that students find it easier to understand the material when they learn through discussions and experiments rather than just listening to the teacher's explanations. Group discussions also help students with lower abilities learn from peers with a better grasp of the material. This indicates that science learning involving interaction and hands-on experience aligns with the constructivist approach. In constructivist theory, students construct their own knowledge through experience, discussion, and interaction with the learning environment. The use of worksheets also helps students stay on track during discussions and lab experiments. Science literacy-based worksheets can help students improve their critical thinking skills by training them to analyze, interpret, and draw conclusions from problems (Agustin & Aziz, 2024).

The Role of Laboratory Work in Improving Science Literacy

Teachers from SMPN 1 Taliwang and SMPN 3 Taliwang both emphasize the importance of hands-on experiments in science education. According to them, students find it easier to understand the material when they see and try things firsthand. For example, when studying topics such as changes in the state of matter, forces, or environmental pollution, students grasp the concepts more quickly by observing these phenomena through experiments. Laboratory work helps students develop scientific literacy by enabling them not only to memorize concepts but also to explain scientific phenomena, interpret data, and draw conclusions from their observations. Activities like these help students understand the connection between science concepts and daily life. Research on science literacy indicates that students' ability to explain scientific phenomena, interpret data, and use scientific evidence remains low; therefore, laboratory-

based learning needs to be implemented more frequently (Cahyani et al., 2024).

Developing Critical Thinking Skills through Discussion and Problem Solving

The interview results indicate that teachers strive to develop students' critical thinking skills through discussions, question-and-answer sessions, and problem-solving. A teacher from SMPN 3 Taliwang explained that students are often asked questions such as why a certain event occurred or how to solve a problem. A teacher from MTsN 1 Sumbawa Barat also noted that students are more confident in expressing their opinions when discussing with their peers. Discussions and problem-solving help students practice asking questions, providing reasons, evaluating opinions, and drawing conclusions. These activities are crucial in science education because students are not merely expected to memorize concepts but also to understand the scientific reasoning behind an event. The use of worksheets based on problem-based learning and the STEM approach has proven effective in enhancing students' critical thinking skills, as students are required to find solutions and explain the reasoning behind their answers (Asri & Ratnaya, 2023).

The Connection Between Science Content and Everyday Life

A teacher from MTsN 1 Sumbawa Barat explained that students find it easier to understand the material when it is linked to their daily lives. For example, when discussing environmental pollution, students are asked to find examples of pollution near their homes or schools. This approach helps students grasp the concepts more easily because they witness the phenomena being discussed firsthand. Learning that connects science material to real-world conditions around students is crucial for improving science literacy. Students will more easily understand the benefits of science and use scientific concepts to solve problems they face in daily life. Learning based on real-world or socioscientific issues has been shown to improve students' science literacy by helping them understand problems in their environment from a scientific perspective (Chomsun et al., 2024).

Challenges in Implementing Constructivist Learning

Although discussion, laboratory work, and worksheets are considered effective, the three teachers also mentioned several challenges in implementing them. The teacher from SMPN 1 Taliwang noted that these methods take more time and require preparation of lab equipment. The teacher from MTsN 1 Sumbawa Barat mentioned that not all students actively participate in group discussions. Meanwhile, the teacher from SMPN 3 Taliwang explained that the classroom atmosphere often becomes too noisy during lab sessions or discussions. These challenges indicate that constructivist learning requires effective classroom management to ensure that learning activities remain effective. Teachers need to form balanced groups, provide clear instructions, and prepare appropriate worksheets and lab equipment to keep students focused throughout the learning process.

CONCLUSION

The findings of this study indicate that science learning based on constructivist theory, implemented through discussions, laboratory experiments, worksheets,

and problem-solving, is effective in increasing students' active engagement and deepening their conceptual understanding. A learning process that provides students with opportunities to observe, ask questions, analyze, and draw conclusions has been proven to develop science literacy and critical thinking skills. Additionally, linking science content to everyday life enhances students' contextual understanding. Thus, student-centered learning that emphasizes hands-on experiences is crucial to supporting the development of these two skills.

However, the implementation of constructivist learning still faces several challenges, such as limited class time, low participation by some students in discussions, and limited facilities and equipment for practical exercises. This study also has limitations because it involved only a small number of participants and used a descriptive qualitative approach, so the results cannot yet be widely generalized. Therefore, future research is recommended to adopt a more diverse approach, such as a combination of qualitative and quantitative methods, with a larger sample size, and to develop innovative learning models and media to optimize the application of constructivism in improving students' science literacy and critical thinking skills.

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AUTHOR'S CONTRIBUTION

Table of Author Contributions

Contribution Indicators	Author				
	1	2	3	4	5
Conceptualization	✓	✓		✓	
Literature Review	✓		✓	✓	✓
Research Design / Methodology	✓	✓	✓		
Instrument Development	✓	✓			✓
Data Collection	✓				
Data Curation		✓			✓
Formal Analysis		✓	✓		
Data Interpretation	✓		✓	✓	
Writing – Original Draft	✓				
Writing – Review & Editing	✓	✓		✓	
Visualization / Tables	✓				✓
Supervision		✓	✓	✓	✓

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