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Article

Analysis of Students' Questioning Skills to Correct Misconceptions Related to Understanding Temperature and Heat Materials

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ABSTRACT

This study aims to analyze the questioning ability of grade VII students in an effort to correct misconceptions on temperature and heat materials. The ability to ask questions is an important skill in the learning process, because the right questions can help students dig deeper into understanding and identify and correct their misconceptions. This study uses a qualitative descriptive approach with the subject of grade VII students in one of the junior high schools based on Islamic boarding schools in Ponorogo. Data was obtained through tests, interviews, and document analysis in the form of student question notes during the learning process. The results of the study show that most students still have difficulty asking exploratory and critical questions related to the concept of temperature and heat. However, through targeted guidance from teachers, the quality of the questions. From the questions asked by students on the material on temperature and heat, it can be an indicator of misconceptions because by asking questions, students have constructed their own thoughts, making them more curious and satisfying that curiosity through their ability to ask questions. this research connects the two showing how questioning can be a diagnostic and corrective tool to address students' conceptual misunderstandings. This research is important because many students still hold misconceptions about temperature and heat, while their questioning skills remain low, preventing these errors from being revealed. By analyzing students' questions, this study provides an effective way for teachers to diagnose misunderstandings early and improve science learning quality.

INTRODUCTION

Science learning is a compulsory subject from elementary school to university. Science class materials are obtained from nature and are closely related to students' lives. The relationship between scientific concepts in daily life can be studied using scientific methods. The process of searching for scientific facts in life can indirectly stimulate students' curiosity and desire to ask questions (Bukit et al., 2023). Students in the 21st century are more focused on exploring their potential to solve the problems they face during the learning process and their transition to the world of work as adults (Kunayah & Fauziah, 2023).

Students' understanding of science material that is in line with the concepts, laws and theories in science will lead students to achieve a variety of learning goals, besides that understanding concepts is also important to foster curiosity and sensitivity to the environment which of course is accompanied by logical explanations from the teacher. The understanding of science concepts by students must develop and gradual, first students are given an abstract problem obtained through direct observation or observation. A student in forming an understanding in themselves through questioning activities that aim to get clarification or answers that they do not know before or are still in doubt regarding one of the concepts (Deliany et al., 2019).

The science learning process becomes very monotonous and boring when teachers provide learning that only explains the conceptual aspects of science. On the other hand, science material covers many natural phenomena that students have experienced before but are not able to analyze the science concepts involved. In this way, students are encouraged to ask questions to improve their thinking skills. Teachers can encourage questioning skills by asking questions before explaining what has been learned, allowing students to react more openly to what is happening around them (Kalsum et al., 2021).

Questioning is an activity that aims to find information or answers from examples, educational materials, natural phenomena, experiences, or other aspects that are felt to have no clear answers (Ika Pratiwi et al., 2019). The importance of asking questions in science is for students to develop a mindset. This starts from all the fear they feel when studying science because science is closely related to everyday events. Therefore, asking questions is a skill that can express students' critical attitudes and shape their personalities to be sensitive to the environment, think quickly, and be responsive to problems that arise around them (Waruwu et al., 2023). Asking questions to students and teachers is also a type of linguistic communication in learning. Through asking questions, students and teachers can build good relationships and chemistry so that students are more comfortable learning (Amiasih et al., 2017).

Asking questions can also help clarify misconceptions about scientific content, whether it's from textbooks, information provided by teachers, discoveries made by previous students, or information passed down from generation to generation in society (Mariyadi & WA, 2023). Through asking encourages students to expand their vocabulary and think critically to solve problems they encounter during learning and in real life (Jannah & Yuliati, 2016). When students work on a problem, they use questioning and critical thinking skills to solve the problem. This causes misunderstandings and conceptual errors in understanding matter, especially the concept of physics in science (Haerunnisa et al., 2022).

According (Ika Pratiwi et al., 2019) There are 4 indicators of a student's ability to ask questions. 1) Clear and concise question submission, The first indicator means that at the initial stage of asking, the student begins to ask simple questions based on his or her initial knowledge. 2) Expand the scope of the question, This second indicator means that as their curiosity increases, the student begins to relate the question to the events experienced before. 3) Questions have a cognitive level, This third indicator refers to the occurrence of operational verbs in the student's question and indicates the student's level of thinking according to Bloom's taxonomy. 4) Clear and logical order of questions, This fourth indicator shows that students already have the ability to think at a high level to respond to phenomena and are able to ask concise and logical questions.

Intellectual development is closely related to misconceptions about science because a higher level of thinking is required to understand scientific concepts well. Misunderstandings often occur when students are unable to connect new knowledge with existing knowledge. This suggests that students' cognitive structures may not be maximal enough to understand complex concepts. Lovell emphasized that the growth of scientific concepts such as energy and mechanics requires further research, which suggests that a deep understanding requires sustained intellectual development. (Lovell, 1974).

The understanding that students gain from learning in class does not rule out the possibility of misconceptions in a science material. Misconceptions can occur because there are 3 factors, namely: 1) inadequate teaching methods can hinder students' in-depth understanding, 2) irrelevant curriculum can also cause misconceptions 3) learning objectives that are not well defined or too shallow can also hinder students' understanding. In addition, students' previous knowledge and experience can also influence the formation of misconceptions. If the student's previous understanding is wrong, this can hinder the correct understanding of scientific concepts. Finally, cognitive conflict can also lead to misconceptions. This misconception arises when students face a contradiction between their previous knowledge and the new knowledge they learn (Dewi & Ibrahim, 2019). Students who experience misconceptions may have difficulty understanding basic concepts, which can hinder further learning. (Almualimah et al., 2024).

Misconceptions pose obstacles in the science learning process and require effective teaching strategies to overcome them. Research that has been conducted by Perez shows that many difficulties in learning science come from knowledge before starting learning in the classroom and the teacher's lack of understanding of that knowledge. As a way to overcome this misconception, a conceptual change approach is proposed that shows that students can acquire more accurate scientific knowledge when using the right teaching strategies. Teachers should identify misunderstandings in students' thinking before learning through post questions, diagnostic tests, or classroom conversations. Students should be helped to realize that their understanding may be wrong by comparing their ideas with generally accepted scientific concepts (Gil‐Perez & Carrascosa, 1990).

Science is a fundamental subject that helps students understand natural phenomena and develop scientific reasoning. In physics learning, especially in the concepts of temperature and heat, students are often required to connect abstract scientific ideas with everyday experiences. However, many students enter junior high school with limited conceptual understanding, leading to persistent misconceptions such as equating heat with temperature, misunderstanding heat transfer, or misinterpreting real-world events like fever, melting ice, and sea–land breezes. These misconceptions hinder the development of accurate scientific reasoning and affect students' readiness for more advanced physics topics.

Questioning is an essential component of scientific literacy because it encourages students to think critically, seek clarification, and construct deeper conceptual understanding. Research shows that students who actively ask clear, logical, and exploratory questions demonstrate better comprehension and are more capable of identifying their own misunderstandings. Unfortunately, in many classrooms—including boarding school–based environments where students often experience fatigue and limited engagement—questioning skills remain low. As a result, misconceptions remain unexpressed and uncorrected, reducing the effectiveness of science learning.

This research aims to find out how to improve students' ability to ask questions because in the current era students are very rare to do literacy related to phenomena, cases or problems they experience and straighten out misconceptions that occur in students' understanding of temperature and heat materials. The research contribution is to analyze how students' questioning skills can be used as an indicator to detect and correct misconceptions in temperature and heat concepts, providing teachers with practical insights to improve the quality of physics learning in junior high schools.

METHODS

The research was conducted on February 13 2025 at one of the schools based on Islamic boarding schools in Ponorogo Regency. This type of research is qualitative where it investigates the experiences and perceptions of individuals in their social and cultural contexts, with the aim of understanding reality from the individual's point of view. The approach used is phenomenological that focuses on understanding and explaining the individual's life experiences, emphasizing the subjective interpretation and meaning associated with a particular phenomenon. This data based on preliminary study in 7th grade.

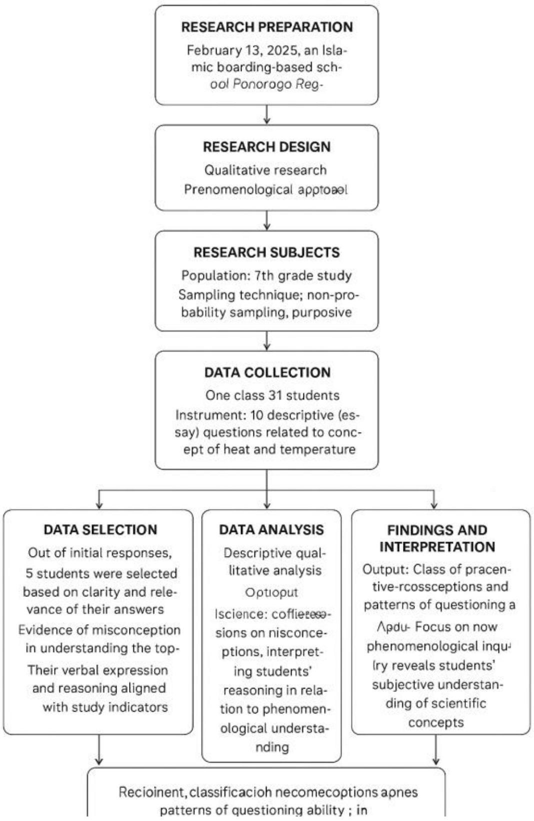

Figure 1. Mechanism Researsch

The subject of the study is grade 7th grade students with non-probability sampling type purposive sampling. The nonprobability sampling method is used in the research whose purpose is to obtain insights from a certain group, namely 7th grade students. Grade 7 was chosen because they are in the transition period from children to teenagers so that it is possible that when learning science there are many concepts that they are not familiar with when they are in elementary school, so it can trigger misconceptions. The research was conducted in one class which contained 31 people who were given 5 essay questions. However, during the analysis of the answers, only 5 students were selected who met the answer criteria in accordance with the indicators of their ability to speak and the answers also contained misconceptions about the heat temperature material.

RESULTS AND DISCUSSION

Understanding the concepts of matter, temperature, heat, and expansion is essential for 7th graders, as these concepts form the foundation of advanced scientific knowledge. Many students, however, enter this stage with misconceptions that hinder learning. Effective questioning practices can help address these misconceptions by guiding students to deeper understanding and accurate conceptualization (Lubis & Lubis, 2016).

The results show that students' questioning skills on temperature and heat concepts vary across three major indicators: clarity, logical sequence, and scope expansion. Most students were able to ask simple and clear factual questions, but struggled to formulate analytical or exploratory questions. This limited questioning ability contributed to the persistence of misconceptions, especially in topics such as differentiating heat and temperature, interpreting everyday thermal phenomena, and understanding heat transfer mechanisms

Based on students' descriptive answers regarding temperature, heat, and questioning skills, responses varied across several contexts. Question number 1 about fever and Body Temperature Students often confuse fever as a disease rather than a symptom of infection. Correctly, fever is a body response when temperature rises above 37.5°C (Aulia, 2020). Misconceptions also occur regarding home treatment—students assume fever must always be eliminated, neglecting that mild fever aids immune response. Proper understanding includes hydration, rest, and temperature control (Tansil et al., 2021).

Question number 2 about global Warming and Polar Ice, many believe polar temperatures are constant and ice melting occurs due to local activities. In fact, temperature varies seasonally, and ice melting is driven by global greenhouse effects (Purnami, 2021). Polar ice maintains climate stability through the albedo effect and supports ecosystems (Iskandar et al., 2020).

Question number 3 about Heat on Beaches students often think all surfaces absorb heat equally. In reality, sand heats faster than water due to its lower specific heat capacity. Misconceptions about heat transfer conduction, convection, and radiation are common (Hamuna & Kalor, 2022). Correctly, heat flows from hotter to cooler areas, influenced by material and environment (Lalu A, 2017).

Question number 4 about Specific Heat of Materials students think type of heat depends on object size, not material properties. In truth, specific heat is intrinsic, depending on molecular structure and bonding (Taqwa et al., 2019). Heat is energy transfer, not a physical property. Specific heat is determined experimentally using $Q = m \cdot c \cdot \Delta T$ (Aisyah et al., 2022).

Question number 5 about Land and Sea Breeze students confuse causes of wind movement, assuming randomness. Land breeze occurs at night (land to sea) and sea breeze by day (sea to land), driven by temperature and pressure differences (Handayani et al., 2023). The main heat transfer involved is convection. Misunderstanding the alternation of wind direction overlooks diurnal heating cycles (Arno et al., 2023).

The data from this research, aimed at understanding the questioning ability of students in addressing misconception-related questions at an Islamic boarding school in Ponorogo, are presented qualitatively. The findings were obtained through interviews with the 7th-grade science teacher and supported by coding analysis using the *ATLAS.ti* application. The following section presents the coding results for the students' levels of questioning ability.

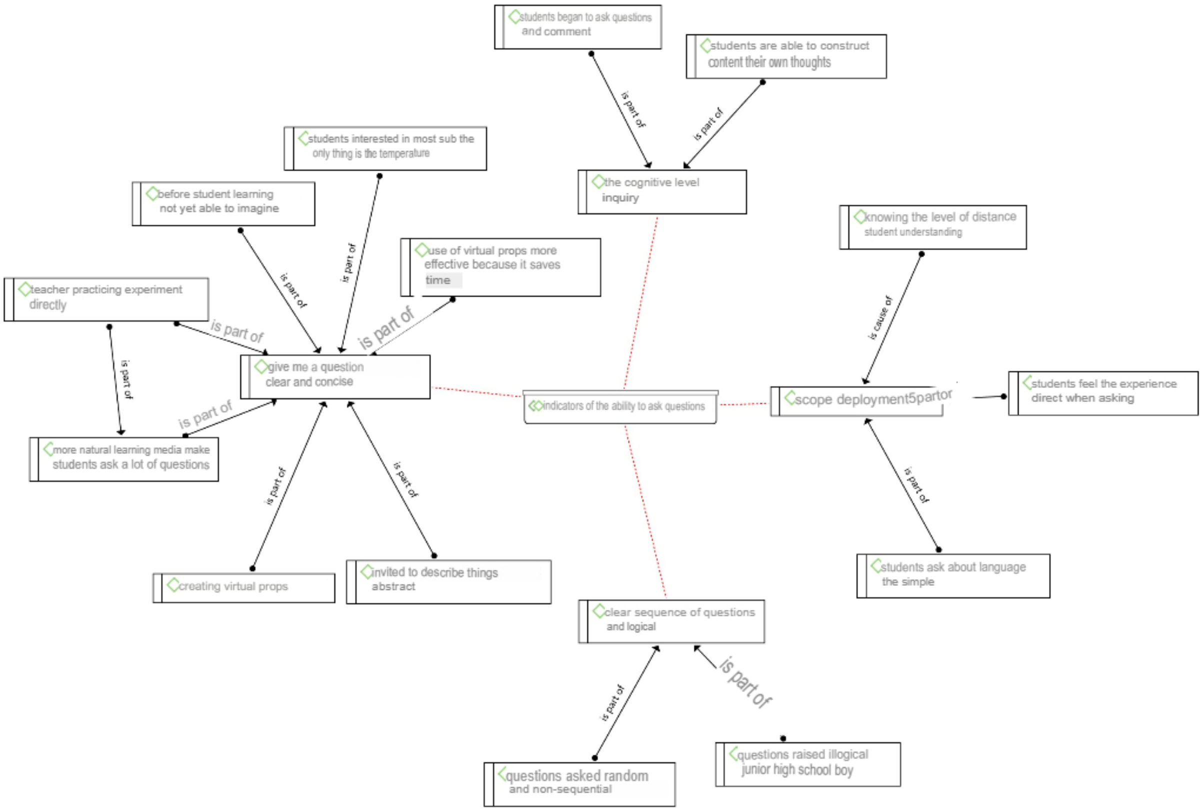

Figure 2. Student Question Ability

The diagram portrays a network of interrelated indicators demonstrating how clear, logical, and contextually broad questions contribute to the development of students' questioning skills. It emphasizes that effective questioning supported by direct experiments, authentic media, and virtual tools encourages imagination, deeper understanding, and active participation in learning (Seng et al., 2025).

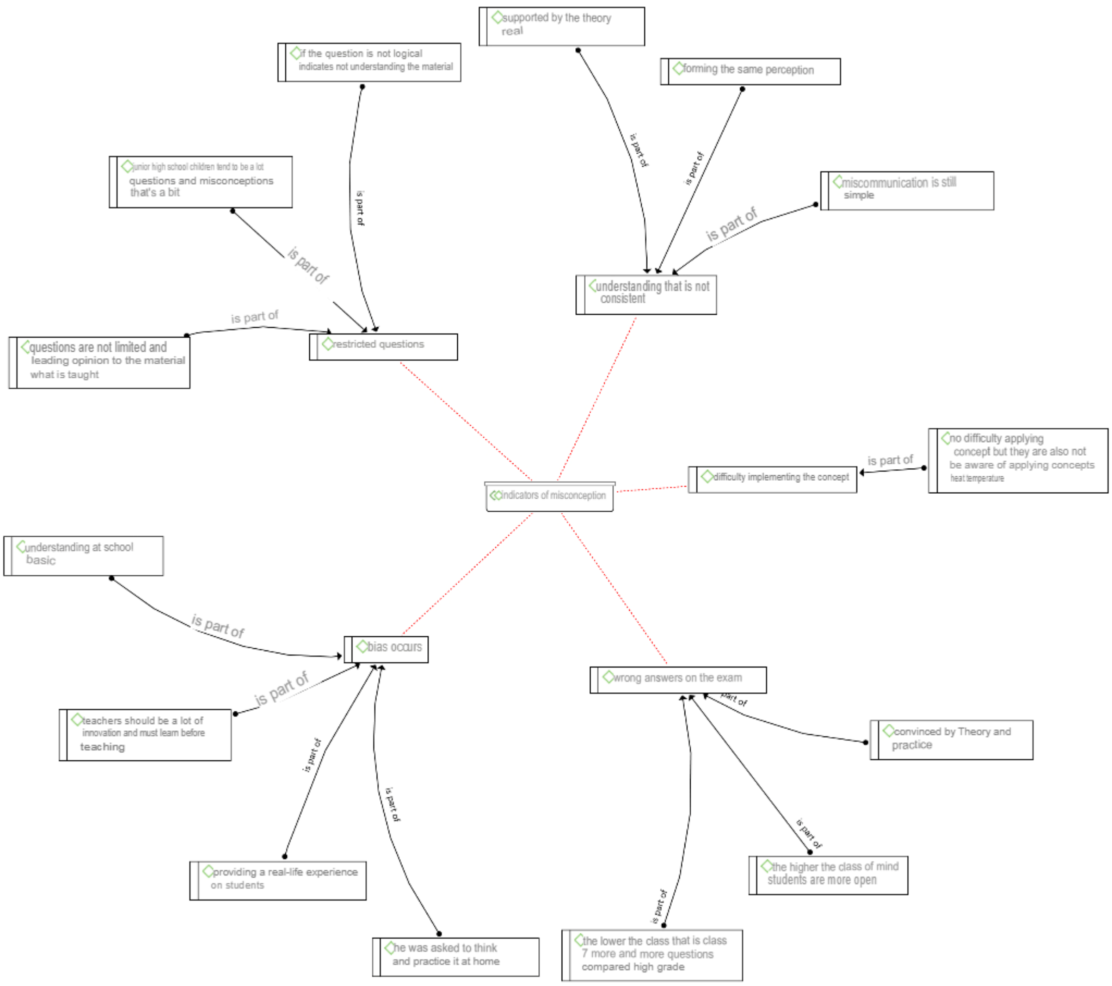

Figure 3. Miconseption factors

The diagram illustrates the indicators of misconceptions among students and the factors that contribute to their development during the learning process. It maps the relationships between limited understanding, inconsistent reasoning, and difficulties in applying scientific concepts. the diagram emphasizes the need for: real-world experiences in learning, encouragement of open questioning, Consistent reinforcement between theory and practice. By addressing these areas, teachers can minimize misconceptions and enhance conceptual understanding in science learning (Susilo & Hadi, 2025).

Misconceptions were found in five key areas: limited questioning, inconsistent conceptual understanding, difficulty applying theory to real situations, incorrect test responses, and bias originating from prior knowledge. These findings indicate that misconceptions are not only cognitive errors but also linked to students' insufficient opportunities to clarify their thinking through questioning (Kalsum et al., 2021) ons foster deeper understanding and application of knowledge (Felker & Dapra, 1975). Strategic questioning enables teachers to uncover misconceptions and guide conceptual change, creating a relational learning environment where students feel safe expressing ideas (Antink-Meyer & Meyer, 2016).

Teachers noted that lack of focus among students in Islamic boarding schools often stems from fatigue and health conditions. Practical group activities can improve engagement. Misconceptions such as equating temperature with heat or misunderstanding thermometer use affect comprehension and should be addressed through inquiry-based learning (Pine et al., 2001). Relational questioning encourages dialogue that helps students identify and correct misconceptions (Skalstad & Munkebye, 2021). Common errors include defining temperature as "heat," measuring temperature incorrectly, and confusing heat with temperature (Schinkel, 2023). Clarifying these concepts strengthens scientific reasoning (Bekkink et al., 2016).

Encouraging reflective questions "How did you reach that conclusion?" develops metacognition. Inquiry-based learning lets students test ideas experimentally, deepening understanding (Cruz-Guzmán et al., 2017). Formative assessments integrated into questioning identify misconceptions and monitor progress (Koch & Eckstein, 1991).

Creating a classroom culture valuing questions builds scientific literacy. Safe spaces for inquiry allow students to challenge assumptions and engage deeply with content (Khishfe, 2019). Open-ended, reflective, and collaborative questioning strategies, supported by real-world contexts, enhance conceptual learning about matter, temperature, heat, and expansion (Benediktsson et al., 1992).

At the center is Indicators of questioning ability in picture 2, connected to three main components: First component is giving clear and concise questions. This involves teachers presenting straightforward questions that stimulate curiosity and understanding (Kalsum et al., 2021). Supporting factors include: Teachers conducting direct experiments, making lessons more engaging. Use of authentic learning media, which increases student participation and curiosity. Virtual teaching aids, which save time and help visualize abstract concepts. Encouraging students to illustrate abstract ideas, helping them think more critically (Sunaryati et al., 2024). It also shows that before learning, students often lack imagination, but effective questioning and media use help overcome this limitation.

Second component is clear and logical sequence of questions. Logical questioning promotes coherent thinking (Rahmayanti et al., 2022). Some students at the junior high level tend to ask random or illogical questions, indicating the need for structured guidance. This indicator emphasizes helping students organize their thoughts to ask logical, sequential questions (Chen et al., 2020).

Third component is scope expansion. This refers to broadening the range of questions to explore various perspectives (Ramadani et al., 2023). It enables teachers to identify students' levels of understanding and encourage direct experiences during questioning. When students ask within a wider scope, they engage more deeply and connect theory with real-life experiences (Nasution et al., 2024).

According picture 3 about misconception has five factors. First factor about limited questioning. This branch explains that when students' opportunities to ask questions are restricted, it affects their learning depth and may conceal existing misconceptions. Junior high school students tend to ask more questions, and as a result, misconceptions appear less frequently. Open questioning helps clarify confusion (Nurcahyo, 2020). When students' questions are not limited and they are allowed to express opinions leading toward the topic being taught, learning becomes more meaningful. This indicates that allowing open questioning reduces misconceptions because students can actively explore and clarify concepts rather than memorizing passively (Rahayu & Fitriza, 2021).

Second factor is inconsistent understanding. This branch shows that misconceptions often arise when students' understanding is inconsistent with real theory or experiences. Illogical questions indicate a lack of conceptual understanding. Consistency in understanding requires support from valid theoretical foundations. Shared misconceptions can form when students adopt the same incorrect interpretation. The misconceptions are still at a simple level, often due to early confusion that is left uncorrected (Haerunnisa et al., 2022).

Third factor is difficulty in applying concepts. This branch represents students' struggle to apply theoretical knowledge in practice, especially regarding heat and temperature concepts. Some students may not struggle visibly to apply concepts, yet they are unaware of whether they are applying them correctly. This shows that misconceptions can be implicit, meaning students might perform tasks correctly but without true conceptual understanding (Rahayu & Fitriza, 2021)

Fourth factor is incorrect answers during tests, this branch reflects how misconceptions manifest during assessments. Students' answers are influenced by their (sometimes incorrect) confidence in theory and practice. Lower-grade students tend to ask more questions, which helps them uncover misconceptions. As students progress, their thinking becomes more open, reducing the risk of misconception (Zayyinah, 2022).

Fiveth factor is bias formation, this section explains that biases in understanding stem from prior educational experiences and insufficient teaching preparation. Misconceptions often begin from incomplete understanding in elementary school. Teachers must innovate and strengthen their understanding before teaching to prevent misconceptions. Providing students with real experiences and opportunities to apply knowledge at home reinforces conceptual understanding and reduces bias (Ali, 2019).

Fostering a conceptual understanding of heat and temperature is more beneficial than memorizing definitions. By engaging students in discussions that require them to articulate their understanding, educators can help them develop a more nuanced view of these concepts. This approach encourages critical thinking and allows students to relate their learning to real-world applications. Students' analytical skills are closely related to questioning skills. Improving students' questioning skills can deepen their understanding of complex problems and encourage them to seek better solutions. Asking relevant questions allows students to explore the problem more deeply and develop the critical thinking skills necessary for effective analysis (Dori & Herscovitz, 1999).

The findings align with earlier research demonstrating that weak questioning skills contribute to misunderstanding scientific concepts. found that students who ask fewer or simpler questions tend to retain misconceptions about temperature and heat. written questions can reveal hidden misconceptions, reinforcing our finding that student-generated questions serve as diagnostic indicators. that logical and structured questioning improves students' cognitive processing. The difficulty observed in forming logically ordered questions in this study is consistent with who reported that inconsistencies in scientific reasoning often stem from fragmented understanding. (Ram, 1991).

Collaborative reflection among educators as a way to improve the practice of questioning. By sharing experiences and strategies, teachers can learn from each other and develop more effective approaches to address student misconceptions. This collaborative environment encourages professional growth and ultimately benefits student learning outcomes. Asking students to provide a written reason for their multiple-choice answers can affect the student's participation and thought process. When asked why, they are more likely to leverage the knowledge they have than to rely on shortcuts or inefficient methods, which may result in better answers. Writing sentences that contain cause and effect allows students to think critically about ideas, deepen their understanding, and find more accurate answers (Koretsky et al., 2016).

The results highlight the need for science learning models that actively promote student questioning, such as inquiry-based or guided discovery approaches. When students are encouraged to ask questions, especially higher-order ones, they become more capable of examining inconsistencies in their understanding. These findings imply that classroom practices should: Provide structured opportunities for students to formulate questions during experiments and discussions. Use student questions as formative assessments to detect misconceptions early. Integrate visual, experimental, and contextual learning aids to strengthen conceptual alignment between theory and real-world phenomena. The close relationship observed between questioning skills and misconceptions indicates that improving students' questioning ability can serve as an effective strategy to promote conceptual change. This complements the theoretical view who states that questioning is central to thinking and learning (Cruz-Guzmán et al., 2017).

The study provides a detailed qualitative analysis of student questioning patterns and links them directly to specific misconceptions in temperature and heat. The use of interviews, test responses, and ATLAS.ti coding strengthens the validity of the findings. The research offers practical insights for teachers to use questioning as a diagnostic tool in physics learning.

The study involved a single class of 7th-grade students, limiting its generalizability. Data were based on students selected purposively, which may not represent all ability levels. The absence of a comparison group limits evaluation of the effectiveness of questioning-based interventions (Koch & Eckstein, 1991).

CONCLUSION

The ability to ask effective questions is essential in overcoming misconceptions in students' understanding of scientific concepts, through a combination of open-ended, investigating, reflective, scenario-based, and comparative questions, educators can create a dynamic learning environment to encourage critical thinking and deeper understanding. By recognizing the relational nature of questions, educators can not only correct misconceptions but also foster a culture of inquiry that empowers students to engage meaningfully with the material. This approach ultimately contributes to the development of students who are confident and capable in the field of science. Traditional learning models commonly used in the classroom often do not encourage active participation of students in the learning process. This is because of its emphasis on memorization and passive learning. As a result, students feel unable to delve into concepts and ask fewer questions. To overcome these problems, the Discovery Inquiry (DI) learning model was introduced. This model aims to encourage active participation of students and critical thinking. In the DI model, students are encouraged to ask questions while exploring scientific concepts. When students have the opportunity to investigate and ask questions, they tend to ask questions that reflect their understanding and curiosity. This active involvement can deepen the understanding of scientific concepts and reduce students' misconceptions.

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