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[Research Article]

Unveiling Misconceptions: A Multilocation Study on First-Year College Students in Indonesia

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ABSTRACT

The aim of this research is to determine whether there are any misconceptions among first-year students regarding the concepts of heat and temperature. This study employs a descriptive research design. The sample used in this study consists of 224 first-year students from both public and private universities in the cities of Singkawang, Bima, Madiun, and the districts of Sumedang, Sintang, and Bandung. Data were collected through a g-form using a four-tier test instrument. The research results indicate that the percentage of misconceptions among students on the concepts of temperature and heat is highest in the sub-topic "Objects with higher temperature definitely have more heat content compared to objects with lower temperature," reaching 62.1%, and the lowest misconception in the sub-topic "Water at a temperature of 0°C has entirely turned into ice," reaching 40.6%. It is hoped that these findings can be utilized by lecturers and teachers in addressing the subtopic of heat and temperature, which is known to have many possible misconceptions. As a result, educators can employ effective instructional strategies to address their students' misunderstandings about heat and temperature

Keywords: Misconception, College Students, Heat and temperature, Indonesia

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1. INTRODUCTION

Students' Understanding of Scientific Phenomena has garnered the attention of science education researchers in recent years. Researchers concur that students bring certain concepts and ideas into the classroom through their ways of thinking, but the ideas brought by students are not always consistent with those of scientists (Garba Shehu, 2015; Mubarokah et al., 2018). Students whose concepts align with those of scientists will strengthen their understanding, while those with differing concepts may harbor misconceptions and tend to be resistant to scientific information they have encountered (Foroushani, 2019; Yildirim et al., 2021).

One condition that needs to be considered in the teaching and learning of physics is the occurrence of misconceptions among prospective teacher students (Bani-salameh, 2018; Halim & Huda, 2020). Prospective physics teacher students must understand the basic concepts before teaching them to their students. If prospective teacher students experience misconceptions, then the students they teach may also experience misconceptions (Hermita et al., 2018; Yuliana et al., 2020). Prospective teacher students may experience misconceptions because the concepts they learn are abstract (Sukarelawan & Rahman, 2019). This results in prospective teacher students who score low in physics learning often not understanding the basic concepts taught by instructors. This indicates that prospective teacher students do not understand physics concepts well. Prospective teacher students do not understand concepts because they misunderstand them or do not understand them correctly (Akcanca & Cerrah Özsevgeç, 2020; Gerhátová et al., 2021; Rosdiana & Kholiq, 2021). This can also be caused by students not understanding the material. The more misunderstandings there are about a concept, the more misconceptions students have, making it increasingly difficult to make changes, especially in the context of physics learning (You et al., 2019). Identifying misconceptions becomes crucial because misconceptions can hinder the physics learning process and have long-term impacts on the students' thinking.

Misconceptions in the field of physics occur across various topics including: temperature and heat concepts (Gürses et al., 2022; Santhalia et al., 2020; You et al., 2019); electrical circuits (Halim et al., 2019; Maison; Hidayat, M; Kurniawan, Dwi Agus; Yolviansyah, Fauziah; Sandra, 2022); impulse and momentum (Samsudin et al., 2015; Triyani et al., 2019); fluids (Halim et al., 2020; Saputra et al., 2023); as well as power and energy (Andriyani Saputri, 2021; Liu & Fang, 2017). However, the most common misconceptions occur in the concepts of temperature and heat (Gürses et al., 2022; Irsyad et al., 2018; Linuwih et al., 2022; Mujib, 2020; You et al., 2019). To address this, tools for identifying misconceptions are required [37]. There are many tools available, such as diagnostic tests. These diagnostic tests are highly efficient in identifying misconceptions. With these diagnostic tests, researchers can quickly identify misconceptions occurring in students compared to other methods. Additionally, a large amount of data has been collected regarding university students' misunderstanding errors related to diagnostic tests.

The diagnostic test used is in the form of Multiple Choice Tests (MCT) that can be used in various ways. There are two-tier MCTs (Appiah-twumasi, 2021; Trudel, Louis; Métioui, 2021); three-tier MCTs (Ekawati et al., 2021; Sari et al., 2020; Suliyanah et al., 2018); and four-tier MCTs (Budi Bhakti et al., 2022; Muchamad et al., 2019). Two-tier and three-tier MCTs can identify misconceptions, but both have limitations. Two-tier MCTs are more inclined to unearth student misconceptions but do not reveal their confidence in the given answers (Trudel, Louis; Métioui, 2021). Additionally, the frequently used three-tier MCTs have many limitations as they assess student confidence at the first level, and at the third level, do not reveal students' confidence in their chosen reasons (Akcanca & Cerrah Özsevgeç, 2020; Ekawati et al., 2021). This also leads to two main problems, including not

considering the aspect of ignorance and not considering students who may guess. Meanwhile, four-tier MCTs can address the weaknesses of two-tier and three-tier MCTs. Four-tier MCTs have many advantages, including improving students' conceptual understanding because there is confidence in the reasons respondents can choose, being more specific in diagnosing student misconceptions, serving as a reference for understanding students' deep understanding, and for determining the learning actions educators will apply in class to reduce misconceptions among students (Topik et al., 2019).

In this study, researchers will identify misconceptions among prospective teacher students on the topic of temperature and heat using a four-tier test. The aim of this research is to serve as a reference for teachers, lecturers, and other researchers in identifying which sub-topics are the main points of misconception in the subject of temperature and heat.

2. METHOD

The purpose of this study is to identify misconceptions occurring among first-year prospective teacher students on the concepts of temperature and heat. This research employs a descriptive study design aimed at obtaining a general overview of the misconceptions experienced by first-year prospective teacher students regarding the concepts of temperature and heat. The study was conducted from March 2023 to April 2023, using a Google Form distributed to several public and private universities in the cities of Singkawang, Bima, Madiun, Sumedang Regency, Sintang Regency, and Bandung Regency, involving a sample of 224 first-year students. The sampling method utilized was random sampling. By randomly selecting samples, researchers can ensure that various types of misconceptions that may exist among students are represented in the sample.

The instrument used in this study is the four-tier test. This test is employed to investigate the existing misconceptions among students. The test was distributed via Google Form to several universities. The four-tier test consists of four levels. The first level comprises multiple-choice questions with four answer choices. The second level indicates the respondents' confidence level in their chosen answers. The third level contains the reasons for the answers. The fourth level involves the respondents' confidence in the reasons they selected. The analysis of misconception distribution among respondents is based on the answer decision categories. This decision is based on the scientific argument that students who understand a concept incorrectly, whether in part or as a whole, are still considered to have misconceptions. The results of the four-tier test decisions are adapted from (Muliyani & Kurniawan, 2021) and presented in Table 1.

Tabel 1. Four-Tier Test Decision

Tier-1	Tier-2	Tier-3	Tier-4	Decision
True	Sure	True	Sure	Scientific Conception
True	Not Sure	True	Not Sure	Lucky guess
Wrong	Not Sure	True	Not Sure	Guess
True	Not Sure	Wrong	Not Sure	Guess
Wrong	Not Sure	True	Sure	Guess
True	Not Sure	True	Not Sure	Lack of Knowledge
True	Not Sure	True	Sure	Lack of Knowledge
True	Not Sure	Wrong	Not Sure	Lack of Knowledge
Wrong	Not Sure	Wrong	Not Sure	No Understanding
Wrong	Sure	True	Sure	Misconception
Wrong	Sure	True	Not Sure	Misconception

Tier-1	Tier-2	Tier-3	Tier-4	Decision
Wrong	Sure	Wrong	Sure	Misconception
Wrong	Sure	Wrong	Not Sure	Misconception
Wrong	Not Sure	Wrong	Sure	Misconception
True	Sure	Wrong	Sure	Misconception
True	Not Sure	Wrong	Sure	Misconception

3. RESULT AND DISCUSSION

The four-tier test can indicate the level of misconceptions among students regarding the concepts of temperature and heat. The misconceptions experienced by students are processed based on the categorization in Table 1. The data analyzed include responses from 224 first-year prospective teacher students on the topic of temperature and heat. Table 2 shows the number of prospective teacher students who experience misconceptions regarding the concepts of temperature and heat.

Tabel 2. The Number of Students Experiencing Misconceptions on the Concepts of Temperature and Heat

Misconceptions	Number of Students	Student Percentage (%)
The object that feels colder to the touch must have a lower temperature than the object that feels warm when touched	131	58,5
The object with a higher temperature surely contains more heat compared to an object with a lower temperature	139	62,1
An object that more easily increases its temperature when heated will be more difficult to decrease in temperature when cooled	106	47,3
Water at a temperature of 0°C has completely turned into ice	91	40,6
The temperature will continue to rise as long as the fire keeps burning while boiling	141	63
The thickness and thinness of an object affect the amount of heat absorbed	121	54
When two objects are heated evenly, the temperature of the object with a larger mass will increase more	122	54,4
The ocean and the sand on the beach are both exposed to sunlight, and they will definitely have the same temperature	102	45,5

Based on Table 2, it is evident that students still experience misconceptions regarding the concepts of temperature and heat, although the percentage of students experiencing misconceptions varies. The highest percentage of students experiencing misconceptions is in the sub-topic 'The object with a higher temperature surely contains more heat compared to an object with a lower temperature,' with 139 students (62.1%). The lowest percentage of students experiencing misconceptions is in the sub-topic 'Water at a temperature of 0°C has completely turned into ice,' with 91 students (40.6%)."

The causes of misconceptions can vary and be complex, involving a number of factors contributing to the misunderstanding of a concept. One of the main causes is everyday experiences that contradict the scientific concepts taught in class (Hermita et al., 2018; Saparni, Syuhendri, 2021; Ültay et al., 2021). Additionally, the learning process in the classroom is one of the factors contributing to misconceptions (Alfiana, R, Parno, Yogihati, 2021; Erceg et al., 2019; Hermita et al., 2018).

After students attend lessons in the classroom, misconceptions can also arise. Misconceptions created by schools are referred to as school-made misconceptions (Barke & Büchter, 2023; Garba Shehu, 2015; Mubarokah et al., 2018). Instructors with good conceptual knowledge but insufficient selection of teaching methods can also lead to misconceptions (Karabulut & Bayraktar, 2018; Linuwih et al., 2022). This is an additional factor contributing to misconception resistance. The teaching process in some universities still focuses on completing the material but lacks focus on the quality of teaching provided to students. This can also reinforce or perpetuate student misconceptions.

Students' continued inability to modify their understanding they still have a tendency to retain and memorize previously learned material is another factor contributing to their misconceptions (Gómez et al., 2020; Rohmah & Fadly, 2021). This is in line with research that shows misconceptions can be resilient, which means that even when students are exposed to logical reasoning in the form of experiments or direct observations to highlight their conceptual errors, it can be challenging to transform their preconceived notions into scientific concepts (Erceg et al., 2019; Oral & Gök, 2021; Colburn et al., 2018; Haryano, 2021).

The concepts of temperature and heat are abstract, so the learning process should utilize visual aids to make abstract concepts tangible (Ning & Chongo, 2023; Sari et al., 2020). Additionally, it is crucial to provide a learning approach that allows students to consider these concepts comprehensively and apply what they know in real and relevant situations (Bani-salameh & Jelovica, 2018). Moreover, students often analogize one event to another. In fact, the similarity of phenomena in daily life involves different sets of concepts, but they still fall under the same general concept. Therefore, analogizing every event like this can lead to misconceptions that can persist in students' minds for a long time.

4. CONCLUSION

Based on the findings, it is evident that the number of students experiencing misconceptions varies across each sub-topic of temperature and heat. The most prevalent misconception is in the sub-topic "The object with a higher temperature surely contains more heat compared to an object with a lower temperature." Several causes of misconceptions include everyday experiences conflicting with scientific concepts, inaccuracies in using teaching strategies, and insufficient depth of conceptual understanding. Therefore, educators should be careful to provide more detailed explanations about certain sub-topics and improve students' understanding of heat and temperature. Meanwhile, instructors should explore appropriate teaching strategies for various conceptual designs, laboratories, and educational technologies that can be used to make learning more engaging.

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