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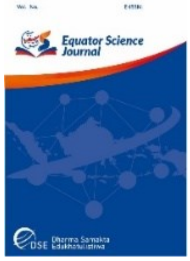

Identification of Misconceptions about Substance Pressure in Junior High School Students using the Three-Tier Diagnostic Test

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ABSTRACT
This study aims to identify and analyze the misconceptions experienced by junior high school students regarding the material on pressure in substances, understand in depth the misunderstandings that arise among students, and explore the reasons behind these erroneous understandings. Using the Three Tier Test Diagnostic instrument accompanied by CRI, this study seeks to provide a clear picture of students' level of understanding of the concept of pressure and to develop effective learning strategies to address these misconceptions. The method used is qualitative descriptive, as this study aims to describe the misconceptions experienced by students, understand students' misconceptions in depth and comprehensively, and explore the reasons behind students' misunderstandings regarding the material on pressure in substances. This study uses a direct survey method with a sample of 30 ninth-grade students from two different schools. Of the 30 students, 7 were male, and 23 were female. The data collection technique in this study employs three-tier diagnostic tests. The test technique consists of 15 multiple-choice questions accompanied by instructions on how to answer the questions. The results of this study show that 59% of students had misconceptions about pressure, 15% of students understood the concept well, 3% of students did not understand the concept but were unsure, and 23% of students did not know the concept.

INTRODUCTION

Education is a conscious and organized effort to create an environment and learning process that supports students in actively developing their potential, including spiritual strength, religious commitment, discipline, character building, moral intelligence, noble values, and practical skills (Wugaje *et al.,* 2023). The education system needs to adapt to the evolving dynamics of national life, especially in responding to changes across various sectors amid the challenges of globalization. Therefore, education must be designed to prepare individuals to compete and contribute effectively in a global society (Syukur *et al*., 2025). Learning is essentially a cognitive process that cannot be directly seen. The internal transformations that take place during learning may not be outwardly visible, but they can be recognized through noticeable changes in behavior. It plays a vital role in shaping a person's knowledge and character, as behavioral shifts contribute to accomplishments that enhance human life. Therefore, learning requires personal engagement to bring about meaningful behavioral changes through interactions with the surrounding environment (Djafar *et al.,* 2024).

Science education has been introduced from an early age, though at each educational level it involves different stages and learning approaches. At the high school level, science is divided into subjects such as Physics, Biology, and Chemistry. Physics, in particular, is a discipline that significantly contributes to technological advancement. In daily life, we constantly engage with our physical and natural surroundings. This aligns with the idea that physics is a field of knowledge that enhances reasoning and analytical abilities, enabling individuals to understand various phenomena in nature (Yuniar *et al.,* 2024). Science is a discipline concerned with the mastery of knowledge involving concepts, facts, principles, and theories that are explored scientifically through discoveries (Wulandari, 2015). In science education, particularly in physics, the emphasis is placed more on students' conceptual understanding rather than their memorization abilities, as physics includes scientific concepts and phenomena that are closely connected to everyday life (Muawanah et al., 2025). States that natural science is a branch of science that studies and teacher various concepts, facts, principles, and theories obtained through a systematic process of scientific inquiry and discovery (Andriani *et al.,* 2021). Natural Science is material studied in junior high school. This is in accordance with Law Number 20 of 2003 concerning the national education system, namely science is a compulsory subject taught at the primary to secondary education level (Rizkika *et al.,* 2022).

The nature of science is a core component of scientific literacy. It involves understanding how scientific knowledge is formed and how scientific processes work, helping individuals think critically and make informed decisions (Djafar *et al.,* 2024). Physics is a branch of science that studies the properties and behavior of matter and energy, as well as the interactions between the two. This science focuses on understanding natural phenomena through observation, experimentation and mathematical analysis. Understanding physics requires mastering concepts that are in line with the thinking of scientists (Monaliata *et al.,* 2023). Physics includes various basic concepts such as mass, force, energy, and momentum, as well as tested laws, such as Newton's Laws and the Laws of Thermodynamics. Using the scientific method, physicists test hypotheses and theories to draw valid conclusions. Knowledge of physics is essential in various fields, including engineering, medicine, and information technology, because physical principles are used in machine design, development of electronic devices, and understanding natural phenomena (Suprapto, 2020). In addition, physics often interacts with other disciplines, such as chemistry and biology, and has an important role in education, providing students with critical thinking and problem-solving skills. Overall, physics is a fundamental science that helps us understand the world around us and contributes to technological and scientific progress (Entino *et al.,* 2021).

Pressure is one of the physics concepts that is very relevant in everyday life. The material of substance pressure is divided into three types, namely pressure in solids, liquids, and gases (Eriyanti et al., 2021). Understanding pressure is important for students because it is the basis for learning advanced concepts, such as hydrostatic pressure, Pascal's law, and Archimedes' law. Many students have difficulty in understanding the material of substance pressure, which leads to misconceptions. However, the concept of pressure is very important to understand. Lack of understanding of this concept can have an impact on students' understanding of other related materials, such as reaction rates and blood pressure (Nisa' *et al*., 2022). For example, some students have a wrong understanding of the difference between objects that float, sink, and float. They assume that the pressure in a liquid is always the same and is not affected by the depth or density of the liquid. In addition, students also think that the greater the density of the liquid, the smaller the pressure will be. There is also the misconception that objects with the same mass will be in the same position in the liquid. In addition, some students assume that by increasing the amount of substance, the density will also increas (E. Sari *et al.,* 2022).

Misconception is a form of misunderstanding that students have of a concept, so that their understanding differs from the view agreed upon by experts. These errors usually arise when students are building cognitive abilities, but fail to realize that the concepts they understand are actually wrong. According to the constructivist view, many misconceptions and beliefs are formed in childhood. Osborne (1983) observed that many elementary school students who have not formally studied the concept of electricity have the erroneous assumption that the electric current will decrease after passing through a light bulb. Based on this view, the incoming current is considered greater than the outgoing current from the lamp. Misconceptions are described as cognitive structures or frameworks that are deeply rooted in the minds of students, but do not match the views of experts. These misconceptions can become obstacles in understanding scientific phenomena and lead to errors in their application. Before teachers can help students overcome misconceptions, they need to first understand the nature and form of these misconceptions. Some methods to identify misconceptions include the use of concept maps, multiple-choice tests with open-ended reasoning, essay questions, diagnostic interviews, and classroom discussions. Detection of misconceptions about a material can be done through diagnostic assessment (Linawati *et al.,* 2025). Misconception is different from not understanding a concept. However, students' lack of understanding of a concept can trigger the emergence of misconceptions (Nisa' *et al.,* 2022).

Misconception refers to an understanding that is not in line with scientific concepts or views recognized by experts in the field. Misconceptions refer to students' inaccurate understanding of a concept that deviates from scientifically accepted explanations, often due to a lack of knowledge. misconceptions arise from misunderstandings and are inconsistent with correct scientific concepts. states that misconceptions can lead to difficulties in connecting related concepts, which in turn may affect students' learning outcomes. Misconceptions can take several forms, including errors in prior knowledge, incorrect associations between different concepts, and flawed ideas (Mu'arikha & Qomariyah, 2021). Not understanding the concept means that students understand the concept with confidence, but their understanding deviates from its true meaning. In addition, it is important to know that misconceptions are not errors caused by students' lack of knowledge (Nurhidayatulah & Prodjosantoso, 2018). A misconception is an incorrect or incomplete understanding of a concept. If a student has a misconception, the concept they know is less precise and deviates from the meaning given by experts, but the concept is correct for themselves. Misconceptions are not simply errors or lack of knowledge. A misconception is an imperfect or misguided understanding. Students who experience misconceptions usually feel confident that their understanding is correct, even though it actually deviates from the actual scientific concept. Therefore, even though it is not in accordance with the correct knowledge, the concept is still believed by students and used in their thinking (Putro *et al.,* 2019).

Understanding physics requires mastery of concepts that are in accordance with the views of scientists. This proper understanding is essential to prevent misconceptions (Isnaini et al., 2024). Misconception refers to an understanding that is not in accordance with scientific concepts or the views of experts in the field. In general, the factors causing misconceptions can be divided into five main groups, namely students, teachers, textbooks, context, and teaching methods (Nurhidayatulah & Prodjosantoso, 2018). In general, understandings that differ from scientific concepts are referred to as misconceptions. Misconceptions in students not only appear before the learning process, but also often occur after teachers teach physics. If misconceptions continue, this can hinder students' understanding of subsequent concepts (Fitria, 2022). One of the misconceptions experienced by students in physics material is about substance pressure. Based on previous research, several forms of misconceptions were found in this material, such as students thinking that pressure is directly proportional to surface area. Students also think that the shape and surface area of the container can affect hydrostatic pressure, and students assume that the lower the place, the less air pressure (Namira *et al.,* 2022).

Misconceptions in students can be found at almost all levels of education, including junior high school (Entino et al., 2021). Overcoming misconceptions requires a special approach in learning, teachers not only need to provide correct information, but also must help students realize errors in their initial understanding and provide support so that they can correct the concepts they have formed. The learning process can help students to develop a more accurate and in-depth understanding in accordance with the correct scientific concepts (Putro et al., 2019). The misconception is a cognitive structure held by students that deviates from the correct scientific concept. Allen (2014) defines scientific misconceptions as knowledge formed through educational experiences or informal events that lack alignment with scientific meaning. Based on these definitions, it can be synthesized that misconception refer to an individual's knowledge that does not align with scientifically accurate concepts (Putri & Subekti, 2021).

The three-tier diagnostic test is an effective method to identify misconceptions experienced by students in various subject matters. Misconceptions tend to be resistant, or difficult to change, even after formal learning. This suggests that students who experience misconceptions often retain their misconceptions as true (Putri, Prastowo & Sanjaya, 2023). Three tier test is a type of test that consists of three levels. At the first level, questions are presented in the form of multiple choices, the second level asks test takers to provide reasons for the answers chosen, while the third level measures the level of confidence of participants in the answers that have been given (Arifin & Wulandari, 2024). This test enables students to discover the accuracy and rationale behind given information, allowing them to solve problems based on informed reasoning. The results of the three-tier test can also be used as a foundation for planning further instructional strategies. One area of physics where misconceptions are commonly found and can be effectively assessed using this method is the topic of vibrations, waves, and sound, as these are closely related to everyday experiences. Common misconceptions among students in this topic include: the concept of vibration (26.39%), the idea of sound slowing down in a medium (23.15%), and misunderstandings related to wave and thunder phenomena (Sari et al., 2024).

Diagnostic tests play a role in evaluating the extent of students' understanding of the acid and base concepts tested in the instrument. One form of diagnostic test that is effective for uncovering misconceptions is the three tier multiple choice. This test consists of three layers. The first layer is a standard multiple choices question, while the second layer explores students' conceptual understanding through the reasons given for the answer. The third layer evaluates the student's level of confidence in the answer. If the student is able to answer correctly and feels confident in his/her answer, then it can be concluded that he/she has a good understanding of the concept. Conversely, if the student answers incorrectly but remains confident, this indicates a misconception. Meanwhile, if students give wrong answers and are uncertain, this reflects that students do not understand the concept or still have limited knowledge of the material (Febrianti & Zainarti, 2025).

Understanding physics requires mastery of concepts that are in accordance with the views of scientists. This proper understanding is essential to prevent misconceptions. Misconception refers to an understanding that is not in accordance with scientific concepts or the views of experts in the field. The purpose of this article is to identify and analyze the misconceptions experienced by junior high school students regarding substance pressure material. Several articles found many misconceptions, especially the material of substance pressure in junior high school students, so research with the title Identification of Substance Pressure Misconceptions in Junior High School Students Using the Three-Tier Diagnostic Test was conducted to prove the percentage of misconceptions in junior high school students. This study aims to identify and understand in depth the various forms of misconceptions experienced by students, in this study a Three Tier Diagnostic Test instrument is used, which is designed to evaluate the level of mastery of the concept of pressure more comprehensively. Through this research, this study aims to provide a more detailed picture of the extent to which students understand the concept of pressure, as well as a basis for designing more effective learning strategies to correct and prevent misconceptions. With a more accurate understanding of the misconceptions that occur, it is hoped that the quality of physics learning can be improved and students can build a more scientific and precise understanding of the concept.

METHOD

This research was conducted in November 2024 in two private junior high schools in Bangkalan. The type of research used is descriptive qualitative research because this research aims to describe the misconceptions experienced by students, understand students' misconceptions in depth and comprehensively, and explore the reasons behind students' misconceptions about substance pressure material. The method used in this research is the direct survey method. The sample in this study used 30 grade 9 students from two different schools. The 30 students consisted of 7 male students and 23 female students. The data collection technique of this study used a three tier diagnostic test. The test technique was carried out with 15 multiple choice questions developed by Putri, Prastowo & Sanjaya (2023). The three-level diagnostic test instrument consists of three stages is the first stage includes multiple-choice questions, the second stage involves choosing the reason behind the chosen answer. Related to the choice of replacement questions, and the third stage is the level of self-confidence in the answers to questions and reasons equipped with CRI (Confidence Rating Index). The category of students' level of understanding of substance pressure material can be seen in Table 1.

Table 1. Modification of Student Comprehension Level Categories

Answers	Reason	CRI Value	Decription	Code
Correct	Correct	> 2,5	Understand the Concept	UC
Correct	Correct	< 2,5	Understand the Concept Less Sure	UCLS
Correct	False	> 2,5	Misconception	M
Correct	False	< 2,5	Don't Know the Concept	DKC
False	Correct	> 2,5	Misconception	M
False	Correct	< 2,5	Don't Know the Concept	DKC
False	False	> 2,5	Misconception	M
False	False	< 2,5	Don't Know the Concept	DKC

RESULTS AND DISCUSSIONS

The results of data analysis regarding misconceptions using the Three Tier Diagnostic Test on substance pressure material can be seen in Figure 1.

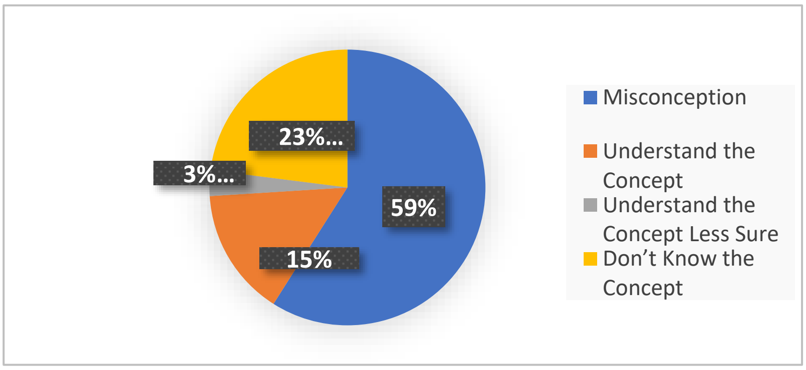

Fig 1. Percentage of Three-Tier Test Results

Figure 1 shows that of the 30 students used for observation, students had misconceptions about the pressure of substances by 59%, students understood the concept well by 15%, students did not understand the concept but were less sure by 3%, and students did not know the concept by 23%. Based on the data in Figure 1, it shows that misconceptions that occur in students in the material of substance pressure tend to be high. Students have received substance pressure material before at school, students still need a re-explanation. Students who experience misconceptions and are not considered by the teacher, resulting in students' misunderstanding of a concept will increase so that students are less able to answer the questions given and ultimately have an impact on the low learning outcomes (Mukhlisa, 2021). Misconceptions about the material can occur to anyone without exception, whether from individuals, students, teachers, or even at the teacher level. In accordance with previous research, it is stated that students' misconceptions about the pressure of substances tend to be high and resistant (Suprapto, 2020).

After observing students during the learning process, a written test was conducted using the Three Tier Diagnostic Test instrument equipped with Certainty Response Index (CRI). This instrument is designed to diagnose students' level of understanding and potential misconceptions in depth. The written test consists of 16 questions, where each question has three interrelated tiers. The first tier (tier 1) was in the form of conventional multiple-choice questions, where students were asked to choose the answer that was considered correct. The second tier (tier 2) contained a choice of reasons that supported the student's answer in tier 1. In addition, at this level students were also asked to fill in the CRI index, which measured the level of confidence students had in their answers in tier 1 and tier 2. The third tier (tier 3) contains statements of students' overall beliefs in answering questions, which provides an overview of the students' subjective level of confidence in their knowledge. Based on the results of the written tests conducted, there were indications of misconceptions among students in all sub-concepts in the partial salt hydrolysis sub-matter.

The results of the analysis show that students tend to have an inaccurate understanding of basic concepts related to salt hydrolysis, such as the relationship between acids and conjugate bases, the nature of salt solutions, and the effect of hydrolysis on solution pH. In addition, students' high level of confidence in their wrong answers also indicates strong misconceptions, requiring more effective learning interventions to improve their understanding. The Three Tier Diagnostic Test instrument equipped with CRI is not only able to identify correct or incorrect answers, but also detect the reasons behind students' errors as well as their level of confidence in the answers given. Thus, this tool provides more comprehensive information about students' understanding patterns and misconceptions. The percentage of students' degree of understanding of each sub-concept in partial salt hydrolysis can be seen in detail in Table 2, which provides a clearer picture of which areas require special After observing students during the learning process, a written test was conducted using the Three Tier Diagnostic Test instrument equipped with Certainty Response Index (CRI). This instrument is designed to diagnose students' level of understanding and potential misconceptions in depth. The written test consists of 16 questions, where each question has three interrelated tiers. The first tier (tier 1) was in the form of conventional multiple-choice questions, where students were asked to choose the answer that was considered correct.

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Table 2. Percentage of students' degree of understanding per sub-concept

Sub Concept	Question Number	Degree of Understanding (%)			
		UC	UCLS	M	DKC
Solid Pressure	1	0	3	77	20
Gas Pressure	2, 3	17	2	65	17
Hydrostatic Pressure	4,7,8, 10	17	3	65	16
Archimedes Pressure	9	47	10	37	6
Pascal's Law	5,6, 11, 13, 15	4	1	53	42

The question sheet used for observation of misconceptions of substance pressure material in junior high school students using the Three-Tier Diagnostic Test consists of 15 questions which are divided into several sub-concepts in it as in Table 2. The sub-concepts contained in the questions include: solid pressure in question number 1; gas pressure in numbers 2 and 3; hydrostatic pressure in numbers 4, 7, 8, and 10; Archimedes' pressure in number 9; and also Pascal's law in question numbers 5, 6, 11, 13, and 15. In the sub-concept of solid pressure, students who Understand the Concept (UC) are 0%, Understand the Concept Less Sure (UCLS) 3%, experience Misconception (M) 77%, and Don't Know the Concept (DKC) 20%. For gas pressure, students who understood the concept (UC) 0%, understood the concept less confidently (PKKY) 2%, had misconceptions (M) 65%, and did not know the concept (TTK) 33%. For hydrostatic pressure, students who understood the concept (PK) were 17%, less sure of the concept (PKKY) were 3%, misconceptions (M) were 65%, and did not know the concept (TTK) were 16%. In Archimedes' pressure, students who understood the concept (PK) were 10%, understand the concept less sure (UCLS) 37%, M 37%, and DKC 16% while Pascal's law, students who understood the concept (UC) were 4%, understand the concept less sure (UCLS) 1%, misconceptions (M) 53%, and don't know the concept (DKC) 42%. The test was designed to measure students' level of understanding of the tested sub-concepts, namely solid pressure, gas pressure, hydrostatic pressure, Archimedes' pressure, and Pascal's law. The data showed that the percentage of misconceptions was still quite high in almost all sub-concepts, especially solid pressure and gas pressure. This emphasizes the importance of remedial learning to overcome misconceptions and improve students' concept understanding.

Misconceptions in the questions show that there are still misunderstandings in some questions. In question number 4, 26 students had misconceptions related to hydrostatic pressure material, especially in explaining the pressure at various points in a liquid. Many students often misunderstand the concept of hydrostatic pressure, where they assume that the factors that affect this pressure are the size and shape of the container, not the depth of the object submerged in the liquid. This misunderstanding makes them unaware that hydrostatic pressure actually increases as the depth of the object in the liquid increases. They tend to attribute the pressure to the characteristics of the container, whereas the main factor that determines the amount of hydrostatic pressure is the depth of the object in the liquid (Mustikasari *et al*., 2017). Meanwhile, in question number 1, 23 students also experienced conceptual errors in understanding solid pressure, which discusses the pressure generated by blocks with different cross-sectional areas. Many students misunderstood the relationship between surface area and pressure. They often assume that the larger the surface area of an object, the greater the pressure. In fact, this understanding is wrong. Pressure, by definition, is the force applied to a given area. In other words, pressure is calculated as force per unit area. Therefore, if the surface area of an object increases, but the applied force remains the same, the resulting pressure will actually be smaller. This shows that pressure is inversely proportional to surface area when the force remains constant (Mustikasari *et al*., 2017).

Misconceptions were also found in question number 2, which discussed gas pressure, especially the phenomenon of using straws involving differences in air pressure. In addition, in questions number 5 and 6, which are both related to Pascal's law, there were 21 students each who did not understand the concept. According to Asaefullah et al. in 2023, there are several common misconceptions related to Pascal's law, including: (1) pressure is considered directly proportional to the cross-sectional area, and

(2) the force acting on the cross-sectional area is considered to be transmitted in all directions with the same magnitude. According to Asaefullah et al. in 2023, there are three main steps that can be used to overcome misconceptions, namely: (1) identify or reveal the misconceptions that students have, (2) find the cause of the misconception, and (3) design appropriate actions to overcome it (Asaefullah *et al.,* 2023).

In this research, the first step is done by using instruments that can identify students' misconceptions. One way is by giving questions in a test instrument, which can help reveal errors in students' concept understanding. Therefore, this misconception problem needs to be a concern in the world of education so that students' erroneous conceptions can be overcome according to their respective problems. Problem number 5 discusses Pascal's principle in the context of pressure in a closed system, while problem number 6 relates to lifting using a hydraulic machine based on the principle of pressure. Finally, in question number 12, 17 students did not understand the concept of applying Pascal's law in a closed system. The overall data shows that students' understanding of pressure material, both in liquid, gas, and its application in Pascal's law, still needs to be improved with a more effective learning approach. Students often have difficulty connecting new knowledge with prior knowledge, which makes it difficult for them to understand the application of concepts such as Pascal's Law in real life. This misunderstanding is exacerbated by learning methods that are less innovative and do not involve students actively, so their understanding of the material becomes shallow. Research shows the need for more effective learning strategies to improve student understanding. In addition, each student's different personal experience and way of thinking can hinder the acceptance of the correct explanation if they have already formed an initial misconception (Asaefullah *et al.,* 2023).

CONCLUSION AND SUGGESTION

Based on the research involving 30 students from two private junior high schools in Bangkalan City, it can be concluded that the Three Tier Diagnostic Test is effectively used to identify misconceptions in substance pressure material. The results showed that students experienced many misconceptions in the sub-concepts of solid pressure, gas pressure, hydrostatic pressure, and Pascal’s Law. However, students’ understanding of Archimedes’ Law is better than the other sub-concepts, which indicates the need for more effective learning strategies on sub-concepts with high levels of misconceptions to improve students’ overall understanding.

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