



Concept Understanding Level of Junior High School Students on Substance Pressure Material

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Abstrak

Rendahnya pemahaman konsep pada siswa dapat mengakibatkan siswa mengalami kesulitan dalam mempelajari materi tertentu. Untuk mengatasi hal tersebut, maka diperlukan identifikasi pemahaman konsep pada siswa menggunakan metode yang tepat. Penelitian ini bertujuan untuk menganalisis tingkat pemahaman konsep siswa menggunakan metode five tier test pada materi tekanan zat. Penelitian ini menggunakan pendekatan kuantitatif dengan jenis penelitian survei. Subjek dalam penelitian ini yaitu siswa kelas VIII dan IX yang berjumlah 716 siswa. Sampel yang digunakan adalah siswa yang telah menerima materi tekanan zat yang terdiri dari 258 siswa. Instrumen yang digunakan adalah five tier test. Berdasarkan hasil penelitian dapat diketahui bahwa persentase pemahaman konsep siswa tiap indikator dan subkonsep tekanan zat sebesar 16%, sehingga dapat disimpulkan bahwa tingkat pemahaman konsep tekanan zat pada siswa menggunakan metode five tier test termasuk dalam kriteria rendah. Penelitian selanjutnya diharapkan dapat mengembangkan kembali penelitian ini, sehingga nantinya dapat digunakan sebagai acuan guru dalam menentukan strategi pembelajaran yang tepat untuk meningkatkan pemahaman konsep siswa mengenai tekanan zat.

Kata Kunci: Pemahaman Konsep, Tekanan Zat, Five Tier Test.

Abstract

Low concept understanding on students can cause students to experience difficulties in learning certain materials. To overcome this, it is necessary to identify understanding of the concept in students using the right method. This research aims to analyze the level of students' concept understanding using the five tier test method on substance pressure material. This research uses a quantitative approach with a survey type of research. The subjects in this research were students in 8th and 9th grade totalling 716 students. The sample used was students who had received substance pressure material consisting of 258 students. The instrument used a five tier test. Based on the results of the research, it can be seen that the percentage of understanding of the concept of the students for each indicator and sub concept of substance pressure is 16%, so it can be concluded that the level of understanding of the concept of substance pressure in students using the five-tier test method is included in the low criteria. Future research is expected to develop this research again, so that later it can be used as a reference for teachers in determining the right learning strategy to improve students' understanding of the concept of substance pressure.

Keywords: Concept Understanding, Substance Pressure, Five Tier Test.

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1. INTRODUCTION

Concept understanding of students is possible to be different. Students who come to school to learn are not a "blank paper", basically they already have prior knowledge (preconceptions) before participating in learning under the guidance of the teacher (Hidayatullah et al., 2020; Kampourakis, 2016). In fact, the students' preconceptions are either in accordance or not in accordance with the actual theory. This phenomenon underlies an initial concept in students. This depends on how students understand the learning that has been delivered by the teacher. Understanding the concept is very important, because it will be easier for students to learn other things related to the learning that has been taught by the teacher (Aen & Kuswendi, 2020; Putra et al., 2018; Susanti et al., 2021). Students' low concept understanding is characterized by students not understanding the meaning, definition, and reasoning of parts of knowledge that are related to each other (Kartikasari & Nuryasana,

2022; Sadiqin et al., 2017). Students who are smart and skilled in solving problems, do not necessarily have a good understanding of concepts, because when solving problems, students often only memorize material without understanding the concept to find a solution to a problem. Concept understanding is needed by students in all the subjects, especially on Natural Science. Science is one of the subjects that must be given and studied by students in junior high school. Mastery of some knowledge about facts, concepts, and principles regarding events that occur in the universe is related to science learning (Dede et al., 2018; Febriyana et al., 2021). Science consists of several disciplines such as chemistry, physics, biology, and IPBA. In learning science, especially in physics, students are expected to be able to understand concepts deeply and be able to implement these concepts in solving a problem (Shalihah et al., 2016; Sujarwanto, 2019). The problem that often occurs in schools is that students often lack understanding of concepts even though learning has been delivered by teachers, especially in science learning, especially in physics. This is in accordance with research conducted that state physical science does use a lot of causal relationships interpreted in mathematical equations which may be the cause of students' lack of understanding of concepts and errors in interpreting the concepts that have been taught (Azizah et al., 2020; Salma et al., 2016). Concept understanding in students can be known from the level of understanding when students are given a certain assessment.

The level of understanding of students' concepts can be known through assessments conducted by teachers, but often teachers only use the final assessment using multiple choice questions and essay tests to determine students' understanding of concepts. The use of multiple choice tests is not effective, because it cannot determine the level of understanding of basic concepts in students (Irianti, 2021; Suryani et al., 2016). The use of essay tests is also not effective because in identifying student understanding, it takes a long time, even though there are time constraints in teaching. One way that can be applied to determine the level of understanding of student concepts is through diagnostic tests that are tested on students (Annisa et al., 2019; Widiyatmoko & Shimizu, 2018). The type of diagnostic test that can be used to determine the level of understanding of concepts in students is the five tier diagnostic test. The diagnostic test is a diagnostic test modified from the four tier test. The five tier test instrument consists of five tiers, where the first tier is conceptual questions which include multiple choice questions, the second tier is in the form of students' confidence in their ability to answer multiple choice questions, the third tier is in the form of reasons underlying the answers to questions in multiple choices, the four tier is in the form of students' confidence in their ability to answer reasons, and the five tier is in the form of students' confidence in the correlation (relationship) between multiple choice answers and reasons that have been chosen (Setiawan & Jaelani, 2021; Siswaningsih et al., 2015).

There are several advantages of using the five tier test when compared to the three tier test and the four tier test. There are several advantages of using a five tier test when compared to a three tier test or four tier test. In the three tier diagnostic test in determining multiple choice answers and reasons, students can only choose a single belief in choosing between multiple choice questions or reasons (Hermita et al., 2017; Yuberti et al., 2020). If students have unequal beliefs in choosing answers to multiple choice questions and reasons, then this single level of belief cannot determine student confidence in the multiple choice answers and reasons that have been answered. In the four tier diagnostic test, there is no choice of belief in the existence of a causal relationship between multiple choice answers and reasons for answers. When students choose an answer reason, they often only feel confident that the answer reason is correct, but students are not sure if there is a causal relationship between the answer and the answer reason that has been determined (Dirman et al., 2022; Setiawan & Jaelani, 2021). So, the five tier test method is better for use in identifying concept understanding in students. Based on that, the researchers conducted interviews and

documentation studies on science teachers at SMPN 1 Beji, where based on the results of these interviews it can be known that the test method for understanding science concepts used by science teachers at SMPN 1 Beji is in the form of multiple choice tests and essays that are examined during tests. The use of multiple choice tests and essays cannot know for sure whether students understand the concept or do not understand the concept, so they do not know the parts where students experience misconceptions, and others. In fact, students often just guess in answering questions without knowing the reasons for choosing answers. When learning about substance pressure, students do not respond to the learning taught by the teacher. Students only memorize material such as memorizing mathematical formulas on substance pressure, but when given problem solving problems, students experience problems in solving problems so that it is difficult to apply the concepts of substance pressure that have been learned. Based on the initial study of concept understanding tests tested on students, it was found that there were still many student scores that did not fulfill the Minimum Completion Criteria. Student learning results in the form of understanding concepts that are not complete or do not exceed the Minimum Completion Criteria are 92%, so there are allegations of difficulties in understanding science concepts. Based on that, an appropriate instrument is needed to diagnose students' understanding of concepts such as the use of a five tier test instrument.

Based on research by previous study it shows that the concept understanding of junior high school students on the subject of Archimedes' Law is still relatively low (Ningrum, F.S.; Linuwih, 2015). The test of students' concept understanding used essay tests and interviews, without using reasoned diagnostic tests. Furthermore, research on concept understanding conducted by other study shows that the concept understanding of high school students on static fluid material is classified in a low category with a percentage of concept understanding of 14% (Rizkiyati, 2018). The concept understanding was tested using a four tier test instrument. Research on concept understanding conducted by other study showed that high school students' concept understanding on harmonic vibration material was still classified as moderate with a percentage of concept understanding of 51.8%, where the instrument used still used multiple choice questions (Riwanto et al., 2019). Based on previous research and the results of observations regarding students' understanding of concepts, the purpose of this research is to analyze the level understanding of students' concepts using the five tier test method on the material of substance pressure, where this research is designed to help students identify the level understanding of concepts on the material of substance pressure, besides that it can also help teachers in knowing the understanding of concepts in students. For future researchers, it is hoped that this research can be used as a references.

2. METHODS

This research uses a quantitative approach with a survey research type. The design of the survey research used is a cross sectional survey design, where the researcher collects data at a predetermined time to describe the sample conditions (Creswell, JW; Poth, 2017). The survey technique can be used in measuring the behavior of several populations through samples regarding students' concept understanding as a variable in this study. The subjects of this research were all students in 8th and 9th grade at SMPN 1 Beji in the 2022/2023 school year totaling 716 students. The sample in this research were students in 8th and 9th grade at SMPN 1 Beji in the 2022/2023 school year totaling 258 students. The sample selection was adjusted using purposive sampling technique. The criteria and considerations for sampling in this research are that the students selected as samples are students who have received lessons on substance pressure.

The data collection technique carried out in the form of tests tested to students. The instrument used was a written test of students' concept understanding in the form of a five tier multiple choice test consisting of 20 questions. The first tier is in the form of multiple choice questions, the second tier is in the form of confidence in the selection of multiple choice questions. The third tier is the reason for choosing the answer to the multiple choice question. The fourth tier is confidence in the selection of reasons. The fifth tier is a choice of correlation (relationship) between multiple choice questions and reasons (Setiawan & Jaelani, 2021). The instrument test was carried out with an expert validity test.

The results of the five tier diagnostic test were analyze on the basis of the answers chosen by students on each question tested. The percentage of each student's level understanding of the concept on substance pressure can be calculated using the percentage formula for the ratio of the number of questions answered with the criteria of understanding the concept to the number of five tier diagnostic test questions tested. Then to find out the level of understanding of the concept of all students can be known through the percentage formula for comparing the number of students who are classified as understanding the concept criteria with the total of students (Kurniawan, 2018). If these calculations have been carried out, the next thing to categorize the level of understanding of student concepts according to Table 1.

Table 1. Criteria for Students' Concept Understanding

Percentage Range of Concept Understanding	Concept Understanding Criteria
$0\% < \text{Concept understanding} \leq 30\%$	Low
$30\% < \text{Concept understanding} \leq 70\%$	Medium
$70\% < \text{Concept understanding} \leq 100\%$	High

The criteria for students' concept understanding are also obtained from the analysis of each indicator of concept understanding. Here are some indicators of concept understanding is show in Table 2.

Table 2. Concept Understanding Indicator

Concept Understanding Indicator
1. Restate a concept
2. Classify objects according to certain characteristics
3. Give examples and non-examples of a concept
4. Present concepts in the form of mathematical representations
5. Develop necessary or sufficient conditions of a concept
6. Use, utilize, and select certain procedures
7. Apply concepts to problem solving

3. RESULTS AND DISCUSSION

Result

The research data were obtained from testing questions about understanding the concept of substance pressure material using the five tier test method on students at SMPN 1 Beji who had received substance pressure material. The classes selected as samples amounted to 8 classes including 8th A grade consisting of 32 students, 8th B grade consisting of 30 students, 8th C grade consisting of 32 students, 8th I grade consisting of 32 students, 8th H

grade consisting of 32 students, 8th K grade consisting of 34 students, 9th I grade consisting of 34 students, and 9th K grade consisting of 32 students. The total sample of the 8 classes is 258 students. [Table 3](#) show the percentage of SMPN 1 Beji students who understand the concept of substance pressure based on indicators of concept understanding through the five tier test method.

Table 3. Percentage of Level of Understanding of SMPN 1 Beji Students for each Indicator

Concept Understanding Indicator	Percentage of Concept Understanding (%)	Criteria
Restate a concept	27	Low
Classify objects according to certain characteristics	24	Low
Give examples and non-examples of a concept	10	Low
Present concepts in the form of mathematical representations	12	Low
Develop necessary or sufficient conditions of a concept	16	Low
Use, utilize, and select certain procedures	14	Low
Apply concepts to problem solving	7	Low

Based on [Table 3](#), it can be known that the average percentage of students who understand the concept of substance pressure on the indicator restates a concept of 27%, classifies objects according to certain properties of 24%, gives examples and non-examples of a concept of 10%, presents concepts in the form of mathematical representations of 12%, develops necessary or sufficient conditions of a concept of 16%, uses, utilizes, and chooses certain procedures of 14%, and applies concepts to problem solving of 7%. If all these indicators are averaged for each indicator, then the concept understanding of SMPN 1 Beji students on substance pressure material is 16% and is included in the low criteria. The understanding of concepts experienced by students is also different for each item, where from 20 items of the five tier test on substance pressure material is grouped into 4 sub concepts including solid substance pressure, liquid substance pressure, gas substance pressure, and pressure applications in living things. The percentage of student data on each sub concept of substance pressure is presented in [Table 4](#).

Table 4. Percentage of Students' Concept Understanding Level of SMPN 1 Beji on each Subconcept of Substance Pressure

Subconcept of Substance Pressure	Percentage of Concept Understanding (%)	Criteria
Solid Substance Pressure	23	Low
Liquid Substance Hydrostatic pressure	26	Low
Pressure Archimedes' law	11	Low
Pascal's law	7	Low
Gas Substance Pressure	17	Low
Application of Pressure on Living Things	10	Low

Based on [Table 4](#), it can be known that the average percentage of students who understand each sub concept of substance pressure includes the percentage of students'

concept understanding on the sub concept of solid substance pressure of 23%, on the sub concept of liquid substance pressure, among others, the percentage of students' concept understanding on the sub concept of hydrostatic pressure of 26%, The percentage of students' concept understanding on the sub concept of Archimedes' law of 11%, the percentage of students' concept understanding on the sub concept of Pascal's law of 7%, the percentage of students' concept understanding on the sub concept of gas pressure of 17%, and the percentage of students' concept understanding on the sub concept of pressure application in living things of 23%. Based on the average percentage of students' concept understanding for each sub concept, it shows that the highest average percentage of students' concept understanding is in the hydrostatic pressure sub concept and the lowest average percentage of students' concept understanding is in the Pascal's law sub concept. The criteria for students' concept understanding are included in the low criteria.

Discussions

Students' concept understanding for each indicator is in the low category. In the indicator of restating a concept with a percentage of concept understanding of 27%, students have difficulty in stating the concept of solid substance pressure in a mathematical equation into the form of a definition. In the concept of solid substance pressure, students can determine the mathematical equation of solid pressure, which is $P = \frac{F}{A}$, but have difficulty in expressing the mathematical equation into a definition. Many students assume that the greater the force exerted on the object, the smaller the pressure on the object. The actual concept is that pressure is defined as force per unit area, where the force F is the magnitude of the force acting in the direction perpendicular to the area A , so that the greater the force exerted on the object, the greater the pressure on the object as well as if the greater the cross-sectional area of an object, the smaller the pressure on the object (Hossain et al., 2021; Pelullo & Di Giuseppe, 2018).

In the indicator of clarifying objects according to certain characteristics with a percentage of concept understanding of 24%, students have difficulty in determining a concept of substance pressure based on certain characteristics. In the concept of liquid substance pressure, especially hydrostatic pressure, students have difficulty in determining which object has the greatest pressure in water. The majority of students assume that the greater the mass of the object, the greater the hydrostatic pressure. The actual concept is that hydrostatic pressure is influenced by the density of the liquid, the gravitational acceleration of the liquid, and the depth of an object in the liquid so that the deeper the position of the object in water, the greater the hydrostatic pressure will be (Halliday, D., Resnick, R., & Walker, 2012; Saehana et al., 2019).

The low understanding of the concept of substance pressure in students is found in all sub concepts of substance pressure. In the concept of solid substance pressure such as where the percentage of students who understand the concept is 23%, the majority of students still think that the pressure of an object is inversely proportional to the force exerted on the object. In addition, students also think that the pressure of an object is directly proportional to the surface area of the object, where the greater the surface area of the object, the greater the pressure on the object. This is in accordance with research conducted where there are still many students who have difficulty in understanding the concept of solid pressure (Jiang et al., 2019). The actual concept is that the pressure of an object is directly proportional to the force applied and inversely proportional to the surface area of the object, so that the greater the force applied, the greater the pressure on the object, and vice versa, the greater the surface area of the object, the smaller the pressure on the object (Ismail et al., 2021; Sholihat et al., 2017).

Students have difficulty not only in understanding the sub concept of solid substance pressure, but also in understanding the concept of liquid substance pressure, which is the sub concept of hydrostatic pressure. In the sub concept of hydrostatic pressure with a percentage of students' concept understanding of 26%, the majority of students still think that hydrostatic pressure on an object is influenced by the shape of the object. Some other assumptions of students related to the concept of hydrostatic pressure are that students think hydrostatic pressure is influenced by the shape of the vessel and the volume of the liquid. Students also assume that hydrostatic pressure is affected by the closer the hole is to the surface of the liquid. This is in accordance with research conducted by previous study found where there are still many students who have difficulty in understanding the concept of hydrostatic pressure (Berek et al., 2016). The actual concept, hydrostatic pressure is not affected by the size of the object, the shape of the vessel, and the volume of the liquid. The concept of static fluid is that the hydrostatic pressure at all points with the same depth is the same, independent of the shape of the container, where if the depth of the object is greater, the greater the hydrostatic pressure (Khotimah et al., 2020; Mufit et al., 2023). In addition, hydrostatic pressure also depends on gravity and the density of the liquid.

Students not only have difficulty in understanding the concept of solid substance pressure and liquid substance pressure, but students also have difficulty in understanding the concept of gas substance pressure. The percentage of students who understand the concept is 17%, the majority of students still think that air pressure in highlands is higher than air pressure in lowlands. The correct concept is that the higher the place, the smaller the gravitational force, so the air pressure is also smaller (Duda et al., 2020; Flores-Amado et al., 2020). Students' difficulty in understanding the concept of pressure of gaseous substances is also shown in the answers of students who assume that gas balloons can fly in the air because the density of the air balloon is made greater than the density of air by heating the air balloon. Then, it is about air pressure at a height that is associated with the volume of objects at different heights. Students assume that the balloon can pop at a certain height because at a certain height the balloon will expand. The correct concept is that the higher the place, the lower the air pressure. At low pressure, the volume of an object will increase just like a balloon, so at a certain height the volume of the balloon will increase and then burst (Berek et al., 2016; Nuayi et al., 2018).

This research shows results that are aligned with research that has been carried out previously on the Topic of Substance Pressure and its Application in Daily Life, where in this research it can be seen that students' concept understanding on substance pressure also shows low results, many students have misconceptions (Raehan et al., 2020). This concept understanding is still tested using the two tier test method. Another research using Five-Tier Test on Wave Concepts shows that a five-tier diagnostic test has been built and applied to identify students' conceptions into conceptual understanding, misconceptions, and not conceptual understanding (Fenditasari et al., 2020). Another research that provides evidence to support this research is research to Reveal Conceptual Understanding of Electrical Engineering Students, which shows that the use of a five-tier diagnostic test is more effective than a four-tier diagnostic test to identify students' conceptual understanding (Noriyatus et al., 2020). This is because the five tier test produces a more accurate analysis of student answers.

Based on the analysis, it can be seen that students' understanding of concepts in substance pressure is still relatively low. Even though students who understand the concept of the lesson well, it will be easier and more effective in building their own thinking. This is in accordance with previous study who explained that concept understanding is the basis of student knowledge and the key to the success of learning, because understanding points to an explanation of a more meaningful concept (Strømme & Mork, 2021). Natural science materials, especially physics, in this case, namely substance pressure, all concepts are related

to one another. If the basic concepts that students have are still low, it will be even more difficult to understand the next material (Iroegbu & Ray, 2021; Wardani et al., 2020). The understanding of science concepts in low students is also determined by the success of the teacher in teaching. Through this description of the analysis of student understanding concept at SMPN 1 Beji, it should motivate teachers to improve the quality of learning by using appropriate learning strategies and methods, classifying the understanding of concepts experienced by students more accurately, determining sub materials that require special emphasis, and using more interesting learning media, so it is hoped that the understanding of science concepts in students will also increase.

The use of multiple choice questions using true-false statements does require questions about the causal relationship between the statement and the reason for the statement, this is intended to further determine the difficulty of students in determining the answer to the question being examined. Through the analysis of the level of understanding of this concept, it is hoped that it can help students in knowing the level of understanding of concepts in themselves, students can know certain sub concepts that require more specific emphasis, so that it is hoped that the understanding of concepts in students will increase

4. CONCLUSION

Based on the results of the data analysis obtained, it can be concluded that the level of understanding of the concept of substance pressure of SMPN 1 Beji students is in the low category. The lowest student concept understanding is found in the indicator of applying concepts to problem solving and in the sub concept of Pascal's Law. The use of the five tier test method is able to identify students' concept understanding in more detail because there are levels in the questions to find out students' answers regarding the cause and effect relationship in multiple choice questions and reasons.

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