Identification of junior high school students’ misconceptions on solid matter and pressure liquid substances with four tier test

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Abstract. Misconception is students’ understanding about particular concept in which student strongly believed but it is not appropriate with scientific theory. However the student did not aware of this inappropriateness. This study aims to identify students’ misconceptions of junior high school by using a four-tier test, the sample was grade 9 junior high school student have studied pressure on the substance and liquid topic, with a total sample of nine students. Sampling technique used is purposive sampling. The data obtained through a written test in form of 17 items of four-tier test and interview. Misconceptions were identified using a combination of analysis techniques on a four-tier response test developed by Caleon and Subramaniam. Identified that not all students were found experienced misconceptions, most common misconceptions on item number 12 about pascal principle as much as 6 students. From the interview it is also revealed that the same student misconception on pascal principle. This indicates that the identification of student misconceptions using four tier test analysis is used effectively. Factors that lead to students’ misconceptions are students come from the students themselves and from the learning environment of students, especially classmates.

1. Introduction
Misconception is still considered as one of the problems in the field of education, particularly in science learning at schools. A lot of research has been done on student misconception, and the results showed that students who have misconception greatly affect the learning process and the understanding of the lessons as proposed by [1]. Therefore, to understand the scientific concepts, students cannot be separated from the general misconception because it may complicate them to accept the scientific concepts.

Misconception is the thinking of students who are inconsistent with the scientific knowledge they acquire [2]. Meanwhile, according to [3] states that misconceptions related to science are defined as students' thinking that is inconsistent with the laws of science. Misconceptions may cause new knowledge to be incorrectly integrated into the student's cognitive structure [4]. Since misconception is the thing that can affect students' understanding of concepts, it is essential to figure out the misconception possessed by the students. There are several methods that can be used to determine the student misconception. According to [5], several methods that can be used to determine the understanding of concepts and the students' misconception are the open questions, diagnostic tests, concept maps, prediction-observation-explanation, and interviews regarding an incident or event, an interview about a concept, word association and drawing.
Diagnostic tests Instrument of a four-tier test is the development of a three-tier test that is combined with a confidence rating (level of confidence) on the ground answer, so that is apart from the level of confidence of the knowledge answers. In the developing process of [6], four tier tests pass through four stages including the test of knowledge of the multiple choice in the first stage and in the second stage is the students’ confidence level for the answers in the first stage which include confident and unconfident answers, then the third stage is the specific of semi-enclosed multiple choice tests which include the reasons’ of students’ answer in the first stage, and the fourth stage is the students’ confidence level to answer the third stage with certain and uncertain choices [6].

The study using a four-tier test in identifying misconception has been done by [7] on 26 students in 14 questions which results in students have the opportunities to comprehend the concepts, misconception, or failure to understand the concepts and error. In addition, the identification of misconceptions using three tier test, where the three tier test is the basis of the development of four tier tests also performed by [8].

The concept of pressure is one of the important topics in the subject matter of science in the junior high school level. This material is one of the topics that has quite high difficulties because it is abstract. Thus, it leads students to confusion to easily grasp the concept of the pressure. Hence, it is necessary to identify students’ misconception on the concept of pressure, so the identification of students’ misconception is required to decide the appropriate learning methods to eliminate and correct these misconceptions. Therefore, the purpose of this study is to identify the misconception of VIII grade junior high school students on the material using a four-tier test pressure.

2. Method
The method used in this research is descriptive method. The population of this study is all students of class IX in one junior high school in Bandung city. The sampling was done using purposive sampling because students in class IX had to do remedial subjects so that the researcher take only a sample of students who do not do remedial, to obtain a sample in this study which is 9 students. In this study, the main data was taken from the tests of four-tier tests and supporting data derived from student interviews.

This research passed through several stages. The first stage is the provision of a test of a four-tier test on the material pressure as a sample that has been selected, then the students' conceptions Calculations are carried out manually by a combination of the answers to the four-tier test Mechanical analysis of a combination of the answer to the four-tier test using technique which is developed by [6]. After the data identification of students' conception was grouped, the researcher conducted interview to acquire more data and information about the misconception that occur on these students. The following is the table of students’ conceptions categories:

| No. | Category       | Combination answers | Answer | Reason   | Rating reasons confidence |
|-----|----------------|---------------------|--------|----------|---------------------------|
| 1   | Misconceptions|                     | True   | False    | Sure                      |
| 2   |               |                     | True   | Wrong    | Sure                      |
| 3   |               |                     | Wrong  | False    | Not sure                  |
| 4   |               |                     | False  | True     | Not sure                  |
| 5   | Lack of knowledge |                 | True   | True     | Not sure                  |
| 6   |               |                     | True   | False    | Not sure                  |
| 7   |               |                     | True   | True     | Sure                      |
| 8   |               |                     | True   | True     | Not sure                  |
| 9   |               |                     | True   | False    | Not sure                  |
| 10  |               |                     | False  | True     | Not sure                  |
| 11  |               |                     | False  | True     | Not sure                  |
| 12  |               |                     | False  | False    | Not sure                  |
Table 1. Cont.

| #  | Conception of student | True | False | Sure | Not sure | True | False |
|----|----------------------|------|-------|------|----------|------|-------|
| 13 | False                | Not sure | False | Not sure |
| 14 | True                 | Sure | False | Not sure |
| 15 | True                 | Not sure | False | Not sure |
| 16 | False                | Sure | False | Not sure |
| 17 | False                | Not sure | Wrong | Not sure |
| 18 | False                | Sure | True  | Sure   |
| 19 | False                | Not sure | True  | Sure   |
| 20 | Error                | Confident | False | Sure   |
| 21 | True                 | Not sure | False | Sure   |
| 22 | False                | Sure | False | Sure   |
| 23 | False                | Not sure | False | Sure   |
| 24 | Understanding the concept of | True | Confident | True | Confident |

3. Result and Discussion
Data analysis results conceptions of students as much as 9 students, which consisted of 20 items can be seen in Figure 1.

![Figure 1. The results of the analysis of students' conceptions](image)

Figure 1 shows that there are students who understand the concept of as much as 14%, do not understand the concept (LOK) as much as 14.2% of students in an error as much as 0.8% and students who have misconceptions as much as 7%. Table 2 shows the percentage results of misconceptions found in every material pressure.

Table 2. Results of the analysis of the material part of the pressure experienced misconceptions

| Pressure material | Amount of students that have misconceptions | Percentage misconceptions |
|-------------------|--------------------------------------------|---------------------------|
| Solids            | 4                                          | 20                        |
| Pascal’s Law      | 8                                          | 40                        |
| Legal Archimedes  | 10                                         | 50                        |
| Legal Hydrostatic | 4                                          | 20                        |
Table 2 showed that misconception has the greatest percentage of the Archimedes law materials by 50%. The misconception that was found in the concept of the law of Archimedes in the question number 5 was about the relationship between the volume of objects submerged and the buoyancy force. There were 4 students who experience misconception who assumed that the more volume of the object submerged, the greater object would be because of the greater buoyancy force. Another misconception was laid on Archimedes law material in question number 16 which was about the concept of volume relationship between the buoyancy and the submerged objects which happened to 3 students, where they assume that the greater the buoyancy of the submerged object if the volume is small and the density of the fluid is great. There were also students who assume that the buoyancy will be even greater if the volume of the submerged object gets smaller.

Besides the results above, there is also a misconception on the concept of the law of Archimedes for question number 7 and 10 about the law of Archimedes in everyday life and about the relationship between density and the buoyancy force when floating, flying and sinking. Students assume that the buoyancy in the water add the buoyancy force of the coins so the coin’s weight gets heavier. Moreover, the students assume that the mass of the object that is larger than the liquid “A” causes it to sink. In line with the research conducted by [9], where there are misconceptions of the students on the law of Archimedes is also found in Turkey, where students assume that the object of greater mass will sink while the same thing but has a mass smaller will not sink in liquid. In addition, research conducted by [9] had a misconception where the students explain the state of floating, flying and sinking of the object depends on the weight of the object.

The misconception with the second largest percentage, namely the legal materials pascal with a large percentage of 40%, misconception found in this concept for question number 12 about the material relationship force with a field of press on the principle of Pascal where the students assume that the ratio of the surface area of a second injection of the same by comparing the force with the second shot and, there are students who get misconception on the question number 14 on the material influences on the surface of the piston against the force on the other piston surface, where students assume that a large total force of F_1 and F_2 is always a constant value.

The misconception is also found in the solid material and legal pressure Hydrostatic with a large percentage of 20%. Misconception at a pressure of solids found in question number 1, which is about the relationship between the surface area of the press pressure on the solids, where students assume that the surface area of the two beams are different but the pressure generated will always remain the same. And there is a misconception on the material solid pressure in the question number 13 about the classification pressure of solids based on a surface area of press, where students assume that the surface area is directly proportional to the pressure, so the larger the surface area causing greater pressure.

Misconception on material hydrostatic pressure, occurred to the question number 6 about the hydrostatic pressure on the communicating vessels, where students assume that the hydrostatic pressure caused by the buoyancy of the bubbles results in the larger bubble size when approaching the surface. And misconceptions on the matter hydrostatic pressure also occurs in question number 15 about the relationship of the depth of liquid toward hydrostatic pressure, which students assume that the hydrostatic pressure received by the fish while they are at the half depth of the water, because there is total pressure on the surface and in the bottom of the aquarium. This is similar to the research conducted by [10], which students assume that the greatest hydrostatic pressure is on the surface of the liquid, this assumption happened because students think that the surface of the liquid is at the highest position so that it has the greatest potential energy.

Based on the findings in this research, researcher conducted interviews to students who experience misconception to get more information about the following misconception. The interview conducted not only to students who experience misconception at the time to answer the four-tier test, but also to all of the students who became the subject of research as well as the interviewees. From the interviews, it was found that students who experience misconception when answering questions four tier test also had the misconception at the time of the interview, so it can be concluded that the four-tier diagnostic test is an effective test to solve the misconception exist among the students. Four-tier diagnostic test is an effectiveness tests in recruiting misconception caused by this test which has been distinguished between
a confidence level of knowledge students to select an answer and a confidence level of students to choose the reasons from the answers of knowledge [6].

From these results, we can also find some of the factors that caused students to experience misconception, such as students’ less interest of misconception for science lessons especially for the material pressure. As said by [11], various studies show that student interest contributes effects on misconception. Misconception experienced by students can also cause by student learning that simply use memorizing a concept without connecting between the concepts of the one with the other concepts. This is supported by the results of interviews conducted to the students, during the time that students get questions about a concept; the students tend to guess the answer alone. This is in accordance with what was said by [7] that rote learning is to solve a problem just by trial and error similar to guess a riddle.

Another factor that led to misconception experienced by these students is due to the incompleteness of the information about a concept during the learning process. This occurs as a result of students' understanding of a concept that is fragmented, so that information about the concept becomes corrupted or not complete. Misconception can be caused by a student reasoning is incomplete or incorrect [11]. This leads to students taking the wrong conclusions for the concept, causing their misconceptions.

Aside from the students’ experiences, misconceptions occurred by students is also influenced by the students' learning environment, especially classmates. According [11] young people are very happy to learn in a group with group work even though a few people often dominate the study groups. If a student has a misconception of these dominant, then obviously they can affect students' understanding over the other, which can affect other students to experience misconception.

4. Conclusion

Based on the identification of misconception on the concept of pressure through four diagnostic tests tier test, some students experience misconception on every material pressure, and misconception mostly occurred in the concept of the law of Archimedes by 50%, also this case happened during the interview. Where is the misconception that occurred during the four-tier diagnostic test and interview are the same students experiencing misconceptions, therefore four tier diagnostic test instrument effectively used in recruiting student misconceptions. Misconceptions that occur in students come from the students themselves and from the learning environment of students, especially classmates.

Acknowledgments

Thank you for one of the schools in Bandung where the data collection in this research. And thanks Also to all validator instrument in this research.

References

[1] H Pesman 2005 Development of A Three-Tier Test To Assess Ninth Grade Student Misconception About Simple Electric Circuits (Middle East Technical University: Not published).
[2] J Clement, E D Brown and A Zietsman 1989 “Not All Perception are Misconception, Finding Anchoring Conception for Grounding Instruction on Student Intuitions” International Journal Scientific and Education 11 p 554-565.
[3] N Dermici 2003 Dealing with misconceptions about force and motion concepts in physics: A study of using web-based physics program Hacettepe Universitesi Editim Fak, Itesi Dergisi, 24 p 40-47.
[4] B Costu 2009 Learning science through the PDEODE teaching strategy: Helping students make sense of everyday situations Eurasia Journal of Mathematics, Science and Technology Education 4 p 3-9.
[5] S Kose 2008 Diagnosing Student Misconception: Using Drawings as a Reasearch Method World Applied Sciences Journal 3 p 283-293.
[6] I S Caleon and R Subramaniam 2010 Do Student know what they know and what they don’t know? Using a four-tier diagnostic test to assess the nature of students’ alternative conceptions” Springer Science 40 p 313-337.
[7] U Turgut 2011 An investigation 10th grade students’ misconceptions (Turkey: Not published}
[8] D Kaltakci and N Didis 2007 Identification of pre-service physics teachers’ misconception on gravity concept: a study with a Three-Tier misconception test Sixth international conference of the Balkan physical union p 499-500.

[9] F Thompson 2006 An exploration of common student misconceptions in science International education journal 7 p 553-559.

[10] A Setyowati 2011 Implementasi pendekatan konflik kognitif dalam pembelajaran fisika untuk menumbuhkan kemampuan berpikir kritis siswa smp kelas VIII Semarang Jurnal pendidikan fisika 7 p 89-96.

[11] F Thompson 2006 An exploration of common student misconceptions in science International education journal 7 p 553-559.