Analysis Profile of Student Misconceptions on The Concept of Fluid Based Instrument Three-Tier Test

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Abstract. The purpose of this research was to analyze the misconception profile of eleventh senior high school students about the concept of fluid. The sample of this research was the eleventh students of science class Karanganyar state Senior High School I and Gondangrejo state Senior High School of Religion with 98 students. The analysis of students’ misconception profile used the instrument of three-tier concept-based test. The item consists of 28 items that consist of three level of completion stage, the first level is multiple choice questions, the second level is a description of the reasons the student’s answer to the first level questions, as well as the third level, is the students level of confidence on the answers have been given. The result shows that 27.58% of students understand the concept of fluid, 45.29% of students don’t understand the concept of fluid, 24.74% of students shows misconceptions and 2.36% of students had errors. The highest misconception was in the concept of Pascal with average 13.96%. Therefore it was concluded three-tier test can be identified misconception as well as the cause of this misconception, such as false positives, false negative to lack knowledge.

1. Introduction
Mastery of concepts is the ability of students in the cognitive domain associated with memory, understanding, implementation, analysis, evaluation, and composition or creation. The ability of students in mastering concepts is very important in physics learning. By mastering the concept of students can improve his intellectual ability to assist in the process of solving the problems facing him and can create meaningful learning [1]. Students when coming into the classroom have brought concepts not infrequently different from the correct concept [2]. Sometimes the results of the interpretation of a concept made by students deviate or not in accordance with the concept that has been agreed by experts [3]. So it is not uncommon for students to experience errors in understanding a concept that resulted in students experiencing misconceptions. One of the causes of misconceptions is the incomplete understanding that students receive from misinformation or incomplete information [4]. (Other than that, in science learning is quite difficult to understand because it is abstract, so many misunderstandings or alternative concepts that affect student learning attitudes [5].

Conceptual change requires a variety of learning processes that allow students to develop new concepts and formulate existing ways of thinking [6]. The conceptual change process begins with assimilation and accommodation. Assimilation occurs because the students’ initial knowledge is...
related to the phenomenon and there has been no conceptual change, whereas accommodation is a conceptual process of change due to student conceptions that are inconsistent with the new phenomenon. In the learning process required clarification of concepts that have been built by students, so that the concept that has been understood by students to be a true concept appropriate with the concept has been agreed[7].

Misconceptions can be defined as concepts that students have that are inconsistent with concepts that have been agreed upon by the expert have several terms, such as "alternative conceptions", "misunderstandings", "naïve beliefs," children's ideas, "," conceptual difficulties", "phenomenological phenomenon," "mental models" and so forth [9]. Misconceptions can persist over a long period of time and must be overcome [10]. Analysis of student misconception can be done by using the interview and assessment. Interviews can be used to investigate students' concepts in depth, but interviews are difficult to do to a large number of students, difficult to analyze and take a lot of time. So the multiple-choice instrument or test instrument is most commonly used so far. The instrument test can be easily given to the students with large numbers and is easy to analyze) [11] . Assessment has a very important role in learning activities, (1) the assessment can help the student know the extent to which students have succeeded in following the lessons given by the teacher, (2) assessment helps teachers to know which students are experiencing difficulty in learning and who successfully master the learning. Other than that, using appropriate assessment instruments and efficient it will facilitate the teacher to know the cause of the difficulties experienced by students in learning and easier to find solutions to solve the problems that occur [12].

Based on interviews conducted in August 2017 with Mrs Nur Hasanah as a physics teacher of Gondangrejo state Senior High School of Religion, Mrs Endah Dwi Rahayu as a physics subject teacher Karanganyar state Senior High School I and Mr Suyadi Gondangrejo state Senior High School, it was found that analysis of mastery of student concepts is generally seen through the results of daily re-evaluation, midterm tests, and final exam of the semester. Students are considered to have understood a concept well if, during the daily test, midterm tests, and final exam of the semester has gotten a good grade. The type of instrument used by teachers is usually an instrument of multiple choice tests and descriptions.

The multiple-choice test, as well as the description, has several advantages. Multiple Choice Test has advantages efficient use of time, while the description test has advantages easily arranged, teachers can know the level of students creativity, analyze and synthesize a student problem, and students can not guess the answers [13]. Multiple-choice tests are often more preferable in science classes since they are easy to apply and evaluate students’ understanding of the related subject [14]. Meanwhile, according to Kusairi and Aman (2013), it’s said that the test description has the advantages of fast, easy to set up and eliminate guesses. while multiple-choice tests can be used to measure different levels of ability, reach a broad concept, and easy in scoring[15]. The method of paper and pencil testing is suitable for administering tests to a large number of students and for evaluating the test-takers’ response patterns and performance, especially for the multiple-choice items [16].

In addition to having advantages, multiple-choice test and description have some drawbacks. Wahyuni, et al explained that the shortage of multiple choice test is that teachers can not know the thinking process of students [17]. While the question of the teacher is difficult to judge the answers of learners appropriately and the time required to correct the answers of students longer. Multiple-choice tests have some limitations in applying such as determining whether a student gives a correct response to a test consciously or just by a chance [18]. Meanwhile, according to Kusairi and Aman explained that the multiple choice test has difficulties in the compilation, while the description problem has a limited amount of material tested, limitation of scoring tools, and limited accessible range of capabilities. The paper and pencil test is difficult to use for assessing and analyzing the test-takers’ internal ideas and often encounters measurement errors due to the students’ examination behaviors, such as guessing [19].
Three-tier tests are one of the assessment instruments that can be used to analyze misconceptions that occur in students. The three-tier test is an instrument that has three levels, where the first level is a matter of choice of answers, the second level is the reason for the answer from the first level, and the third level is the level of confidence in the answers given at the first and second level [20]. The first tier is the conventional multiple-choice step, the second tier is the possible reasons of the given answer for the first tier, and the third tier is the confidence step for the first two tiers [21]. The three-tier diagnostic test is a diagnostic test that is composed of three tiers questions. The first level (one-tier) is a regular multiple choice, the second level (two-tier) in the form of a choice of reasons, and the third level (three-tier) in the form of questions affirmation from the answers that have been made on the level one and two level [22]. The purpose of this research was to analyze the profile of misconceptions owned by students of senior high school the class of eleven natural Sciences on the concept of fluid.

2. Research Methods
The subject of this research is the students of class XI science in Karanganyar, Surakarta. The sample of this research were 98 students consisting of 3 classes from 3 different schools. The sample of the study was determined by the results of the analysis of the value of national examination results of the last 4 years. The sample of the school was selected randomly. The selection of sample class using the random technique. The research was conducted using the qualitative descriptive method. The qualitative descriptive method is done to analyze the specific profile of each student who understands the concept and students who have a misconception on the concept of fluid.

The instrument used in this study uses a conceptual diagnostic test consisting of three levels or three-tier tests. The instrument of three-tier diagnostic test used in this study consisted of 28 items from 11 concepts of fluid. The result of expert validity analysis shows that this instruments has the valid category with Aiken validity index value > from V table (0.75). Reliability of instrument test for Person reliability has value 0.96 with the high category, Item reliability has value 0.69 with the medium category and Internal reliability has value 0.68 with the medium category. The instrument of three-tier test consists of 3 questions of the concept of density, 3 questions of hydrostatic pressure, 2 questions Pascal concept, 3 questions of Archimedes concept, 1 question of meniscus concept, 4 questions of capillarity, 2 questions of viscosity concept, 2 questions of ideal fluid, 4 questions of continuity concept, 2 questions of Bernoulli concept and 3 questions of the applications of fluid concept. The research to analyze students misconception of the concept of fluid is done by several stages, the initial stage of data collection, data processing, descriptions and discussion of the findings in the research. Implementation testing and data collection conducted in February 2018. It was obtained with analysis concept which was arranged by Kaltakci [23].

| First Level | The Second Level | Third Level | Category | The code on The Program |
|-------------|-----------------|-------------|----------|------------------------|
| Correct     | Correct         | Sure        | understand the concept | UC         |
| Correct     | Correct         | Not sure    | don’t understand the concept | NUC        |
| Correct     | Incorrect       | Sure        | Misconception | M          |
| Correct     | Incorrect       | Not sure    | don’t understand the concept | NUC        |
| Incorrect   | Correct         | Sure        | Error     | E          |
| Incorrect   | Correct         | Not sure    | don’t understand the concept | NUC        |
| Incorrect   | Incorrect       | Sure        | Misconception | M          |
| Incorrect   | Incorrect       | Not sure    | don’t understand the concept | NUC        |
3. Results and Discussion

The three-tier test is a two-tier test combined with Certainty of Response Index (CRI) that asks students to respond to a degree of confidence in the answers given at the first and second levels [24]. The three-tier test is a test instrument that has three stages in solving it, the first level is the answer to the question given, the second level is the reason for giving answers at the first and final level is the level of confidence over the answers that have been given. The researchers treated an answer with a low CRI value as a lack of knowledge, irrespective of if the answer was correct or wrong. They stated a correct answer with high CRI value indicates a thorough understanding of the related concept. Likewise, they accepted a wrong answer with a high CRI value to indicate the existence of a misconception [25]. Based on the result of the student misconception analysis test on the concept of fluid by using a three-tier test instrument obtained data that:

Table 2. Percentage of students’ level of understanding on the concept of fluid

| Level of concept understanding       | %   |
|-------------------------------------|-----|
| understand the concept              | 27.58 |
| don’t understand the concept        | 45.29 |
| Misconception                      | 24.74 |
| Error                               | 2.36 |

Table 2 shows that from 98 high school students of science grade XI class got data that 27.28% students have to understand the concept of fluid, 45.29% of students have not understood the concept of the fluid, 24.74% of students had misconceptions and 2.36% of students had errors. Based on the data analysis of student misconception identification, there are still many students who experience misconception. Misconceptions on the students should be identified as soon as immediately and teachers should re-confirm the concept that has been given so as not to re-occur misconceptions about students. In addition, there are still 45.29% of students who have not understand the concept of the fluid well. This should be a serious concern for teachers to make the learning process better so that students more easily understand the concept presented. Percentage of students’ misconceptions level for each indicator of the lesson is presented in table 3.

Table 3. Percentage of conceptual misconception of students on the fluid concept of each indicator

| Level of concept understanding       | %   |
|-------------------------------------|-----|
| Density                            | 18.36 |
| Hydrostatic                        | 28.57 |
| Pascal                             | 37.75 |
| Archimedes                         | 24.82 |
| Meniscus                           | 21.42 |
| Capillarity                        | 35.04 |
| Viscosity                          | 15.30 |
| Ideal Fluid                        | 17.34 |
| continuity                         | 25.76 |
| Bernoulli                          | 30.10 |
| Application of concept             | 15.64 |
Based on data analysis using the the-tier test instrument can be seen that still found misconception experienced by a student on every indicator of learning. The highest misconception occurs in the concept of Pascal with a percentage of 37.75%, or with an average percentage of misconceptions of 13.97%. The misconceptions that occur in students are caused by various causes, such as students are unable to give the right reasons at the second level but at the third level, they believe that the answers they provide at the first and second levels are the correct answers. However, sometimes the textbooks become a source of student misconceptions with the information they provide [26]. It is believed that most of the misconceptions are originated from students’ experiences of daily life. The commonality of the misconceptions across different cultures and populations suggest that outside effects such as instructional practices, textbooks and the excessive reliance on daily language should be considered as potential sources of misunderstandings [27]. Misconceptions about students who have a different culture, religion, and language are frequently similar to each other. Misconceptions may deeply penetrate into students’ minds and resist change. Daily language, culture, and religion can cause the formation of misconceptions. Misconceptions can be parallel to the explanations made by earlier scientists in interpreting scientific phenomena. Misconceptions may develop after a formal teaching [28]. In figure 1, shows the percentage of correct responses in every level of questions.

![Figure 1. percentages of correct responses at every level](image)

Based on data analysis using the the-tier test instrument can be seen that still found misconception experienced by a student on every indicator of learning. misconceptions experienced by students are shown in table 4.

### Table 4. Student misconceptions on the concept of fluid

| Concept of fluid | Students misconceptions                                  |
|------------------|----------------------------------------------------------|
| Density          | Students assume objects that have the same mass will have a large density if the volume is greater, |
| Hydrostatic      | Students assume that its surface of water area affects the amount of hydrostatic |
| Concept      | Assumption                                                                 |
|--------------|----------------------------------------------------------------------------|
| Pascal       | Students assume that the area of the field on the piston to be inversely   |
|              | proportional to the force generated on the plane.                         |
| Archimedes   | Students assume if identical objects will experience an increasingly large   |
|              | force Archimedes when placed on a fluid that has a large density.          |
| Meniscus     | Students assume that if the sunken of the meniscus in water caused by the  |
|              | cohesion force of water is greater than the adhesion force of water.       |
| Capillarity  | Students assume when water and mercury are each inserted into a small tube |
|              | (capillary pipe) connected, then on the smallest pipe that will have the    |
|              | highest position that water and mercury can achieve.                       |
| Viscosity    | Students have the notion that the viscosity does not affect the fluid flow |
|              | velocity.                                                                  |
| Ideal Fluid  | Students have the assumption that the current line on the ideal fluid is   |
|              | turbulent.                                                                 |
| Bernoulli    | Students have the assumption that the flow rate is directly proportional   |
|              | to the pressure.                                                           |
| Application  | Students assume that the pressure on the underside of the plane's wing and  |
| concept      | the top of the wing of the aircraft is proportional to the speed of the air |
|              | flowing. The students assume if a dive boat to dive must be filled with     |
|              | water, and when the ship is filled with water the volume of the ship will   |
|              | increase, and students assume that the object will be more light when      |
|              | inserted into the water because of the object experience of hydrostatic    |
|              | pressure.                                                                  |

4. Conclusion
Based on the research results can be concluded the three-tier instrument can identify students who have a misconception, students understand the concept of fluid, students do not understand the concept of fluid and students have errors. Based on the results of research that has been done, shows that students are still misunderstood the concept of fluid, so teachers must apply clarification concept after the learning process. Misconceptions of students are difficult to get rid of because the understanding has been formed before the learning process. Educators must be able to reduce the potential emergence of misconceptions on their students. The teacher's first step should be to identify the misconceptions that appear to the student. Identifying and finding solutions to eliminate student misconceptions is important because of students' knowledge and conceptions for subsequent learning. Students have an inability to convey what they understand in the form of the right reason, this is indicated by the inability of students to provide answers on the second level, but at the third level, they believe that the answer they have given is true.

In this study, it is clear that students have serious difficulty with the concept of fluid and their conceptual understanding did not develop. Other reason for these misconceptions might be related to the teaching approach. If teachers give more importance to procedural understanding, their students absolutely have a conceptual understanding. Therefore, expected that teachers should show an effort to provide students with a conceptual understanding firstly and then they should develop teaching strategies. for further research to be conducted, in addition to analyzing student misconceptions are also followed by an analysis of the concept held by the teacher.

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