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Diagnosis misconceptions of junior high school in Lamongan on the heat concept using the three-tier test

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Abstract. Misunderstanding is one of the causes of junior high school students in the city of Lamongan learning difficulties, especially studying physics material. The aim of this study was to investigate whether the three-tier test able to identify student misconceptions. Based on the research objectives to be achieved, this research is a descriptive study using descriptive qualitative methods in explaining the research results. The technique of collecting data through tests is by using a Three-Tier Test diagnostic instrument and open interview. Diagnostic results data are expressed in terms of percentage of the students' conception categories. The sample of this research is the students who have received the Heat material, seventh graders. The subjects of this study were grade VII students totaling 150 students with details of 60 male students and 90 female students with age around 12 to 13 years old. Besides using written tests, interviews were conducted on several students to verify the results of the three-tier test. From the analysis of three-tier test diagnostic data students showed that from 47% including the criteria to master the concept, while the remaining 38% experienced misconceptions, 5% guess or not believe in the answers, and 10% don't know the concept. Conclusions of this study is the three-tier test that has been developed on Heat topic is able to identify misconceptions students quickly and accurately. Therefore, a three-level diagnostic test tool that has been developed to diagnose students' misconceptions about temperature and heat materials can identify students' misconceptions quickly and accurately.

1. Introduction

Physics educators often find that students have a misconception, the different misconception is from the concepts that experts believe. Misconceptions occur in almost all concepts of physics [1]. Misconceptions are also experienced by students on material about Newton's First Law [2], effort and energy [3] buoyancy style [4], as well as temperature and heat [5]. The existence of students' misconceptions will hinder the process of receiving new knowledge that is attempted to be constructed through learning in class so that it will hinder students in the learning process [6]. In some other studies, misconceptions are also often known as alternative concepts [7].

Students based on age, gender, and ability tend to carry misconception derived from personal experiences and social interaction results. Misconception can result from limitations in observations and experiences in the everyday environment [9]. Misconception can also be obtained from different experiences and inaccurate sources of information. This becomes a bad basis for students in constructing knowledge. Students can properly use a concept in a certain context, but can also experience misconceptions on the same concept but in different contexts. They need help precisely and



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as early as possible to overcome the misconception [9]. Given this, the identification of students' misconception through research is often done by educators and researchers. This is important for being a source of information for educators and researchers in pursuing the development of learning in the classroom to overcome and correct misconceptions.

Temperature and Heat concept is one of the often misconception physics concepts which closely related to the students' life. Some researchers find that students think temperature and heat are the same things [1]. Other researchers noted the students' thinking that the temperature of an object depends on the size/ mass where, if a large object is large, and vice versa [12], the temperature of the object continues to increase when it changes shape [13], if the mass is small, the heat to be absorbed is greater so that the temperature rises quickly [14], and if the heat capacity is large, the temperature objects will quickly rise [8].

Identification of misconceptions is an important thing to do in the process of learning physics. Identification can be done before, during, and after the learning process and needs to be followed up with efforts to make students free from misconception [14]. Efforts to identify misconceptions must be carried out appropriately in order to avoid follow-up errors. Errors of identification will cause errors in how to overcome them, and the results will not be satisfactory [13]. Therefore, before proceeding further in the response, teachers must first have the knowledge and ability to correctly identify misconceptions, so that at all times can be used in learning. Therefore, researchers and educators are required to continue to develop various efforts to overcome misconceptions even though the results have not been encouraging.

One way that is considered effective in identifying the students' misconceptions is the diagnostic test of misconceptions in written form. Misconception diagnostic tests are intended to determine the learning difficulties experienced by students related to the existence of misconceptions. Misconception perception diagnostic tests are needed in identifying misconceptions experienced by students [11]. Various types of assessments as diagnostic tests are used in science education to identify the students' misconceptions including Open-Ended [6], concept maps [5], multiple choice [14]. Several studies have succeeded in developing misconceptual diagnostic instruments whose results can be identified quickly and accurately, including multiple choice (*two-tieredtwo-tiered*) [3] and choice three-tiered multiple (*three -tier*)[5].

Three Tier Test diagnostic instruments can be predicted to be able to identify the students' misconceptions more accurately than One-Tier or Two-Tier diagnostic tests [2]. Three Tier Tests will allow teachers and students to identify misconceptions so as to give the teacher an overview of students' mastery of the material that has been delivered, and students will correct their misconceptions with scientific conceptions or there is a change in the wrong concept towards the correct concept. [11] state that the Three Tier Test can be considered as a more valid and reliable instrument for performance appraisal or misconception. Research that is relevant and has used a diagnostic instrument Three-Tier Test is Arslan et al. [3], concluded that diagnostic instrument Three-Tier Test a valid and reliable could not only identify the teacher's misconceptions in teaching but also the students' misconceptions in learning. [13] in his research concluded that the Three Tier Test developed was a reliable and valid measuring tool to investigate the students' conceptual understanding and misconceptions.

This research is aimed to investigate whether the developed Three-Tier Test diagnostic instrument was truly able to identify the students' misconceptions. The results of the study are expected to be a reference and source of information for researchers and educators to overcome and follow up the students' misconceptions on each concept of temperature and heat. Therefore, researchers consider the need to identify the students' misconceptions on the concept of temperature and heat using a Three Tier Test.

2. Methods

Based on the research objectives to be achieved, this research is a descriptive study using descriptive qualitative methods in explaining the research results. The technique of collecting data through tests is

by using a Three-Tier Test diagnostic instrument and open interview. Diagnostic results data are expressed in terms of percentage of the students' conception categories.

The sample of this research is the students who have received the Heat material, seventh graders. The sample consisted of 5 different schools in Lamongan city, namely SMP Negeri 1 Lamongan, SMP Negeri 1 Pucuk, SMP Negeri 1 Sukodadi, SMP Negeri 3 Lamongan, SMP Negeri 2 Sukodadi. The subjects of this study were grade VII students totaling 150 students with details of 60 male students and 90 female students with age around 12 to 13 years old. Each school is taken a sample of class VII, the sample is taken randomly to check misconceptions experienced by students after they get the temperature and heat subject matter.

The research instrument used was a diagnostic instrument and the student interview guidelines. The diagnostic instrument was developed based on misconceptions on the concept of temperature and heat which were referred from several related journals. Each item contains one misconception. Interview guidelines are developed according to the results of misconception diagnosis. The interview questions are the same as the questions on the diagnostic instrument. The following are the concepts and misconceptions contained in each item of the diagnostic instrument.

Table 1. Concepts and misconceptions in diagnostic instruments

Related to	Misconception	Item number question
Temperature	Distribution of a substance of different size resulting in each part having a different temperature	9, 10, 11
Heat	Temperature and heat are considered the same two things	1,2
Expansion	Expansion of solids is greater than liquid	12
	Object expansion is not influenced by coefficients	
	Object expansion only occurs in one linear dimension only	14
	The mass of expanding objects increases	15
	Expansion due to an increase in the number of particles	
Effect of heat on objects	Expansion due to increased particle size big	16
	High heat type of substance will accelerate the substance absorb heat	3
	The lighter color of the object will be absorbent light	17
Change of Being	The temperature will rise when the water changes shape (yawning)	4
	The temperature will drop when the water changes shape (freezes)	5
	The temperature will rise when the substance changes shape	6,7
Heat transfer	Substances change in form when mixed with other substances	8
	Heat transfer by conduction causes size particle enlarges	18
	Material particles in the heat transfer by conduction move according to the heat flow	19
	The cold temperature of the environment is transferred to the body	20

The Three-tiered diagnostic instrument consists of 20 questions. Each question consists of three levels, the first level is the choice of ordinary answers, the second level is the choice of reasons, and the third level is the level of confidence in the answers and reasons. The eight possible combinations of students' answers and the categorization guidelines for answers to the concept mastery questions of Three-Tier can be seen in table 2.

Table 2. The Answers Categories of Three-Tiered Test

Tier 1	Tier 2	Tier 3	Category
True	True	Sure	Mastering the Concept (MK)
True	False	Sure	Misconception (MS)
False	True	Sure	Misconception MS)
False	False	Sure	Misconception (MS)
True	True	Not Sure	Guessing, No Conception (MB)
True	False	Not Sure	Do not know the concept (TT)
False	True	Not Sure	Do not know the concept (TT)
False	False	Not Sure	Do not know the concept (TT)

The validity and reliability of the instrument was Three-Tier Test also determined. Validity was obtained from two professors in material and language. The instrument validity consisted of content validity and construct validity. The content validity was 70,35% which was included in the high category, and the construct validity was 75.50% which was included in the high category. Instrument reliability was determined through an instrument trial on junior high school students who had received temperature and heat material. The reliability of the instrument was obtained at 0.54 which included in the moderate or sufficient category. So, it can be said that the use of Three Tier Test diagnostic instrument has fulfilled the requirements to be used in research.

3. Result and Discussion

3.1 overall student conception of concepts in diagnostic instruments

Results of data analysis from Three-Tier diagnostic instruments students tests showed that the 136 students who were the object of research, 47% included the criteria of mastering the concept, while the remaining 38% experienced misconceptions, 5% included the criteria for guessing or lacking confidence in the answers, and 10% of students did not know the concept (Figure 1). [10] in his research on the analysis of students' misconceptions using CRI (Certainty of Response is Index) on the concept of temperature and heat found that about 49.69% of students identified misconceptions, students knew the concept of 41.62%, and did not know the concept (lack of knowledge) around 9.00%.

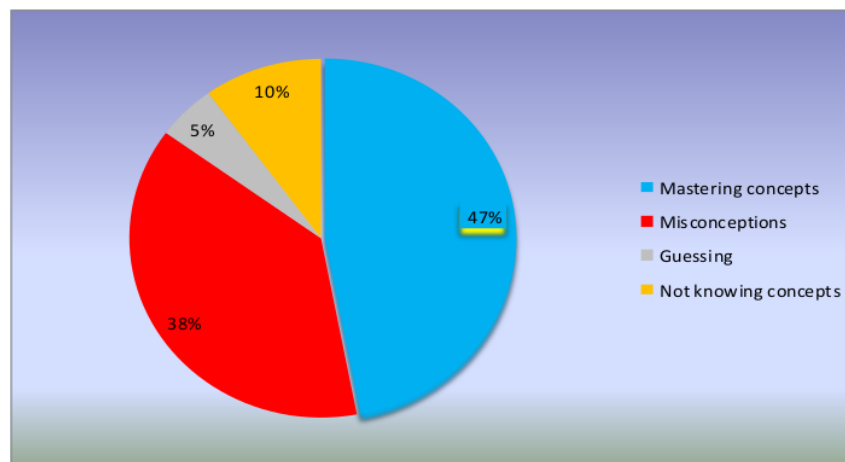
**Figure 1.** Overall the Students' Conception

Figure 1 shows that in general, the students who experience misconceptions are fewer than students who master the concepts. The high level of students mastering concepts because students have received learning that addresses the concepts tested in diagnostic instruments. The high percentage of students experiencing misconceptions is due to students themselves, students' intuition is wrong with the concept (38%). Where students are not able to abstract concepts correctly and most students have forgotten material that they have previously learned or student retention is weak against certain concepts (10%). Weak retention (memory) of students on the material that has been learned causes students to quickly forget the material and formulas that they have memorized (Kurniawan, 2013). Students in understanding concepts are also influenced by the opinions of their friends (22%) when discussing in groups, learning methods that are less appropriate with physics material (11%), and textbooks (3%).

The percentage of students who guess or are not confident is less than students who do not know the concept, namely 5% and 10%, respectively. Student's lack of confidence or guesswork in answering questions is due to the lack of students' understanding of the concepts of temperature and heat so that students feel unsure of their correct answers. Students who do not know the concept due to students have never received or learned the concepts tested in the instrument or the concept is foreign to them so students find it difficult to abstract the concepts in the problem. When learning, students determine, interpret and save their own concepts that enter the brain [14]. Students who are passive in learning will not rearrange their knowledge optimally while students who actively rearrange their knowledge to the maximum when they are involved in learning, so that the understanding of the concept is better. Misconceptions can also occur during the learning process, where the learning methods used are not in accordance with the concepts being taught.

From the interview results obtained data that students feel challenged in working on diagnostic instruments in the form of *Three Tier Test*. This is because the students are required to think harder to understand each concept in the choice of reasons and students also feel very responsible for providing answers that best suit their thoughts and beliefs. *Three-tier tests* for students are a form of questions that they rarely encounter and are different from the forms of questions they have often worked on. According to students, the advantage of a *three-tier test* is that they are more able to explore their knowledge of concepts, through these questions students are able to know the application of concepts in daily life (contextual), make them more thorough and not guess what they answer, and students are more aware and understand the level of mastery of their respective concepts, namely whether they have mastered the concept, are still misconceptions, just guessing or not confident of the answer, or even not knowing the concept at all. Meanwhile, the lack of a *three-tier test* is the long description of the questions and the reasons that make the students need a long time to answer. Also, the questions are like trapping if they are not careful. Thus, the three-tier test diagnostic instrument used in this study was able to identify students' misconceptions

4. Conclusion

From the analysis of three-tier test diagnostic data students showed that from 47% including the criteria to master the concept, while the remaining 38% experienced misconceptions, 5% guess or not believe in the answers, and 10% don't know the concept. This is caused by students having received learning that discusses the concepts being tested but students have difficulty abstracting concepts correctly so that intuition on students' initial knowledge persists, and most students forget about the material already discussed or student retention is weak against certain concepts. The use of a three-tier test diagnostic instrument is able to categorize students' conceptions into four criteria for mastery of concepts, namely mastering concepts (MK), misconceptions (MS), guessing or not confident in answers (MB), and not knowing concepts (TT). Students become aware of the concepts they have for the concepts of temperature and heat. Therefore, a three-tier test diagnostic instrument that has been developed to diagnose students' misconceptions on temperature and heat material is able to identify students' misconceptions quickly and accurately.

5. Reference

- [1] Alwan AA. Misconception of heat and temperature among physics students *Procedia-Social and Behavioral Sciences* **12** 600-14.
- [2] Arslan HO, Cigdemoglu C, Moseley C 2012 A three-tier diagnostic test to assess pre-service teachers' misconceptions about global warming, greenhouse effect, ozone layer depletion, and acid rain *International journal of science education* **34** 11 1667-86.
- [3] Caleon I, Subramaniam R 2010 Development and application of a three-tier diagnostic test to assess secondary students' understanding of waves *International journal of science education* **32** 7 939-61.
- [4] Calik M, Ayas A 2005 A comparison of level of understanding of eighth-grade students and science student teachers related to selected chemistry concepts *Journal of research in science teaching* **42** 6 638-67.
- [5] Chou CY 2002 Science Teachers' Understanding of Concepts in Chemistry. *Proceedings-National Science Council Republic of China Part D Mathematics Science and Technology Education* **12** 2 73-8.
- [6] Cetin-Dindar A, Geban O 2011 Development of a three-tier test to assess high school students' understanding of acids and bases *Procedia-Social and Behavioral Sciences* **15** 600-4.
- [7] Gurcay D, Gulbas E 2015 Development of three-tier heat, temperature and internal energy diagnostic test *Research in Science & Technological Education* **33** 2 197-217.
- [8] Goh NK, Chia LS 1986 A practical way to diagnose pupils' misconceptions in science.
- [9] Haryono HE 2018 The Effectiveness of Science Student Worksheet with Cognitive Conflict Strategies to Reduce Misconception on Heat Concept *Jurnal Pena Sains* **5** 2 79-86.
- [10] Montfort D, Brown S, Findley K 2007 Using interviews to identify student misconceptions in dynamics. *In 2007 37th Annual Frontiers In Education Conference-Global Engineering: Knowledge Without Borders, Opportunities Without Passports*
- [11] Svandova K 2014 Secondary school students' misconceptions about photosynthesis and plant respiration: Preliminary results. *Eurasia Journal of Mathematics, Science and Technology Education* **10** 1 59-67.-67.
- [12] Thompson F, Logue S 2006 An exploration of common student misconceptions in science. *International education journal* **7** 4 553-9.
- [13] Tipler PA, Mosca G 2008 *Physics for Scientists and Engineers Study Guide*. Macmillan.
- [14] Tsapalis G, Papaphotis G 2001 Quantum-chemical concepts: Are they suitable for secondary students?. *Chemistry Education Research and Practice* **3** 2 129-44.

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