Eleventh-grade student’s conceptions about temperature and heat

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Abstract. The aim of case study is to identify student misconceptions of temperature and heat in senior high school. The learning process cannot be separated from the learning difficulties while students are learning Physics. Participants in this study are eleventh-grade senior high school students (14 male’s students and 16 female students) in Bandung. The instruments used were 12 multiple-choices questions on temperature and heat, embedded by the level of confidence of students answering questions. Six misconceptions about definition of heat and temperature, thermal expansion, substance phase, category transition in the form phase of objects, principle of conservation of energy and heat transfers are 73.35%, 38.35%, 20.0%, 95.0%, 58.35% and 45.6%.

1. Introductions
One of the lessons taught in high school is physics the most basic science because it deals with the behaviour and structure of objects [1]. The process of learning physics cannot be separated from the problem of learning difficulties. The problem of learning difficulties is also experienced by students in Physics. Learning difficulties of students include difficulties in understanding the concepts learned from a physics learning material. An understanding of a concept is called conception. Misconception is a concept conflict that is understood by someone with the concept used by the relevant scientific expert [2,3]. Students’ misconceptions are hard to transformation in a short time because misconception is entrenched in students’ thinking [4]. In science education is important to determine students ‘misconceptions [5].

The writer is interested in conducting a case study on the issue of raised issues at the high school level. One topic of physics in high school students is temperature and heat. In accordance with the formulation of the problems that have been described at the beginning, the purpose of this study is to help students in the temperature and heat.

2. Methods
2.1. Method
The method used is a case study. This can be in the form of programs, activities, screenings, or groups of individuals that relate to certain times or ties. Cases can be in the form of one person, class, and school. Reports from case studies only apply to cases, because each case is unique and different from other cases [6].
2.2. Population
The population in this study were all students in one of the private high schools in Bandung. From the classes, the sample was taken by random sampling. Participants in this study are eleventh-grade high school students (14 male’s students and 16 female students) in Bandung.

2.3. Instrument
Instruments used in the entire series of case study activities, namely a set of diagnostic test questions, in the form of 12 multiple choice questions with temperature and, accompanied by the level of confidence of students answering the question. The problem used has weaknesses that have not been through the testing phase, so it has not been validated. The following is one example of the instrument.

> The amount of heat needed to change the shape of an object depends on ...
> A. The mass of objects and the heat of objects
> B. The mass of objects and changes in temperature of objects
> C. Changes in the temperature of objects and heat of objects
> D. Heat type and latent heat
> E. Period of time and latent heat

•Are you sure?
A. Sure
B. Not sure

2.4. Data analysis
Data Analysis use there are two tier multiple choice diagnostic tests. The diagnostic test multiple-choice two-tier can be used in particular to identify misconceptions experienced by students on specific content [7]. The first level of five choices and answers. The second level is self-confidence in answering questions. Distractors answers are explanations of students obtained from literature, interviews and open responses. But in this case study it was used “sure” and “not sure” of the second test level.

| Table 1. Student Conception |
|-----------------------------|
| Tier 1 | Tier 2 | Criteria Conception |
| Correct | Sure | Scientific Conception |
| Correct | Not sure | Lack of knowledge |
| Wrong | Sure | Misconception |
| Wrong | Not Sure | Lack of Knowledge |

After obtaining the number of students who misconceptions about each problem. Then it is converted into a percentage with equation 1.

\[
\% = \frac{\text{Students Conception}}{\text{Total Students}} \times 100\% \tag{1}
\]

3. Results and Discussion
From the data collection, the distribution of diagnostic tests questions was given to 30 students. Percentage of conception, with criteria scientific conception, misconceptions, and lack of knowledge of temperature and heat. For more details, the results can be seen in Table 2.
Table 2. Percentage of Conception

| Code | Concept | Criteria Conception |
|------|---------|---------------------|
|      |         | Scientific Conception (%) | Misconception (%) | Lack of Knowledge (%) |
| 1    | Definition of heat and temperature | 23.3 | 73.35 | 3.35 |
| 2    | Thermal Expansion | 53.35 | 38.35 | 8.3 |
| 3    | Substance Phase | 80.0 | 20.0 | 0.0 |
| 4    | Category transition in the form phase of objects | 1.65 | 95.0 | 3.3 |
| 5    | Principle of conservation of energy | 16.7 | 58.35 | 25 |
| 6    | Heat transfers | 42.3 | 45.6 | 12.2 |

From the results of the data processing above, it was found in several questions that they still had a high percentage of misconceptions. Among them are code 1, code 4, and code 5 in figure 1.

![Figure 1. Percentage of misconception](image)

Problem code 1, misconceptions experienced by students were still high at 73.35%, 22 students included in the misconception criteria from a total of 30 students who worked on diagnostic questions. The indicator to be achieved in this matter is to mention the definition of heat. In the case of a given phenomenon When a teapot of cold water is placed on a burning stove, the stove has a higher temperature than water, and water also receives energy. Then the question was asked whether the form of energy that moved because of the temperature difference. But some students still answer convection and conduction. Students only memorize, so that when given the phenomenon of water that is cooked in a teapot that students imagine is related to heat transfer. Students give answers to believe in the degree of confidence, so students are considered to be in the category of misconception.

At the basic level, the obvious problem is that students are unable to distinguish clearly between the concepts of heat and temperature [8,9].

Problem code 4, 28 students in the misconception category of a total of 30 students. The indicator to be achieved in this matter is categorizing transition in the form phase of objects. Students have not been able to categorize transition in the form phase of objects that release heat is when the event freezes and condenses. Students give answers "sure" in the degree of confidence, so students are considered to be in the category of misconception.

The indicator to be achieved in this matter is to mention the factors that influence the nature of transition in the form phase of objects. Students have not been able to mention the object depending on
the mass m (kg) and latent heat L (J/kg). Students give answers "sure" in degrees, so students are considered to be in the category of misconception.

Lewis and Linn report suggesting that children and adults both rely on intuitive concepts about temperatures of different substances based on how the material feels [10].

Problem code 5, 17 students from 30 students are included in the criteria for the misconception. Students have not been able to categorize heat transfer by radiation based on images in accordance with the indicator of the problem to be achieved. Some students still assume that the occurrence of sea breeze and land winds is one of the phenomena of heat transfer by radiation students give answers to believe in the degree of confidence, then students are considered in the category of misconception.

Based on the field conditions during the field study, students have received content for temperature and heat learning materials, but from the description of physics subject matter teachers, temperature and heat have not been discussed in detail. This can be one of the factors causing misconceptions experienced by students is still high. According to the misconception literature, thermal science presents a wide range of conceptual challenges for students at all educational levels [11].

4. Conclusions
The results of the diagnostic tests, students have difficulty in the definition of heat. Students only memorize, so that when given the phenomenon of water that is cooked in a pot that students imagine is related to heat transfer. Misconception also occurs in category transition in the form phase of objects. Students have not been able to categorize that the transition in the form phase of objects that release heat is when the event freezes and condenses. In the indicator mentioning the influential factors transition in the form phase of objects, students have not been able to mention the amount of heat needed to transition in the form phase of an object depending on the mass (kg) and latent heat L (J/kg). The next indicator is categorizing heat transfer by radiation. Some students still think that the occurrence of sea wind and land again is one of the phenomena of heat transfer by radiation.

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