Profile of Conceptual Understanding and Misconceptions of Students in Heat and Temperature

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ABSTRACT

This study was aimed to describe the level of conceptual understanding and misconceptions of students in heat and temperature. This research used descriptive methods. The research subjects were high school students in SMA Pusri Palembang totaled 42 students. Samples were selected based on purposive sampling. Data were collected through tests. The test instrument used is a set of diagnostic test questions that have been developed previously, namely the Indonesian version of the HTCE instrument. Data were analyzed using descriptive statistics. Research shows that 28.87% of students understood the concept of changing the form of a substance; 59.52% of students did not understand the concept of the heat transfer properties of materials; and the highest misconception of 42.86% in the concept of temperature. These results indicate that the applied learning has not had a maximum impact on students understanding of concepts, so it needs learning innovation as a whole. One of the learning innovations that can be done is making conceptual change text.

Keywords: *Conceptual understanding, Misconception, Heat, Temperature.*

1. INTRODUCTION

The concept is built based on facts and students' perceptions because the concept is a generalization of something [1]. Understanding the concept is a thought process carried out by a person to deeply understand an object or event [2]. Understanding the concept of learning shows the ability of students to record and transfer information back from learning to be used in solving, analyzing, and interpreting problems [3]. Physics is a science that has many concepts to be able to understand and solve problems related to the environment.

The main problem in teaching physics in schools is how to identify problems according to their surroundings and solve them using the physics concepts they understand [4]. Besides, weak mathematical understanding and lack of understanding of physics concepts cause other problems in teaching physics [4]. Students' understanding of concepts is reflected in the results of evaluating student learning outcomes [5].

Students following science learning in class have initial conceptions and ideas related to the phenomena to be studied, but sometimes they are not in line with the scientific viewpoint [6]. Often these initial conceptions and ideas have made an impression and are difficult to erase from the memory of these students. Based on these problems, since the 1970s educational research has begun to focus on the initial conceptions possessed by students or prospective teacher students. However, research conducted in the 1980s shows that many teachers have an understanding of the concept that is not under the actual concept and is similar to the conceptions of students before learning the concept [6]. This shows that the change in concept does not only happen to students and prospective teacher students, but can also happen to teachers or anyone.

The difference between students' concepts and the concept has various terms, including alternative concepts [7]; children's scientific intuition [8]; and misconception [9]. Based on these terms, this study uses the term misconception as a learning difficulty in teaching concepts, especially physics. Misconceptions can occur because students participating in learning in school previously have a concept of something called a conception and are increasingly embedded in students after participating in learning and become even stronger [10].

The research that has been carried out shows that the alternative concepts possessed by students and student-teacher candidates cannot be changed just like that [6] [11]. Misconception is more than just an inaccurate memory of certain facts. Misconceptions start from understanding some concepts that are not understood thoroughly and cause the understanding of these concepts to be less accurate[12]. Misconceptions can occur to anyone and to various scientific concepts, one of which is the concept of physics as a branch of science. One of the concepts of physics that has many misconceptions is the concept of temperature and heat.

There have been many discussions regarding the misconceptions of physics, one of which is the concept of temperature and heat. Temperature and heat are physical concepts that often have misconceptions. This is supported by the existence of several previous studies related to conceptual understanding and misconceptions of temperature and heat. Previous research found students' misconceptions that the water in a high-pressure container boils at temperatures above 100o Celsius and cooking soup using high temperatures will cook faster[12]. Besides, students assume that temperature is a property of certain materials or objects, metals can attract, hold, and absorb heat and cold, the boiling point of water is only 100o Celsius, and the water temperature is unlikely to reach zero degrees Celsius[13].

Although there has been a lot of research on the conceptual understanding and misconceptions of temperature and heat, it does not mean that understanding of the concept has increased and misconceptions are reduced or even lost. This allows a low understanding of concepts and misconceptions of temperature and heat material to still occur in physics learning in high school. Based on this, the purpose of this study was to describe the level of understanding of students' concepts and misconceptions on temperature and heat material for high school students. The research results obtained are then used as a reference for finding solutions to solve these problems by paying attention to the phenomena around students.

2. METHOD

2.1. Research, Design, and Research Subject

Research that has been carried out using descriptive methods. The purpose of this study was to describe the level of understanding of the concepts and misconceptions of students on temperature and heat. The research was conducted at SMA Pusri Palembang in October 2020. SMA Pusri is one of the private high schools in Palembang, South Sumatra. SMA Pusri are schools consisting of boys and girls with various cognitive abilities. The subjects of this study were 42 students of class XI SMA Pusri Palembang. This research was conducted on students who had not studied temperature and heat material.

2.2. Instrument and Data Collecting

The research data were collected using a temperature and heat material diagnostic test that has been developed previously, namely Heat and Temperature Conceptual Evaluation (HTCE)[14]. The instrument used in this study is a translation into Indonesian from HTCE. The form of questions is in the form of multiple-choice tests with reasons. The number of questions used are 28 questions covering the concepts of temperature and heat, phase change of object form, heat transfer, and heat properties of materials.

2.3. The Data Analysis

Data analysis was performed using descriptive statistics. The first step is to classify the data obtained according to the sub-concept of heat and temperature. Then analyze and classify students' answers according to the category of conceptual understanding. The final step is to calculate the percentage of each understanding. Furthermore, interpret the data to conclude from the research results. The categorize the students' level of conceptual understanding into conceptual understanding, partial conceptual understanding, understanding concepts but still experiencing misconceptions, misconceptions, and not understanding concepts [15].

3. RESULT AND DISCUSSION

The research that has been carried out aims to describe the level of understanding of the concepts and misconceptions of students on temperature and heat. The research was conducted before students studied temperature and heat material, so that this study provided a real picture of students' initial conceptions before participating in temperature and heat learning. The results of the temperature and heat material diagnostic tests using the HTCE instrument are then grouped according to the sub-concept of temperature and heat under study. The next step is to classify the results per sub-concept into several categories of conceptual understanding, then calculate the percentage and analyze the reasons given. Based on the results of the research data analysis, the students' understanding of the concepts of temperature and heat was obtained as shown in Table 1.

Table 1. Level of understanding of the concept of heat and temperature

Concept	Level of Undestanding	Frequncy	%
Heat dan temperature	conceptual understanding	2	4,76
	partial conceptual understanding	1	2,38
	understanding concepts but still experiencing misconceptions	1	2,38
	Misconceptions	18	42,86
	not understanding concepts	20	47,62
Phase change of object form	conceptual understanding	12	28,57

	partial conceptual understanding	2	4,76
	understanding concepts but still experiencing misconceptions	1	2,38
	Misconceptions	10	23,81
	not understanding concepts	10	23,81
Properties of materials	conceptual understanding	5	11,90
	partial conceptual understanding	0	0
	understanding concepts but still experiencing misconceptions	2	4,76
	Misconceptions	10	23,81
	not understanding concepts	25	59,52
Heat transfer and Black Principle	conceptual understanding	10	23,81
	partial conceptual understanding	2	4,76
	understanding concepts but still experiencing misconceptions	0	0
	Misconceptions	9	21,43
	not understanding concepts	21	50

Table 1 shows that the level of understanding of students' concepts in each material varies. Students do not understand the concept of being dominated by the concept of the heat transfer properties of the material which is 59.52% and understand the biggest concept in the concept of phase change in the form of a substance of 28.87%. The data obtained shows that in the learning process to understand the concepts of temperature and heat, students cannot be separated from misconceptions. The highest misconception occurred in the concept of temperature and heat of 42.86% and the lowest was in the concept of heat transfer of 21.43%. The profile of the misconceptions that occurred is presented in Table 2.

Table 2. Profile of heat and temperature misconceptions

Concept	Level of Undestanding
Temperature	Temperature is easier to absorb if the initial temperature is low
	The temperature in the surrounding environment affects the final temperature of the object
	The temperature of the mixture of the two objects being mixed is greater than the initial temperature of the object
	Temperature changes are influenced by the size of the heat given
Phase change of object form	The process of changing the form of a substance is accompanied by changes in the temperature of the substance
	Specific heat does not affect the slope of the temperature and time graphs
	When an object is heated continuously, the object's temperature will continue to increase
Properties of materials	In normal conditions, water does not boil at a temperature of 100o Celsius
	Each material is capable of storing different heat energy
	Metal objects can absorb object temperature
	Metals have good conductivity to accept cold temperatures
	Metal is a conductor object so it can conduct temperature
Heat transfer and Black Principle	Only the mass of the object being heated affects the amount of heat that is transferred
	Changes in temperature do not affect heat transfer
	The mass of the first object is greater than the second object, so the first object requires a greater heat
	Heat equals temperature
	The amount of heat energy that the first object gives to the second object is the same because the temperature is the same
	When mixing two objects with different temperatures until thermal equilibrium occurs, what happens is the temperature of the object that flows not heat.

The profile of misconceptions shown in table 2 shows results that are almost similar to previous studies, both those conducted on students and student-teacher candidates[16][17]. These results indicate that misconceptions can happen to anyone and anywhere. Based on previous research there are some similar misconceptions, but some of the research that has been done is given to students or prospective teacher students who have studied heat and temperature material. This shows that even though students' understanding of concepts increases, misconceptions still occur[18].

The varying levels of conceptual understanding indicate that students' lack of understanding of the concepts of temperature and heat affects their learning process[19]. This requires innovation efforts in teaching the concepts of heat and temperature. Research on efforts to improve learning outcomes of temperature and heat material and to reduce misconceptions has been carried out both through the use of inquiry learning methods with virtual laboratories, development of two-tier test tools to assess student understanding, and the development of conceptual change text[20][21][22].

The research that has been done is expected to provide additional information regarding the misconceptions of high school students in Palembang on heat and temperature material. This makes it possible to develop learning tools that are appropriate to the conditions experienced by students. Based on several learning innovations to improve conceptual understanding and reduce misconceptions of temperature and heat and other physics concepts, the use of conceptual change texts provides quite effective solutions. Conceptual change text is a printed or electronic teaching material that is compiled based on the conceptual theory of change so that it causes dissatisfaction with the reader's pre-conception and instills a new conception that is easy to understand and can remediate the misconceptions it has[23]. A solution to change one's conception is explained in the conceptual theory of change which is called the conceptual change model and consists of two basic questions, namely (1) how is the conceptual environment so that the conception can change ?; (2) what are the conditions so that the old conception can be replaced by a new one? [24][25].

Research on conceptual change that has been carried out shows that student-teacher candidates have a better understanding of concepts when studying by being given an analogy related to daily life experiences [26]. Besides, the results of other studies show that the conceptual understanding of prospective teacher-students is significantly better and shows a positive effect when given learning using conceptual change texts enriched with meta conceptual processes [20].

Conceptual changes to change old conceptions into new ones that are correct according to scientific principles using conceptual change texts are not easy. One of the solutions to include the concept of local wisdom to make it easier to understand because it is often encountered in everyday life. Local wisdom is a view of life and knowledge as well as various life strategies in the form of activities carried out by local people in answering various problems in fulfilling their needs [27]. Local wisdom that will be raised in this study is the local wisdom of Palembang City related to the concepts of temperature and heat. An example of Palembang's local wisdom which is related to the concept of temperature and heat is the production of kemplang and the manufacture of smoked fish, where there is a role for heat which causes kemplang and the fish to expand and experience changes in temperature and shape [28].

Based on the description regarding the integration of local wisdom in the text, the conceptual change of heat and temperature is expected to be an alternative in reducing student misconceptions. This is because the misconception is one of the learning problems that must be corrected and reduced immediately so as not to complicate the student learning process at the next level.

4. CONCLUSION AND LIMITATION

4.1. Conclusion

The research concludes that the level of understanding of the concepts of heat and temperature in students varies. The results of the data analysis showed that 28.87% of students understood the concept of changing the form of a substance; 59.52% of students did not understand the concept of the heat transfer properties of materials; and the highest misconception of 42.86% in the concept of temperature. The results obtained are expected to be used as initial information to develop learning tools that focus on improving learning outcomes and reducing misconceptions of heat and temperature.

4.2. Limitation

The limitation of this research is that the research subject is limited to one private school in Palembang City, South Sumatra. This results in the conclusions obtained can only be generalized to the research subject. To obtain a comprehensive profile of heat and temperature misconceptions in senior high schools in Palembang, it is necessary to conduct research on a broader scale and include public and private SMA. However, the implementation must be accompanied by sampling with appropriate sampling techniques so that the conclusions obtained can be generalized to the population.

AUTHORS' CONTRIBUTIONS

Each author has contributed to the preparation of this article. Contributions made include: (1) Study conception and design by Saparini, Murniati, and Syuhendri; (2) Acquisition of data by Rizaldi, W.R .; (3) Analysis and interpretation of data by Saparini; (4) Drafting of manuscript; and (5) Critical revision by Syuhendri and Murniati. The resulting manuscript was then summarized on the 4th Sule-IC by Rizaldi W.R.

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