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Guided Inquiry and PSR In Overcoming Students' Misconception on The Context of Temperature and Heat

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Abstract. Recently, students are still experiencing difficulties and obstacles in the concept of physics. This is due to a lack of correct understanding of students or may be teachers' poor understanding to the concept so that the incorrect concept planting to students happened. Improper understanding or submission of a concept is called misconception. Therefore, to form the well concept of students, one of the models that can improve the conceptual level of students is with guided inquiry which is combined with the practicum, simulation and real practicum (PSR). The purpose of this research is to know the influence of guided inquiry model combined with PSR to decrease students' misconception. The method used in this research is the strong design through *t* test to see the effect of learning model and PSR to student misconception. This research shows there is influence of IT and PSR to student misconception. Thus IT and PSR can be recommended to improve students' conception. The implications of this study are to provide an overview of students' misconceptions reduction with appropriate learning models combined with PSR.

INTRODUCTION

Limited knowledge and the difficulty of understanding the concept of physics is one of the main obstacles for students to understand physics. This constraint is due to a lack of correct understanding of the concept of physics instilled by the teacher from the beginning or also gets a less correct concept of the learning environment [1], [2]. Improper understanding or improper delivery of a concept is called misconception [3], [4]. Misconceptions can be described as an understanding of the concepts that students have and are believed to differ from the concepts advanced by experts. The misconceptions of these students must be straightened out by means of learning associated with natural phenomena that exist around the student and followed by scientific explanation. This is so that scientific understanding can be conveyed appropriately [5].

From researches on misconceptions made by experts in various materials of physics is expected to overcome, prevent or detect misconceptions. To date, many studies have found that students still experience difficulties or misconceptions on temperature and heat matter. Therefore, the efforts to overcome student misconception in temperature and heat matter are important. This is because the material is very closely related to the surrounding environment and a strong foundation to enter a higher level of college [6], [7].

On temperature and heat matter, students often mention that temperature and heat are the same things, whereas temperature and heat are something very different but have attachment [8]. In addition, other studies suggest that students still experience misconceptions about improper definitions of temperature and heat [9]. Therefore students should be assisted in overcoming misconceptions. One way to overcome misconceptions can be done by providing a strategy or learning model. It can change the initial concept of students that are different from the scientific concept. Most students have had preliminary concepts prior to learning [10]. If the initial concept that is believed by the

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students is not in accordance with the scientific concept, it will occur a cognitive conflict in students [11], [12] Students tend to be difficult to change their initial concept, so it takes a scientific concept that can stimulate students to change early concepts that did not fit the scientific concept [13].

One alternative to reduce student misconceptions is to use the inquiry approach [14], [15]. The teacher guides the students to do the activity by giving initial questions and leads to a discussion. The teacher has an active role in determining the problem and the stages of the solution [16], [17]. The guided inquiry learning model represents a series of instructional activities that emphasize the critical and analytical thinking process in searching for and finding out for them the exact answer to a questioned problem [18], [19]. Guided inquiry learning involves students in concepts and principles, and encourages students to have experience and conduct experiments that make it possible to find principles for themselves [20], [21] . The purpose of guided inquiry models is to develop intellectual skills [22], think critically [23], and be able to solve problems scientifically [24]. The inquiry stages include a) orientation, b) formulating the problem, c) formulating the hypothesis, d) collecting data, e) testing the hypothesis, and f) formulating the conclusions. Thus, in this guided inquiry model the students are actively involved in solving a problem the teacher provides [25].

In the matter temperature and heat cannot be directly observed by the naked eye thus It is causes the practice of calor is abstract. In understanding a concept, students connect what is seen, heard and also practiced during learning [26]. In order for students to understand the concept of heat, it is necessary to have a practicum that can be clearly observed by the students. Practicum that can support students in understanding the concept of heat more clearly that is by using the simulation, practicum and real laboratory. Simulations are useful for visualizing complex and invisible concepts with the naked eye [27]. The use of computers in learning, used to display a practicum simulation. A practicum simulation is performed if the practicum is actually less able to provide students with understanding of a concept. In this simulation students can see things that were once abstract to be more real. Real practicum also helps students understand the concept of heat, which can be observed by students in a clear or real. Through real practicum, what is delivered will focus the attention of the students and through observation of the actual event, the student is easier to understand, remember and more easily straighten or correct the deviant concept [28]. By using PSR, it is expected that teachers can be more easily in conveying learning about temperature and heat and easily understand the concept well related to the microscopic state of objects when given heat. Understanding the concept is expected to reduce student misconceptions about temperature and heat. So far, guided inquiry research combined with PSS is still limited even if there is only on learning and certain material [29], [30], [31]. From the number of existing records and studies, the purpose of this study is to reduce students' misconceptions through guided inquiry learning model using practical simulation and real practicum (PSR).

METHODOLOGY

This research uses mixed method research design by combining quantitative and qualitative research [32]. The mixed method research cultivates quantitative data and qualitative data to provide a thorough and in-depth understanding of the problem under study. This type of research design is done using Embedded Experimental Design. The research subject was conducted at SMAK Frateran Malang. The subjects of this study were 10th graders with a sample of one class. Technique of taking data used by simple random sampling with number of student counted 25 student. The research instrument is about the concept of temperature and heat. Data collection techniques used for the research process is embeddedexperimental model which is divided into two that is convergent and squential. In the study, the researchers used the convergent data collection that was done by interview and observation. The collection of qualitative data was taken from data of student conception test for pre-testand post-test. Data analysis technique done is data of pre-testand post-test result tested by using t-test, then calculation of effectsize and N-gain.

RESULT

Description of pre-test and post-test result of concept mastery in experiment class can be shown in Table 1.

TABLE 1. Description of Mastery Concept Data

Degree of Understanding	Average (%)	
	Pre-test	Post-test
Understand Concepts	0.48	0.58
Misconceptions	0.18	0.08
Do not understand	0.33	0.17

Based on Table 1, the average students who mastered the concept increased from 0.48 to 0.58, the mean misconception of students decreased from 0.18 to 0.08, while the average students who did not understand the concept decrease from 0, 33 to 0.17 after being treated. In this study, students' misconception data were obtained based on pre-testand post-test results consisting of 20 numbers including indicators and learning objectives. The following figure describes the results of student misconceptions on each item before and after the treatment shown in Figure 1.

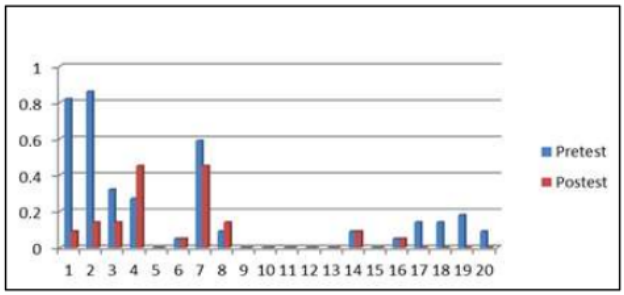

FIGURE 1. Comparison of Misconceptions of Each Item Before and After Treatment

Based on Figure 1, the percentage of misconceptions of the student group at post-test decreases from the percentage of misconceptions at the time of pre-test on item # 1, 2, 3, 7, 17, 18, 19 and 20. While the number 5, 9, 10, 11, 12, 13, and 15 students already understand the concept. Thus, there are two items that represented misconception after post-test namely numbers 4 and 8. Furthermore, the test results data then averaged. The mean results of student misconceptions before and after learning can be shown in Figure 2.

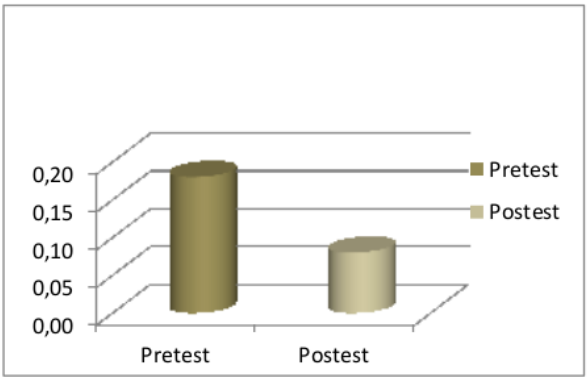

FIGURE 2. Comparison of Misconceptions Mean of Pre-test and Post-test

Based on Figure 2, the mean percentage of comparison of student misconceptions on each item decreased from 0.18 during the initial test to 0.08 in the final test.

Normality test

The result of normality test of mastery of physics concept is presented in Table 2 by using Kolmogrove-Smirnov statistic with SPSS 16.0 for windows program at sig 0,05 level. The result of concept test based on Kolmogrove-Smirnov statistic shows the value of sig pre-test and post-test is 0,200 and 0,165. Because sig value. or probability>0.05 for pre-test (0.200>0.05) and post-test (0.165>0.05) then the data is normally distributed.

Test Concept Mastery Hypothesis

Hypothesis test results can be described as follows.

H_0 : There is no improvement in conceptual mastery by using guided inquiry learning model combined with practical simulation and real practicum.

H_1 : There is an increase in conceptual mastery by using a guided inquiry learning model combined with a practical simulation and a real practicum.

Hypothesis test results are presented in Table 3 by using T-paired with the help of SPSS 16.0 For windows at sig.0,05 level.

The Result of Hypothesis Test of Concept Mastery

Test Criteria: If $sig_{count} < Sig_{tabel}$, then there is an increase and if $sig_{count} > Sig_{tabel}$ then there is no increase. Based on the results of the analysis, conceptualization shows $sig_{count} > Sig_{tabel}$ (0.00 <0.05), so it can be concluded that H_0 is rejected and H_1 is accepted, it indicates there is an increase in concept mastery by using guided inquiry model.

The result of N-gain Mastery Concept

N-gain is used to determine the increase in pretest-posttest value. it was found that the N-gain concept mastery value was 0.23. Based on the category of N-gain / Gain index (Hake, 1998) the range of 0.23 is in the low category, so it can be concluded the improvement of concept mastery on pre-test and post-test is low.

D-Effect Size Mastery Concept Result

D-effect size is used to calculate the power difference between pre-test and post-test. It is found that the D-Effect Size value is 0.26. Based on the category of values D-Effect Size range 0.26 is in the category of moderate effects.

DISCUSSION

The result of the research, guided inquiry learning model combined with the simulation practice and the real practicum influenced the decrease of student misconception. This is supported through the mean percentage of student misconceptions on each item after the lesson. Based on these averages, student misconceptions decreased from 0.18 during the initial test to 0.08 during the final test and had significant differences based on statistical tests. Historical studies also found that the mean degree of misconceptions prior to the study was 57%, while after the study; the mean misconception was 18,86%. This means a decrease in the average degree of student misconception after being given learning with guided inquiry learning model [33].

The result of data analysis toward concept mastery obtained from the multiple choice test showed that the mastery of the concept of students increased after treatment was given. From the multiple-choice preference test given at the time of pre-test and post-test, it was found that the students who understood the concept increased from 0.48 to 0.58, the misconception students decreased from 0.18 to 0.08 and the un-understood students decreased from 0.33 to 0.17. This shows that the level of mastery of the concept increases after the treatment. Learning with guided inquiry can also improve mastery of student concepts. This is evidenced by the analysis $sig_{count} < sig_{tabel}$ (0.000 <0.005). To increase the mastery of pre-test and post-test problems based on normalized N-Gain values are in the

low category with a range of values of 0.23, whereas to calculate the strength of differences between pre-test and post-test use D-Effect Size calculations. Based on the research, it is found that the strength of pre-test and post-test difference is in medium effect category with range 0,26. This is caused by students who still have the ability or mastery of the concept that is not adequate or weak [34], [35], [36]. Therefore, students need to be trained intensively to build better conceptual [37], [38], [39], [40].

This is the sample of Temperature and Heat questions and student answers' discussion. It based on test results and interviews at the beginning and end of learning.

1. In everyday life we know calor (heat). What is a calor?.
A. A form of energy that can be scientifically transferable from high temperature objects to low temperature objects
B. A form of energy that can move from a low temperature object to high temperatures
C. A form of energy that moves from an object that has the same temperature.
D. The size of the degree of coldness of an object.

One of students' answer:
1. If two objects with different temperatures touched it will occur heat transfer from high to low temperature.
2. If two objects with different temperatures are touched it will occur heat transfer from low to high temperature.
3. The heat will stop flowing when the temperature of both objects is the same.
4. If the object receives heat, the temperature of the object will rise, and vice versa if the object releases heat then the temperature of the object will drop.

"Based on test results and interviews in the initial test, misconception students assume that if two objects are touched or mixed then the heat scientifically moves from low to high temperatures. They assume that the heat will come when water is heated and the initial temperature of the water is low and finally hot so that the water temperature rises. There is also a saying that the heat is equal to the temperature so that the heat is a measure of the degree of coldness of an object While the understood students stat that if two objects are touched or mixed then the calor will move from high temperature to low temperature. It was only in the final test that some students who were initially misconceptible and did not understand replied that calor is a form of energy that can be scientifically transferred from objects of high temperature to low temperatures".

2. A steel bar is heated on one end. What happens to these steel molecules once they are heated?
A.The steel molecule will feel hot
B.The molecule in the steel will move in the direction of the heat transfer
C.The distance of the molecules on the steel will be increasingly tenuous
D.The steel molecule will shift toward the heat source

One student's answer:
1. The molecules in the steel come vibrating faster when the temperature on the steel rises.
2. The molecule on steel remains silent as the temperature on the steel rises
3. The molecule in steel moves as the temperature rises but does not move in position, even though the heat moves
4. The molecules in steel move as the heat moves

"Based on test results and interviews in the initial test, the understood students point out that the distance molecules on steel will be increasingly tenuous because molecules in steel to vibrate faster when the temperature on steel rise while the un-understood students state that they are confused whether the convection is accompanied by displacement of the substance particles or not. Then in the final test, students who do not understand state that the range of molecules in the steel will be increasingly tenuous because the molecules in steel come vibrate faster when the temperature on the steel rose".

One example of the Simulation Practicum on the concept of temperature and heat to construct a student conceptual relates to the state of molecules in solids, liquids and gases.

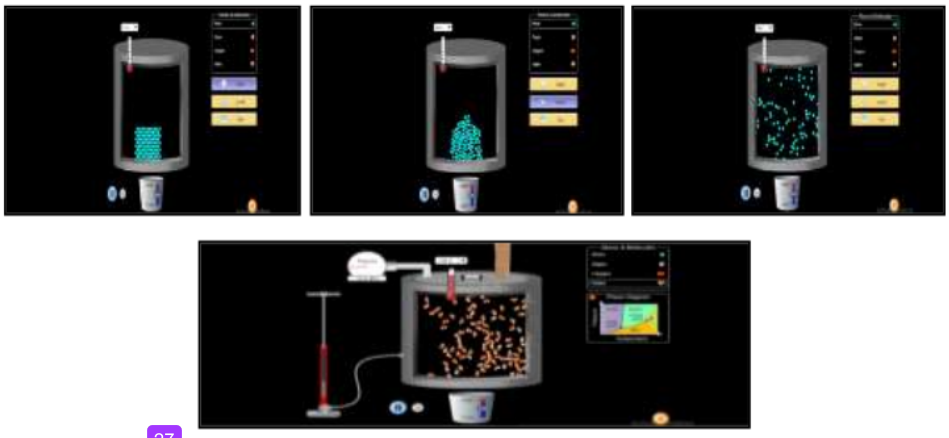

FIGURE 3. a. Particular state of solid, b. liquid, c. Gas objects and d. Particular state of fluid material that are connected with bicycle pump (https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html).

CONCLUSION

Based on the research and hypothesis test results, it can be concluded that there is a difference of misconception of 10th grade students on temperature and calor material before and after learning with guided inquiry learning model combined with practical simulation and real practicum. Another result indicates that there is a decrease in student misconception in the pre-test and post-test process. Thus a guided inquiry learning model combined with a simulated and real practice can reduce student misconceptions and improve students' conceptual concepts for temperature and heat. The implications of this research are to illustrate that the guided inquiry learning model combined with PSR contributes greatly to reducing student misconceptions on physics learning. The limitation of this study is to simply measure students' conceptual material temperature and heat. It is expected that further research can measure other variables that are in line with the guided inquiry learning model to improve students' physics learning outcomes.

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