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Teams games tournaments with cognitive conflict instruction (CCI) model to unveil students' misconceptions

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Abstract

This research aims to identify the physics misconceptions experienced by students on the subject of heat material. This research method uses a three-tier diagnostic test is expected to be able to detect students' misconceptions in physics well. The research participants involved were 150 grade VII students in five state junior high schools in Lamongan district .The development of a close-ended three-tier instrument is based on the students' answers to cognitive conflict instruction (CCI). The analysis results obtained that CCI is a valid and reliable instrument to identify misconceptions. The results of the identification of misconceptions in participants found that 45% of students who were categorized as mastering the concept criteria, there are 35% Misconception criteria, 10% Guessing criteria and 10% of the criteria for not knowing the concept

Keywords: Misconception, Heat material, Three Tier Test

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1. Introduction

One of the suitable learning models is Teams Game Tournament (TGT) cooperative learning model. TGT is a cooperative learning method using academic tournaments, and quizzes and a progress score system, where students compete as representatives of their team with other team members whose previous academic performance is equal to them (Haryono et al., 2018). In addition to choosing a learning model, one way to reduce misconceptions is by using cognitive conflict instruction. The goal is that students can reconstruct the problems faced by the guidance from the teacher and provide opportunities for students to get used to finding and solving problems in a logical, systematic, and directed way to drawing conclusions (Aulia et al., 2018). Cognitive conflict strategies also seek active interaction between students and teachers in the learning process that contrasts cognitive abilities with learning resources so that students can understand concepts correctly. In this situation there is a conflict between what is on the student and a situation that is deliberately created. Active interaction between students and teachers is an important thing in cognitive conflict.

(Sagala et al., 2019) states that cognitive conflict strategy is a conceptual change strategy in an effort to change student misconceptions to the correct concept. (Widiyati, 2012), states that cognitive conflict is an important condition for conceptual change. Cognitive conflict instruction in physics learning are effective enough to reduce student misconceptions in helping to achieve a higher balance of science. Cognitive conflict instruction teach students to solve problems by expressing ideas or ideas so that they are challenged to prove these ideas. This is in line with the results of the study which states that remediation using the TGT cooperative learning model can reduce misconceptions of class X B SMA Negeri 1 Bulu on Temperature and Heat material with an average percentage reduction in misconceptions of 23.33% (Suhu & Kalor, 2015).

According to (Aulia et al., 2018) misconceptions or misconceptions point to a concept that does not correspond to the scientific understanding or conception of the wrong student. Misconception is a major problem that is being faced in the world of education. Misconceptions in physics learning are common. Research shows there are 700 studies on misconceptions in physics, there are 300 misconceptions about mechanics; 159 on electricity; 70 about heat; optics and material properties; 35 about earth and space; as well as 10 studies on modern physics (Handhika et al., 2015). Based on observations made in junior high school as patently as Lamongan, nearly 55% of junior high school students in grade VII experience misconceptions about heat material and changes in substance form. This fact was discovered by researchers through pre-research activities. Pre-research was conducted on students, where 29% understood the concept, 54% experienced misconceptions, 17% did not know the concept in the question table. (Sözbilir, 2003) also explains that the causes of misconceptions are classified into five groups, namely students, teachers, textbooks, context, and teaching methods. One way to reduce misconceptions can be done by using appropriate learning models and strategies.

Misconceptions often occur in all fields of science, such as biology, chemistry, physics and astronomy. No area is free from misconceptions. Even according to Wandersee, Minities and Novak in (Paul, 2013) ,it is clear that misconceptions occur in all fields of physics. In addition, Kasmiati's research cited by (Karademir & Ünver, 2018) states that misconceptions occur not only from the category of students who have low scores, but also experienced by students who have high physics scores.

(Berg, 1991) states that the misconceptions that are often experienced by students are: Temperature and heat are difficult to distinguish, Heat is still often considered a fluid (matter), Hot heat and cold heat are each considered to flow independently, Heat is energy from hot objects. 5.

Temperature is a measure of the mixture of hot heat and cold heat. Hot heat flows from a hot object to a cold object while the direction of cold heat flow is the opposite. Temperature is often considered an extensive variable whose magnitude is related to the amount of matter (mass). For example, if 1 liter of water with a temperature of 60^0C is separated by two times a liter, some students think that the temperature of each portion is 30^0C.

(Paul, 2013) states that the misconceptions that are often experienced by students are: Boiling is the highest temperature reached by an object, The temperature of boiling water increases if it continues to be heated, Heat is not energy, Heat is a substance, Heat only moves upward, Understanding temperature is the same as understanding heat, heat and cold are not the same, temperature is a property of a material, the temperature of an object depends on the size of the object, the temperature of ice is constant and cannot change.

(Saricayir et al., 2016) in his research found 5 kinds of misconceptions related to temperature and heat, including: The temperature is proportional to the mass of the material, the temperature can move like heat, objects that rapidly increase in temperature tend to be slow to fall in temperature, and vice versa, specific heat. and transferability of heat capacity such as temperature, misconceptions about thermal equilibrium. Only (Pancer et al., 2019) in his research found 12 kinds of misconceptions related to temperature and heat, some of which are: Heat is a measure of the temperature of an object, Heat and cold have different properties, Boiling is the maximum temperature reached by a substance, Water always boils at temperature is 100°C regardless of the circumstances, Ice temperature always equals 0°C, Evaporation only occurs after the substance has boiled, and all solids can melt when heated.

One of the causes of the low quality in natural science education is the misconceptions and learning conditions that are less concerned with the preconceptions or initial conceptions that students have. The conception of physics can occur at any level of education, whether in elementary school, secondary school students even teacher or lecturer (Fenditasari et al., 2020) (Fratiwi et al., 2020). According to (Ratnasari et al., 2017) Misconception is an understanding of different concepts between the concepts that students have and the actual concepts. Student misconceptions in natural science materials can be caused by material containing abstract concepts. Abstract concepts are difficult to understand because they require deep thinking to solve problems that cannot be directly observed (Alwan, 2011). One of them in the field of physics is temperature and heat topic.

Good and correct physics learning will be realized by choosing the right model, method, strategy according to the subject matter so that it can reduce misconceptions that have occurred in students. To make students aware of the misconceptions experienced, it can be done by presenting experiences, namely in the form of experimental activities that may conflict with what the students previously thought. The difference between the results of observations and what is thought will lead to cognitive conflict in students' thinking.

Cognitive conflict needs to be generated in dealing with students' misconceptions with the existence of an interesting learning atmosphere and which can challenge students emotionally to be involved in it. This statement is supported by the findings of (Verawati et al., 2019), that cognitive conflict approaches and interesting situations are factors that influence the change in students' conceptions.

Efforts to build cognitive conflict situations in the learning process can be done by applying cooperative learning models. Learning in class always involves interaction between students. The learning model that provides opportunities for students to work cooperatively is a cooperative learning model. Cooperative learning is a learning model that is carried out in groups, students in one class are made into small groups of 4 to 5 people to understand the concepts facilitated by the teacher (Celik, 2016). The cooperative learning model used in this study is the TGT type, a type of cooperative

learning that places students in study groups. Academic games are given to ensure that all group members have mastered the lesson. Student academic games will be divided into tournament tables, where each tournament table consists of 3 to 4 people who are representatives of their respective groups. Ensure every table game so that no participant comes from the same group. Students are grouped in one tournament table homogeneously in terms of academic ability (Prahani et al., 2016).

The cognitive conflict instruction managed by TGT Cooperative is used by researchers so that students can better master the concept and reduce misconceptions on heat material. Students can also form an understanding or conceptual understanding of heat material. Based on the description above, in this study the researcher wanted to examine the effect of TGT type cooperative learning with the cognitive conflict model to reduce heat misconceptions in junior high school students. The goal is to determine the significant effect on heat misconceptions in junior high school students after learning using the TGT cooperative learning model with cognitive conflict instruction.

2. Methods

2.1 Participant

The sample of this research is the students who have received the Heat material, seventh graders. The sample consisted of five 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

2.2. Instrument

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 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 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)

2.3. Data analysis

This analysis aims to identify students' misconceptions about the concept of heat. Identification of student misconceptions was analyzed based on student responses. Students' responses were then categorized into four categories of conceptions. Conception categories include as mastering the concept criteria, misconception criteria, Guessing criteria and the criteria for not knowing the concept (Adimayuda et al., 2020; Aminudin et al. ., 2019; Purwanto et al., 2020).

Misconceptions can be identified by giving multiple choice test questions that are adjusted to the heat subject of junior high school. In the use of the three-tier diagnostic test, multiple choice questions have three levels of answers. For the first level, which is in the form of multiple choice questions in general, the second level is in the form of students 'reasons for choosing answers at the first level, and the third level is in the form of students' confidence in the answers of the previous two levels. This study uses a three-tier diagnostic test with open reasons, because it is expected that the reason given by students is an understanding that has been owned and accepted during the learning process of each student. In addition, there is belief, namely to find out the consistency of students against their understanding. The identification of physics misconceptions uses a three-tier diagnostic test to classify students who understand concepts, misconceptions, and do not understand concepts. Because the mistakes of students in giving answers are not all classified as misconceptions, this can occur because students do not understand the concept. To analyze the data that has been collected, the researcher takes the following steps: (1) Analyzing students 'answers between multiple choice results, reasons and students' beliefs according to the level of understanding on the three-tier diagnostic test. (2) Grouping the categories of students' answers into understanding, lack of understanding, and misconceptions. (3) Calculating the percentage of misconceptions experienced by students on each item. (4) Making conclusions from the data obtained in the form of misconception profiles and misconception percentages.

3. Result and Discussion

3.1 An overview of the percentage of student misconceptions

This research was conducted in five state junior high schools in Lamongan district. This research was conducted on VII grade students. The results indicated that there were misconceptions in the heat material. Based on data analysis from the three tier test diagnostic instrument, there were 45% of students who were categorized as mastering the concept criteria, there are 35% Misconception criteria, 10% Guessing criteria and 10% of the criteria for not knowing the concept can be seen in Figure 1.

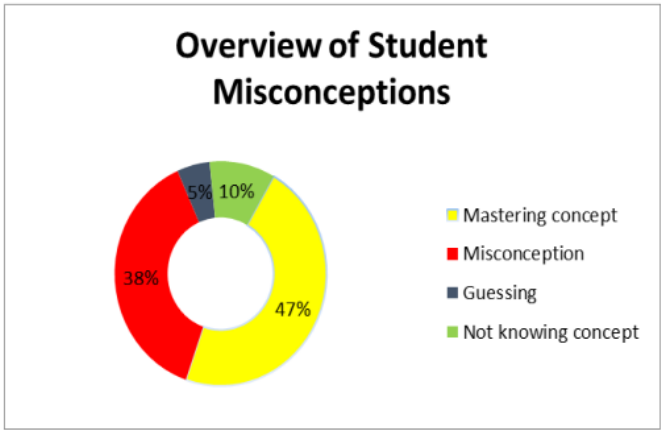

Figure 1. Overview of student misconceptions

Based on the results of the student's conception analysis, the level of conception of grade VII students was still quite low with a percentage of below 50% of the heat material. The cause of not optimal students' conceptions was due to the many alternative concepts. Based on the results of the identification of the number of students who were classified as misconceptions about 30%, due to the students themselves. 10% of students who entered were classified as not knowing the concept because they were unable to abstract the concept properly and most students have forgotten or have weak memory of the previous material that they have learned. The students' weak memory of the material caused students to quickly forget the material and formulas that they have memorized (Tentang et al., 2013) .Only 5% were categorized as guessing category.

The causes of misconceptions were categorized into five aspects originating from students, namely student preconceptions, associative thinking, humanistic thinking, incomplete or wrong reasons and wrong student intuition, can be seen in figure 2.

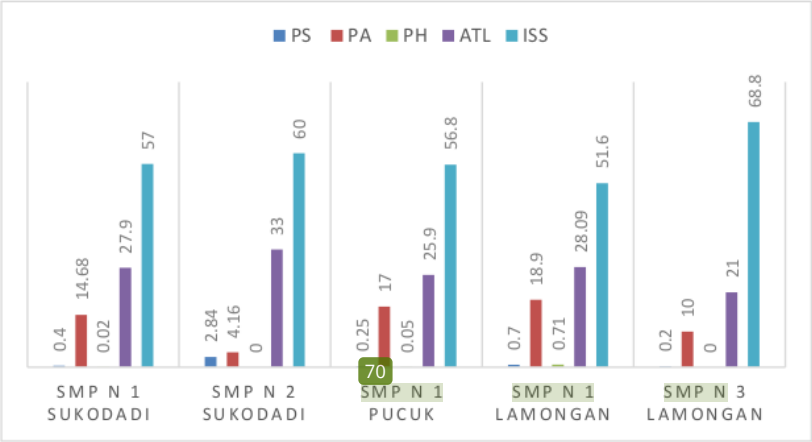

Figure 2. Percentage of Causes of Misconceptions

Description:
SP = Student's preconception
AT = Associative Thinking
HT= Humanistic Thinking
AWR = Incomplete or Wrong Reason
WSI = Wrong Student Intuition

3.2 Data Analysis on the Causes of Misconceptions

This analysis was conducted to obtain a descriptive picture of the research variables used.

a. Classic assumption test

1) Multicollinearity Test

(Ghozali, 2018) Multicollinearity test aims to test whether the regression model found a correlation between independent variables (independent). A good regression model should not have correlation between the independent variables. To show the multicolonierity are:

Tolerance value <0.10; VIF value> 10.

Referring to the two opinions above, based on the results of the research that has been carried out, the following values can be obtained:

Table 2. Multicolonierity Test

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	X1	,350	2,855
	X2	,224	4,457
	X3	,266	3,756
	X4	,537	1,863
	X5	,612	1,633

a. Dependent Variable: Y

From the results of table 1 it can be seen that the student preconception variable (X_1) has a tolerance value of 0.350 with a VIF value of 2.855, Associative Thought (X_2) has a tolerance value of 0.224 with a VIF value of 4.457, Humanistic Thought (X_3) has a tolerance value of 0.266. With a VIF value of 3.756, Incomplete or Wrong Reasons (X_4) has a tolerance value of 0.537 with a VIF value of 1.863 and Wrong Student Intuition (X_5) has a tolerance value of 0.612 with a VIF value of 1.633. Based on this explanation, it can be concluded that the tolerance value for all independent variables is> 0.10 and the VIF value <10. So in this study there is no multicollinearity.

2) Autocorrelation Test

(Ghozali, 2018) states that autocoleration test aims to test whether in the linear regression model there is a correlation between the confounding error in period t with the confounding error in period t-1 (previous). Autocoleration can be detected using the Durbin-Watson test (DW test). The basis for the decision is that if the durbine watson value is between du to 4-du there is no autocorrelation symptom. The results of the analysis can be seen in the table as follows

Table 3. Autocorrelation Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,455[a]	,207	,162	,937	1,794

a. Predictors: (Constant), X5, X1, X4, X3, X2

b. Dependent Variable: Y

It can be seen in table 2 that the value of Durbin Watson in this study was 1.794 while the DW table was significant at 0.05, where N was the number of samples, namely 95, and k was the number of independent variables, namely 5.From the dw table it was obtained the value of DU = 1 , 7781 and dL = 1.5572. So it can be seen in decision making, namely (4-dw)> dU, so there is no negative authorization in this study.

3) The heteroscedasticity test

The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from the residual observations to other observations. If the residual variance from one observation to another is constant, it is called homoscedasticity and if the variance is different it is called heteroscedasticity. If there is a certain pattern, such as the dots that form a certain regular pattern (wavy, widened then narrowed), this indicates that there has been heteroscedasticity. If there is no clear pattern and the dots spread above and below the number 0 on the Y axis, it indicates that there is no heteroscedasticity.

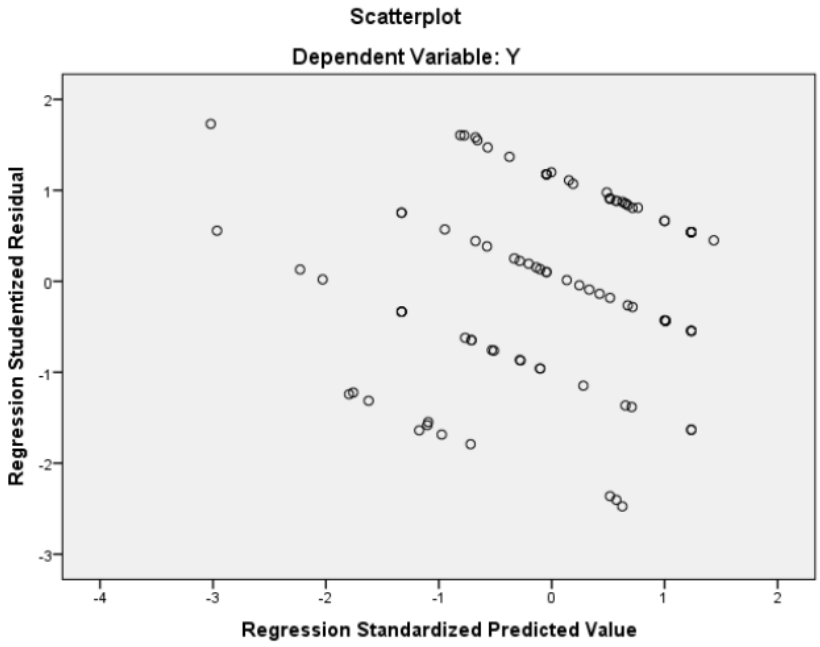

Figure 3. Heteroscedasticity Test

From Figure 3, the results of the heteroscedasticity test by means of a scatterplot of points spread randomly above or below the number 0 and on the Y axis. This shows that there is no heteroscedasticity in the regression model. Thus, this regression model is suitable for students 'preconception variables, associative thinking, humanistic thinking, incomplete or false reasons, student's wrong intuition of misconceptions.

b. normality test

(Ghozali, 2018) states that normality test aims to test whether in the regression model, confounding or residual variables have a normal contribution. It is known that the t and F tests assume that the residual value follows a normal distribution. If this assumption is violated, the statistical test will be invalid for a small sample size. There are two ways to detect whether the residuals are normally

distributed or not, namely by graph analysis. Graph analysis is one of the easiest ways to view residual normality by looking at the distribution of data (points) on the diagonal axis of the graph. Basic decision making.

If the data spreads around the diagonal axis of the graph and follows the direction of the diagonal line, then the regression model meets the normality test. If the data spreads far from the diagonal axis of the graph and does not follow the direction of the diagonal line, the regression model does not meet the normality test.

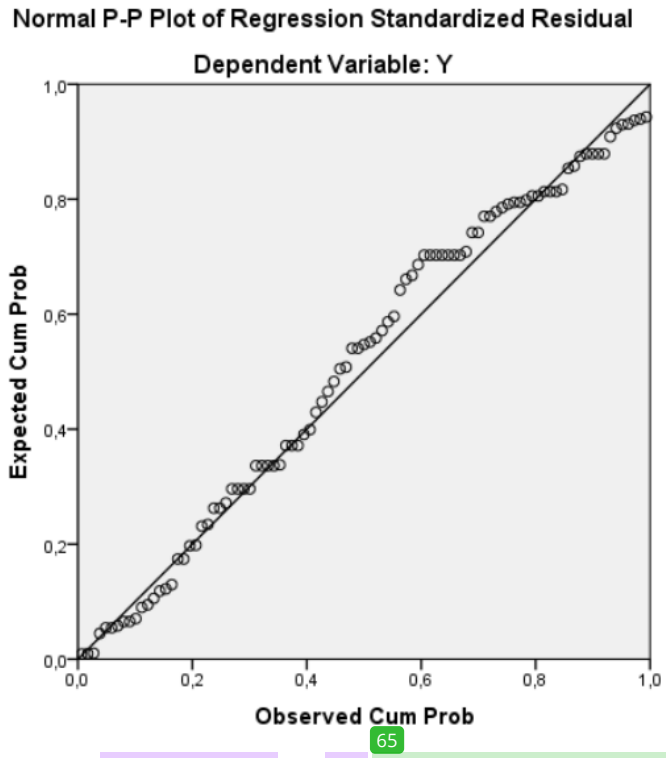

Figure 4. Normal P-P plot of Regression Standardized Residual

From the Normal P-P Dependent Variable Plot above, it can be concluded that the Normal P-P Dependent Variable Plot shows that the points spread around the diagonal line and follow the direction of the diagonal line or, so the regression model meets the assumption of normality.

c. Multiple Linear Regression Test

In the following, the researcher will present an overview of the results of statistical calculations, namely the independent variables X_1, X_2 X_3 on the dependent variable (Y), then the formulation of multiple linear regression analysis used is as follows:

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + \varepsilon$$

Where :

Y = Student Misconception
A = Constant Number
b_1 b_2 b_3 b_4 b_5 = Regression coefficient to be calculated
X_1 = Student's Preconception
X_2 = Associative Thinking X_3 = Humanistic thinking X_4 = Incomplete Reason
X_5 = Student Intuition Wrong
ε = Standard Error

Table 4. Multiple Linear Regression Test Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients
		B	Std. Error	Beta
1	(Constant)	1,515	,589	
	X1	,009	,175	,092
	X2	,129	,205	,197
	X3	,001	,195	, 021
	X4	,272	,162	,333
	X5	,588	,144	,282

a. Dependent Variable: Y

from the results of table 4, the regression calculation shows a regression equation as below:

$Y = 1.515 + 0.009X_1 + 0.129X_2 + 0.001X_3 + 0.272X_4 + 0.588\ X_5$

Description :

The regression equation can be explained as below:

- b_1 = The regression coefficient b_1 Student's Preconception is 0.009 indicating that Student's Preconception has an influence of 0.9% on Student Misconceptions.
- b_2 = The regression coefficient b_2 of associative thinking is 0.129, indicating that associative thinking has an influence of 12.9% on student misconceptions.
- b_3 = regression coefficient b_3 humanistic thinking of 0.001 indicates that humanistic thinking has an influence of 0.1% on student misconceptions.
- b_4 = regression coefficient b_4 for incomplete reasons of 0.272 indicates that incomplete reasons have an effect of 27.2% on student misconceptions.
- b_5 = regression coefficient b_5 wrong student intuition of 0.588 indicates that reasons that are not different from wrong student intuition have an effect of 58.8% on student misconceptions

This means that it has a direction of change in the same direction as the dependent variable. The regression coefficient for the student's wrong intuition variable of 0.588 has a greater value than the other independent variables. Thus it can be concluded that the most dominant factor affecting students' misconceptions is the wrong intuition of students.

Based on Graph 2, it can be explained that the results of the percentage causes of misconceptions from 5 junior high schools in Lamongan district. The results showed that the percentage of causes for misconceptions at SMP N 1 Sukodadi in the student preconception category was 0.4%, Associative Thinking was 14.68%, Humanistic thinking was 0.02%, incomplete or wrong reasons were 27.9% and intuition. 57% of students were wrong. The percentage of causes of misconceptions at SMP N 2 Sukodadi in the category of students 'preconceptions was 2.84%, associative thinking was 4.16%, humanistic thinking was 0%, incomplete or wrong reasons were 33% and students' wrong intuition was 60%. The percentage of causes of misconceptions at SMP N 1 Pucuk in the student preconception category is 0.25%, Associative Thinking is 17%, Humanistic thinking is 0.05%, incomplete or wrong reasons are 25.9% and wrong student intuition is 56, 8%. The percentage

of the causes of misconception SMP N 1 Lamongan in the student preconception category is 0.7%, Associative Thinking is 18.9%, Humanistic thinking is 0.71%, the reasons are incomplete or wrong is 28.09% and the students wrong intuition is equal to 51.6%. And the percentage of the causes of misconceptions at SMP N 3 Lamongan in the student preconception category is 0.2%, Associative Thinking is 10%, Humanistic thinking is 0%, incomplete or wrong reasons are 21% and wrong student intuition is 68.8%. Of the five aspects of the cause of misconceptions the highest is in the category of students' wrong intuition with an average of above 50%.

The results showed that the highest cause of misconception was in the wrong student intuition category, from the five junior high schools in Lamongan district, the wrong intuition category for students was above 50% on average. The highest occurred in SMP Negeri 3 Lamongan, which was 68.8% and the lowest intuition of students was at SMP 1 Negeri Lamongan. The next cause of the misconception is the category of reasons that are incomplete or the percentage is wrong, on average, above 20% of the five junior high schools in Lamongan district. Meanwhile, the percentage of the causes of students' preconceptions, associative thinking and humanistic thinking was under 20% on average.

From the results of the interviews with several students, it was found that almost all students were challenged in taking the diagnostic test in the form of a three tier test, the students were also responsible for giving their answers. Of the five criteria for conception, students are more familiar with the concept than the other criteria, because students have already received heat material beforehand. However, the percentage of misconceptions is also quite high. This is because there are five aspects that cause student misconceptions. The highest aspect of them is the students' false intuition. According to students, the existence of a diagnostic test in the form of a three tier test was able to provide experience with the concept. However, descriptions of questions and reasons that are long enough take a long time to answer.

4. Conclusion

Learning using TGT cooperative with cognitive conflict instruction (CCI) can reduce heat misconceptions. The results of conception identification in students indicate that junior high school students still experience misconceptions about the concept of Heat. These results were obtained based on the results of the instrument tests tested on 150 junior high school students. Based on the results of the research and discussion, it is suggested that: (1) Diagnostic tests using the Three Tier Test can be further developed in other physics materials. (2) It is necessary to evaluate the learning process to minimize misconceptions that occur in students and correct student conceptions that are still wrong.

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