

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

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### Suggested Citation:

Haryono, H. E., Samsudin, A., Aini, K. N., & Siahaan, P., (2021). Teams' games tournaments with cognitive conflict instruction (CCI) model unveil students' misconceptions. *Cypriot Journal of Educational Science*. 16(4), 1343-1355. <https://doi.org/10.18844/cjes.v16i4.5983>

Received from November 17, 2020; revised from March 16, 2021; accepted from April 19, 2021.

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### Abstract

The purpose of this research is to see what physics misconceptions students have regarding heat material. This study employs a three-tier diagnostic exam designed to identify students' physics misunderstandings. 150 grade VII students from five Lamongan district state junior high schools were included in the study. Creating a closed-ended the students' responses to the cognitive conflict instruction are used to create a three-tier instrument (CCI). The findings of the research revealed that the CCI is a viable and reliable tool for detecting misunderstandings. The findings of the detection of misconceptions in participants revealed that 45 % of pupils met the mastery criteria, 35 % met the misconception criteria, and 10% met the guessing requirement.

**Keywords:** Misconception, heat material, three-tier test

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## Introduction

One of the most relevant learning approaches is the cooperative learning paradigm of the team games tournament (TGT). TGT is a cooperative learning approach that involves students competing as team representatives against other team members with equal academic accomplishment through academic tournaments, quizzes, and a progress score system (Haryono, Selirowangi & Aini, 2018). Using the cognitive conflict instruction, in addition to adopting a learning model, is one approach to prevent misunderstandings. The objective is for students to be able to rebuild issues with instructor assistance, as well as providing chances for students to practice discovering and solving problems in a logical, systematic, and direct manner (Aulia, Diana & Yuberti, 2018). Cognitive conflict approaches aim active involvement between learner and instructors in the learning process that contrasts between cognitive capacity and learning resources in order for learners to understand topics correctly. There is a disconnect here between what the pupil is thinking and a situation that has been intentionally created.

According to Sagala, Umam, Thahir, Saregar, and Wardani (2019), the cognitive conflict approach is a conceptual change method that aims to address students' misunderstandings. According to Widiyati (2012), cognitive conflict is a necessary prerequisite for conceptual transformation. In physics, cognitive conflict training is beneficial in reducing student misunderstandings and assisting in the attainment of a better level of science balance. Students are taught to solve issues by expressing thoughts and then being pushed to substantiate these ideas through cognitive conflict teaching. This is in accordance with the findings of the study, which show that remediation utilizing the TGT cooperative learning approach may reduce misunderstandings about temperature and heat material in class X B SMA Negeri 1 Bulu by 23.33 % on average. (Suhu & Kalor, 2015).

According to Aulia et al. (2018), Misconceptions refer to an idea that does not match to the incorrect student's scientific knowledge or conception. In the field of education, misperception is a serious issue. Misconceptions about physics are widespread. There are 700 studies on physics errors, according to research, including 300 on mechanics, 159 on electricity, 70 on heat, optics, and material properties, 35 on earth and space, and 10 on current physics. (Handhika, Cari, Suparmi & Sunarno, 2015). According to observations performed at Lamongan junior high schools, almost 55% of grade VII junior high school pupils had misunderstandings regarding heat material and changes in substance form. Researchers found this information during pre-research efforts. Students were pre-researched, and 29 percent of them grasped the idea, 54 percent had misunderstandings, and 17 percent didn't know the topic in the question table. According to Sozbilir (2003), the reasons of misunderstandings are divided into five categories: students, teachers, textbooks, context, and instructional techniques. Using proper learning models and methods is one way to prevent misunderstandings.

All disciplines of science, including biology, chemistry, physics, and astronomy, are prone to misunderstandings. Misconceptions abound in every field. It is obvious that misunderstandings exist in all disciplines of physics, according to Wandersee, Minsties, and Novak (quoted in Paul, 2013). Furthermore, Kasmiati's research (quoted in Karademir & Unver, 2018) claims that misunderstandings are encountered not just by students with poor physics scores, but also by students with excellent physics scores.

According to Berg (1991), students frequently have misunderstandings about temperature and heat, which are difficult to discern. Heat is still frequently referred to as a fluid (matter). Hot and cold heat are thought to move in opposite directions. Heat is the energy emitted by heated things. The combination of hot and cold heat is measured by temperature. Hot heat travels from a hot item to a cold object, but cold heat travels in the reverse direction. Temperature is frequently seen as a large variable whose size is proportional to the amount of matter present (mass). Some pupils believe that if 1 litre of water with a temperature of 60°C is divided by two litres, the temperature of each component is 30°C.

According to Paul (2013), the following are some common misunderstandings among students: Heat is not an energy; heat is a material; heat only travels upward; boiling is the maximum temperature attained by an item; the temperature of boiling water rises as it is heated; heat is not an energy; Heat is a material that travels upwards exclusively. The terms "temperature" and "heat" are not interchangeable, nor are the terms "hot" and "cold." The temperature of a thing is proportionate to its size, whereas the temperature of ice is constant and cannot change.

In their study, Saricayir, Ay, Comek, Cansiz, and Uce discovered five types of misconceptions about temperature and heat, including that temperature is proportional to the mass of the material; temperature can move like heat; objects that rapidly increase in temperature tend to be slow to fall in temperature, and vice versa; and that temperature is proportional to the mass of the material; misunderstandings about thermal equilibrium; and specific heat and transferability of heat capacity, such as temperature. Only Pancer, Rino, Ruhayat, and Wibowo (2019) discovered 12 types of misunderstandings about temperature and heat in their research, some of which are as follows: Heat is a unit of measurement for an object's temperature; heat and cold have different characteristics; a substance's highest temperature is called boiling. Regardless of the circumstances, water boils at a temperature of 100°C; ice temperature is always 0°C. Only after the material has boiled can it evaporate, and all solids can dissolve when heated.

Misconceptions and learning circumstances that are less concerned with students' preconceptions or early notions are one of the reasons of low quality in natural science education. Physics may be conceived at any level of education, including elementary school, secondary school, and even instructors and lecturers (Fenditasari, Jumadi, Istiyono & Hendra, 2020; Fratiwi et al., 2020). According to Ratnasari, Sukarmin and Suparmi (2017), a misperception is a gap in understanding between what pupils think they know and what they really know. Material containing abstract notions might lead to students' misunderstandings in natural science materials. Abstract notions are difficult to grasp since they need profound thought in order to address issues that cannot be noticed directly. In the realm of physics (Alwan, 2011). One of them is the issue of temperature and heat in the physics field.

Good and proper physics learning will be achieved by selecting the appropriate model, technique, and approach for the subject matter in order to reduce student misunderstandings. It may be done by providing experiences to make pupils aware of the misunderstandings they have. Specifically, in the form of experimental activities that may contradict the students' past beliefs. The disparity between what is observed and what is believed will cause cognitive conflict in students' thinking.

With the presence of an intriguing learning environment that may push students emotionally to be interested in it, cognitive conflict must be produced in dealing with students' misunderstandings. This assertion is confirmed by Verawati, Prayogi Gummah, Muliadi and Yusup (2019) results that cognitive conflict methods and intriguing circumstances are elements that affect students' perceptions changing.

Cooperative learning models can be used to help create cognitive conflict situations throughout the learning process. In class, students are continuously interacting with one another. Learning in a group setting is a method of instruction that allows students to collaborate. Learning in a group is a group learning paradigm in which students in a single class are separated into small groups of four to five persons to better comprehend ideas that are guided by the teacher (Celik, 2016). The TGT Learning in a group setting, This research used a type of cooperative learning that groups students into study groups. Academic games are used to make sure that everyone in the group understands the material. Students will be separated into tournament tables for academic games, with each tournament table consisting of three to four persons who are representatives of their respective groups. Every table game is set up such that no two people from the same group are seated at the same time. In terms of academic aptitude, students are classified into one tournament table (Prahani, Limatahu, Soegimin, Yuanita & Nur, 2016).

Researchers utilize the TGT cooperative's cognitive conflict training to help students better understand the notion and eliminate misunderstandings about heat material. Students might also develop a conceptual or theoretical grasp of heat material. In this study, based on the aforementioned description, the study sought to see if combining TGT type cooperative learning with the cognitive conflict model might help junior high school pupils minimize their heat misunderstandings. The objective is to see if studying the TGT cooperative learning model with cognitive conflict teaching has a substantial impact on heat misunderstandings in junior high school pupils.

## **1. Methods**

### *2.1 Participant*

The participants in this study were seventh-grade pupils who had been given the heat substance. The sample included SMP N 1 Lamongan, SMP N 1 Pucuk, SMP N 1 Sukodadi, SMP N 3 Lamongan, and SMP N 2 Sukodadi, all of which are located in Lamongan city. The pupils in this research were in seventh grade, and there were 150 of them, There were 60 men in total and 90 female pupils between the ages of 12 and 13. A random sample of Class VII pupils was chosen from each school to check for misunderstandings that students may have after learning about temperature and heat.

### *2.2. Instrument*

A diagnostic tool and student interview guidelines were utilized as research tools. The diagnostic tool was created based on numerous relevant journals' references to misunderstandings about temperature and heat. There is a misunderstanding in every item. Interview suggestions were developed based on the findings of the misunderstanding diagnostic. The interview questions were identical to the diagnostic instrument's inquiries. Twenty questions make up the three-tiered diagnostic tool. Each question includes three levels: a set of frequent replies, a set of explanations

and a level of trust in the answers and justifications the eight potential permutations of students' replies, as well as the categorization standards for answers to the concept mastery questions at each level, are depicted in Table 1.

**Table 1 shows the three-tiered test's answer categories.**

<b>Tier 1</b>	<b>Tier 2</b>	<b>Tier 3</b>	<b>Type</b>
Correct	Correct	Confident	Mastering the Concept (MK)
Correct	Incorrect	Confident	Misconception (MS)
Incorrect	Correct	Confident	Misconception (MS)
Incorrect	Incorrect	Confident	Misconception (MS)
Correct	Correct	Having doubts	No Preconceptions, Just Guessing (MB)
Correct	Incorrect	Having doubts	Do not understand the idea (TT)
Incorrect	Correct	Having doubts	Do not understand the idea (TT)
Incorrect	Incorrect	Having doubts	Do not understand the idea (TT)

### 2.3 Analyzing data

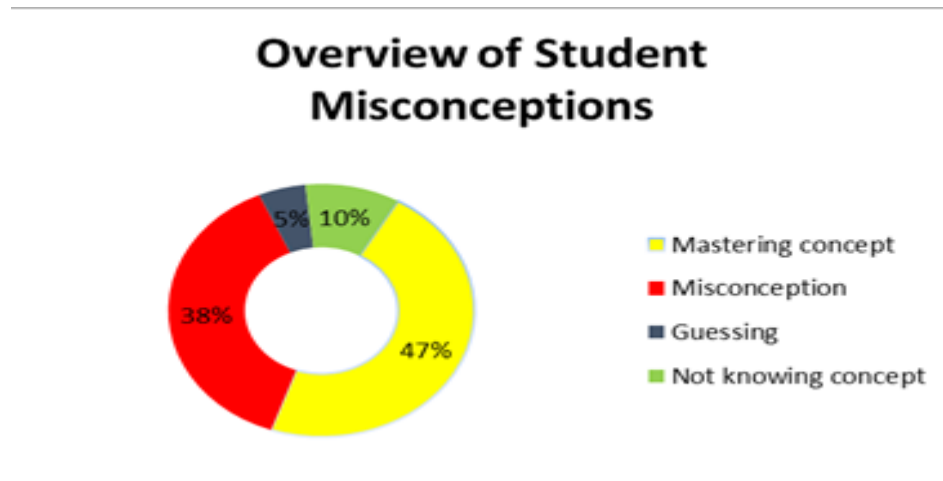
The purpose of this research is to discover what misunderstandings pupils have about heat. Based on student replies, the identification of student misunderstandings was examined. The replies of the students were then divided into four groups based on their conceptions. Mastering the idea criteria, misunderstanding criteria, guessing criteria, and criteria for not knowing the concept are all examples of conception categories (Adimayuda et al., 2020; Aminudin et al., 2019; Purwanto et al., 2020).

Multiple-choice questions tailored to the junior high school heat subject might be used to identify misconceptions questions with several answers when utilizing the three-tier diagnostic exam, provide three levels of replies. The first level is made up of multiple-choice questions; the second level, in general, is made up of students' explanations the first level is for picking responses; the second level is for students' trust in the answers from the first two levels; and the third level is for students' confidence in the answers from the first two levels.. Because it is assumed that the explanation supplied by students is an understanding that has been owned and accepted during each student's learning process, this study employs a three-tier diagnostic exam with open reasons. Furthermore, there is the idea that specifically, to determine the consistency of pupils' knowledge. Pupils are divided into three categories using a three-tier diagnostic exam: those who comprehend ideas, those who have misunderstandings, and those who do not understand concepts. Because not all student errors in answering questions are regarded as misunderstandings, this might happen if pupils don't grasp the topic. The researcher performs the following procedures to analyze the data he or she has gathered: (1) Comparing students' responses on the three-tier diagnostic test to multiple-choice results, explanations, and beliefs. (2) Sorting the categories of the pupils' responses into 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.

## 2. Result and Discussion

### 2.1 A summary of the percentage of students that have misunderstandings

This study took place in five Lamongan district state junior high schools. The kids in this study were in seventh grade. The findings revealed that there were several misunderstandings about heat material. According to the data analysis from the three-tier exam diagnostic instrument, 45 percent of students were classified as mastering the concept criteria, 35 percent as misunderstanding criteria, 10% as guessing criteria, and 10% as not knowing the concept set of criteria., as shown in Figure 1.



**Figure 1.** Overview of student misconceptions

The degree of conception of grade VII students was still relatively poor, with a percentage below 50% for the heat substance, according to the results of the students' conception study. The numerous alternative notions were the cause of non-optimal student conceptions. The percentage of pupils categorized as having misunderstandings was estimated to be around 30% based on the findings, as a result of the kids' own actions. Because they were unable to abstract the idea correctly, 10% of the students that entered were categorized as not knowing the concept, and the majority of the students had forgotten or had a poor recollection of the preceding information that they had learned. Students' poor recall for the content lead them to forget the material and formulae they had memorized rapidly (Tentang et al., 2013). Only 5% were categorised as the guessing category.

As illustrated in Figure 2, the sources of misunderstandings were divided into five categories: student preconceptions, associative thinking, humanistic thinking, inadequate or incorrect reasoning, and incorrect student intuition.

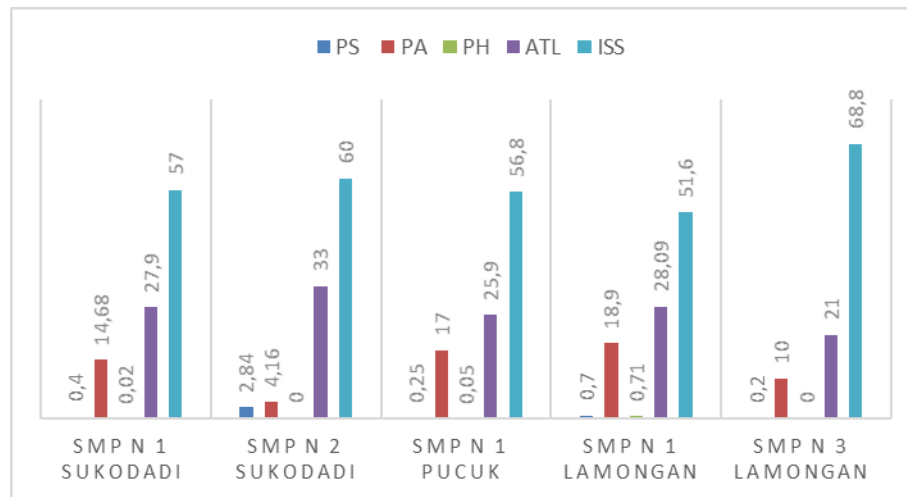


Figure 2: Percentage of causes of Misconceptions

Description:

SP = Student's preconception

AT = Associative Thinking

HT = Humanistic Thinking

AWR = Incomplete of Wrong Reason

WSI = Wrong Student Intuition

### 3.2 Data Analysis on the Causes of Misconceptions

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

#### A. Classic assumption test

##### 1) The Multicollinearity test

The multicollinearity test is used in regression models to see if there is a link between independent variables (independent variables) (Ghozali, 2018). There should be no connection between the independent variables in a decent regression model. A tolerance value of 0.10 and a VIF value of  $> 10$  imply multicollinearity. Based on the investigation's findings, what's next values may be calculated in relation to the two viewpoints stated above.

**Table 2.** The Multicollinearity Test

Model	Coefficients <sup>a</sup>	
	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

Table 2 shows that the student preconception variable (X1) has a tolerance of 0.350 and a VIF of 2.855. The tolerance value for associative thinking (X2) is 0.224, whereas the value of the VIF is

4.457. The tolerance value for humanistic thinking (X3) is 0.266, with a VIF value of 3.756. The importance of tolerance for incomplete or incorrect justifications (X4) is 0.537, Wrong student intuition (X5) has a tolerance value of 0.612, with a VIF value of 1.633, and Wrong student intuition (X5) has a tolerance value of 0.612. According to this explanation, the importance of tolerance for all independent variables is  $>0.10$ , and the VIF value is less than 10. As a result, no multicollinearity exists in our research.

## 2) Autocorrelation test

According to Ghozali (2018), In a linear regression model, the autocorrelation test is performed to check if there is a connection between confounding errors in periods  $t$  and  $t-1$  (prior). Autocorrelation may be identified by utilizing Durbin–Watson test (DW test). The decision is based on the fact that when the DW value is between  $d_U$  and  $4-d_U$ , there is no autocorrelation symptom. Table 3 shows the findings of the investigation.

**Table 3.** Autocorrelation Test

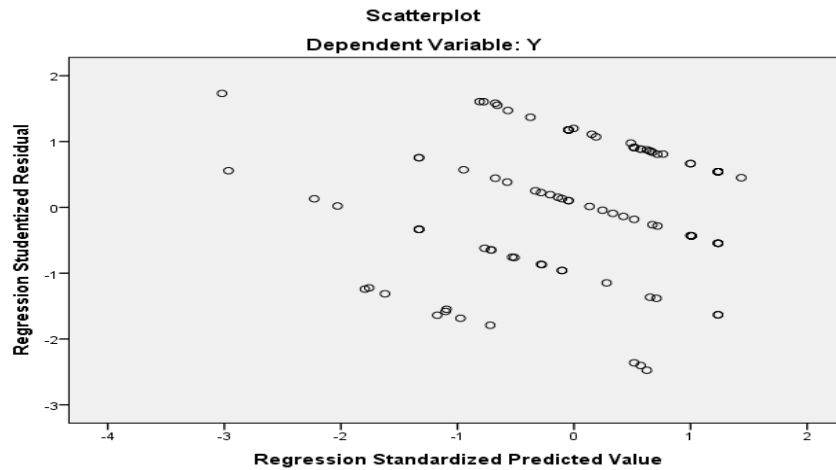
Model Summary <sup>b</sup>					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,455 <sup>a</sup>	,207	,162	,937	1,794
a. Predictors: (Constant), X5, X1, X4, X3, X2					
b. Dependent Variable: Y					

DW's value in this study was 1.794, and the DW table was significant at 0.05, as shown in Table 3, where  $N$  represents the number of samples (95), and  $k$  represents the number of factors that are independent (five). The result for  $d_U = 1.7781$  and  $d_L = 1.5572$  was calculated using the DW table. As a result, it can be shown in decision-making, namely  $(4-DW) > d_U$ ; hence, in this study, there is no negative authorization.

## 3) The test of heteroscedasticity

The test of heteroscedasticity is used to examine if the residual data differ from the other observations in the regression model in terms of variance. When the residual variance from one observation to the next is constant, homoscedasticity occurs, but heteroscedasticity happens when the variance is varied. If the dots form a regular pattern, it's a good sign (wavy, broadened, after which it was constricted), There was heteroscedasticity, as evidenced by this. There is no heteroscedasticity if there is no discernible pattern and the dots are evenly distributed above and below the number 0 on the  $y$ -axis.





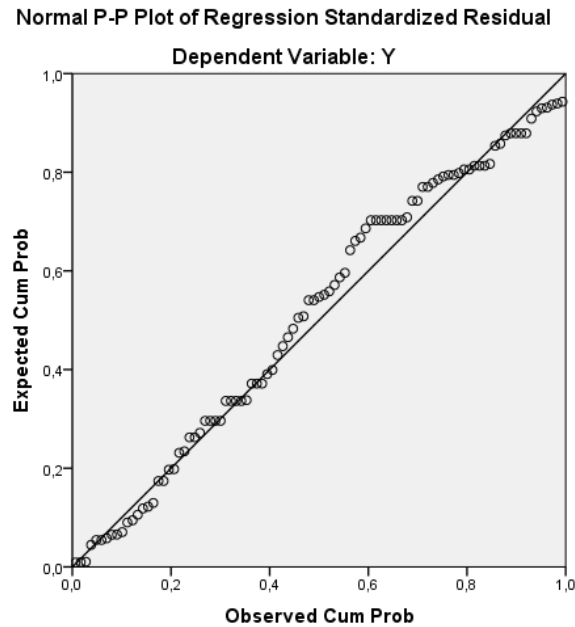
**Figure 3.** Test heteroscedasticity

Figure 3 depicts the test of heteroscedasticity findings as a scatterplot of dots randomly distributed the upper and lower the number 0 on the y-axis. It demonstrates that the regression model has no heteroscedasticity. As a result, this regression model is appropriate for variables such as students' preconceptions, associative thinking, and humanistic thinking, incomplete or false reasons and students' wrong intuition of misconceptions.

#### *B. The Normality test*

The normality test is used to check if confounding or residual variables have a normal contribution to regression model, according to Ghazali (2018). The t and F tests are well-known for assuming a normal distribution for the residual value. If this assumption is broken, the statistical test will be invalid for a small sample size. One of the two approaches for assessing if the residuals are consistently distributed is graph analysis. Graph analysis is one of the simplest techniques to assess residual normalcy. Fundamental decision-making is done by seeing at the distribution of data (points) on the diagonal axis of the graph.

The regression model passes the normality test if the data spreads around the diagonal axis of the graph and follows the direction of the diagonal line. The regression model fails the normality test if the data spreads far away from the graph's diagonal axis and does not follow the direction of the diagonal line.



**Figure 4.** Normal P–P plot of regression standardised residual

The dots spread out around the diagonal line and in the normal direction follow the diagonal line's path P–P dependent variable plot in Figure 4, showing that the regression model meets the criterion of normality.

#### C. Multiple linear regression test

The following, the researcher presents an overview of the results of statistical calculations, namely the independent variables  $X_1$ ,  $X_2$ ,  $X_3$  on the dependent variable  $Y$ , and then 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;

$\varepsilon$  = Standard error

**Table 4.** Multiple linear regression test results

		Coefficients <sup>a</sup>		
		Unstandardised coefficients		Standardised coefficients
Model		B	Std. error	Beta
1	(Constant)	1.515	,589	
	X1	0.009	0.175	0.092
	X2	0.129	0.205	0.197
	X3	0.001	0.195	0.021
	X4	0.272	0.162	0.333
	X5	0.588	0.144	0.282

<sup>a</sup>Dependent variable: Y.

From the results of Table 4, the regression calculation shows a regression equation as follows:  $Y = 1.515 + 0.009X_1 + 0.129X_2 + 0.001X_3 + 0.272X_4 + 0.588X_5$

Description:

The regression equation can be explained as below:

- ▢  $b_1$  is the regression coefficient where students' preconception is 0.009, indicating that students' preconception has an influence of 0.9% on students' misconceptions.
- ▢  $b_2$  is the regression coefficient where associative thinking is 0.129, indicating that associative thinking has an influence of 12.9% on students' misconceptions.
- ▢  $b_3$  is the regression coefficient where humanistic thinking is 0.001, indicating that humanistic thinking has an influence of 0.1% on students' misconceptions.
- ▢  $b_4$  is the regression coefficient where incomplete reasons is 0.272, indicating that incomplete reasons have an effect of 27.2% on students' misconceptions.
- ▢  $b_5$  is the regression coefficient where wrong student intuition is 0.588, indicating that reasons that are not different from wrong student intuition have an effect of 58.8% on students' misconceptions

This indicates that it is changing in the same direction as the dependent variable. The regression coefficient of 0.588 for the students' incorrect intuition variable is higher than the other independent variables. As a result, it may be stated that the most important element influencing students' misunderstandings is their incorrect intuition.

The percentage of causes for misunderstandings from the five junior high schools in the Lamongan district may be described using Figure 2. The percentage of causes for misunderstandings in the student preconception category at SMP N 1 Sukodadi was 0.4 %, associative thinking was 14.68 %, humanistic thinking was 0.02 %, incomplete or incorrect reasons were 0.02 %, and intuition was 27.9 %. 57 %of the pupils were incorrect. At SMP N 2 Sukodadi, the proportion of causes for mistakes in the area of students' preconceptions was 2.84 %, associative thinking was 4.16 %, humanistic

thinking was 0 percent, incomplete or incorrect explanations were 33%, and students' incorrect intuition was 60%. At SMP N 1 Pucuk, 0.25 % of causes of misconceptions were due to student preconceptions, 17 % to associative thinking, 0.05 % to humanistic thinking, 25.9% to incomplete or incorrect explanations, and 56.8% to incorrect student intuition. In SMP N 1 Lamongan, the student preconception category had 0.7 % of the causes of mistake, associative thinking had 18.9%, humanistic thinking had 0.71 %, incomplete or erroneous reasoning had 28.09 percent, and students' faulty intuition had 51.6 % At SMP N 3 Lamongan, the percentage of causes of misconceptions in the student preconception category was 0.2 percent, associative thinking was 10%, humanistic thinking was 0%, incomplete or incorrect explanations was 21%, and improper student intuition was 68.8%. With an average of more than 50%, the category of students' incorrect intuition was the highest among the five causes of misunderstandings.

The results indicated that the category of erroneous student intuition was the most prevalent source of misunderstanding, which accounted for more than half of all misconceptions across the five junior high schools in the Lamongan area. The largest percentage of pupils had intuition in SMP N 3 Lamongan 68.8%, whereas the lowest percentage had intuition in SMP 1 N Lamongan. The second source of misunderstanding is the category of incomplete or incorrect reasoning, which affects more than 20% of the five junior high schools in the Lamongan district. Meanwhile, the reasons of students' preconceptions, associative thinking, and humanistic thinking accounted for less than 20% of the total.

Almost all students were challenged in taking the diagnostic exam in the shape of a three-tier, according to findings interviews with numerous students; the students were also responsible for presenting their responses because students had already received heat material, they were more familiar with the idea than the other four criteria for conceptualization, because the pupils have already been given heat material. However, there is a significant rate of misunderstandings. This is because there are five factors that contribute to pupils' misunderstandings. The pupils' erroneous intuition is the most important element of them. The availability of a diagnostic exam in the shape of a three-tier was able to give students with experience with the issue. Students were able to get experience with the idea thanks to the presence in the form of a diagnostic examination a three-tier test. Long explanations of queries and arguments, on the other hand, require a long time to respond to.

### **3. Conclusion**

Heat misconceptions may be reduced by learning utilizing the TGT cooperative with CCI. According to the findings of student conception identification, junior high school pupils still have misunderstandings regarding the notion of heat. These findings were derived from the outcomes of 150 kids from junior high instrument exams. Based on the findings and discussion, it is proposed that (1) diagnostic tests based on the three-tier test be developed further in additional physics materials. (2) It is critical to evaluate the learning process order to reduce student misunderstandings and rectify misconceptions that still exist.

### **4. Acknowledgements**

The writer want to say thanks you the Ministry of Research and Technology/National Agency for Research and Innovation for funding this study, as well as the author's family for their unwavering bost and assistance throughout the method of investigation, and the scholarly community at large of the Islamic University of Darul 'Ulum Lamongan for their assistance in writing this article.

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