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Conceptual Understanding of Immune System: Implementation of Teams Games Tournament Learning Model Using Kahoot

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ABSTRACT

The immune system material requires a level of abstract thinking, this abstract material makes it difficult for students to learn. Complex and abstract subject matter requires a good understanding of concepts. One way to make it easier for students to understand the concept is by actively involving students and planning effective learning through the cooperative learning model of the Teams Games Tournament (TGT) type using Kahoot. The cause of this look at turned into to decide the effect of the Teams Games Tournament (TGT) cooperative learning model using Kahoot on understanding the concept of the immune system. This studies is a quantitative study the use of a quasi-experimental approach with a pretest-posttest non-equal control group design. The instrument grid is based on indicators of understanding the concept according to Anderson & Krathwohl (2001). The average N-Gain inside the experimental class the usage of the TGT Kahoot is higher than N-Gain in the PBL learning model inside the control class, which is 0.85 compared to 0.75. There is an influence of the TGT learning model using Kahoot on students' conceptual understanding of the immune system material. The application this model requires good classroom management and stable internet connection.

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Introduction

Immune system material requires students to learn about the activation of immune system processes that exist in the human body as a complex coordination mechanism of cells, tissues, and organs that work together to protect the body against viral, bacterial, and foreign body infections (Ristanto et al., 2020). The immune system material requires a level of abstract thinking, this abstract material makes it

difficult for students to learn (Dewi, et.al., 2016). Complex and abstract subject matter requires a good understanding of concepts (Alighiri, et.al., 2018). Conceptual understanding is very important so that learning objectives are achieved (Ristanto, et al., 2018). Understanding is the student capability to derive the authentic meaning of a concept and be able to explain it in their own language (Ristanto et al., 2020). Learning will be more meaningful and can be expanded when students are faced with situations where concepts are applied (Kono

et.al., 2016). Conceptual understanding must be considered in learning to achieve the learning process (Ristanto et al., 2018). Efforts to increase conceptual understanding in the learning process can be done using quality improvement, namely by using examples of synchronous learning (Trilipi et al., 2019). Understanding concepts can help students identify, solve problems, and draw conclusions (Ristanto et al., 2020).

Understanding the concepts and benefits of the learning process itself isn't always the principle attention of the education system so far (Smarabawa et.al., 2013). So far, education is only concerned with obtaining the final result (Smarabawa et.al., 2013). Subject matter that is dense enough to make students more likely to memorize information obtained without trying to relate concepts that have been studied before (Shabania et al., 2015). Kono et al., (2016) revealed that the low understanding of concepts was caused by many factors including not yet maximal students in the learning process, teaching facilities were still limited, learning strategies used by teachers did not involve students cooperatively, still dominated by conventional learning, and students were still lacking in empowerment. The same thing was expressed by Patrianingsih & Kaseng (2016) revealed that the factors that cause weak concepts are conceptual understanding that is not appropriate, students are incomplete in receiving information, interest in learning, and low student experience. One way for students to easily understand concepts is by actively involving students (Tendrita et al., 2017). Various efforts can be used to overcome this, namely the need to use learning methods or media in which there are ways to find out the concepts students already have and so they can keep in mind the material for an extended time period (Masrurroh et al., 2014).

TGT learning model is cooperative learning that make uses of academic tournaments in the form of quizzes with a score system that shows individual progress, in which students compete as representatives in their respective groups with other team participants whose educational overall performance is equivalent to theirs (Slavin, 2015). The TGT learning model that is implemented effectively provides direct experience to students, so they can construct an understanding of the concepts they receive (Velloo & Chairhany, 2013). The TGT learning model makes it simpler for students to recognize concepts through active and fun learning experiences in groups (Oktavia, 2015). In the syntax of the TGT learning model, it usually uses a learning media to make it more

interesting for students (Marwanto et al., 2018). In times, various application-based media have emerged to support the learning process (Mulyani & Haliza, 2021). Internet-based applications must be used by educators as a form of variation in learning in order to attract students more and improve their achievement (Bunyamin et al., 2020). Kahoot is a game-based student response system (GSRS) briefly remodeling school rooms into games, instructors as game show hosts, and students as competitors (Wang, 2015). The purpose of Kahoot is to growth motivation, engagement, amusement and attention, enhance studying achievement and class dynamics (Wang & Tahir 2020).

The aimed of this study became to decide the impact TGT cooperative learning model the usage of Kahoot on understanding the concept of the immune system. The benefit of this research is to become input and consideration for biology learning in schools by applying learning models using appropriate media on immune system material. Then, it is hoped that it can become an additional source of information and reference for teachers regarding learning models using technology-based media to improve the ability to understand concepts in immune system material.

Method

This studies is a quantitative study the use of a quasi-experimental approach with a pretest-posttest non-equivalent control group design (Table 1). The independent variable on this study is the teams games tournament (TGT) learning model the usage of Kahoot whilst the dependent variable on this study is understanding the concept of the immune system.

The description of the table is O_1 = Pretest scores in the experimental class, O_2 = Posttest scores with the TGT learning model, O_3 = Pretest scores in the control class, O_4 = Posttest scores with the PBL learning model, X_1 = Treatment with the TGT learning model using Kahoot, X_2 = Treatment with the PBL learning model.

Table 1. Pretest-Posttest Non-Equivalent Control Group Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

The populace on this study have been all students of science class XI Senior high school 1

Sukabumi, then two classes were selected using Purposive Sampling approach, particularly class XI science 1 and XI science 2 because the two classes were considered equivalent in academic achievement based on the teacher's recommendation. The class that have become the experimental class and the control class were selected by Cluster Random Sampling regardless of the superior class status. The Simple Random Sampling technique using the Slovin formula is used to determine the minimum number of samples used so that out of the total students, students are obtained as research samples so that out of a total of 77 students, 66 students are obtained as research samples.

The instrument grid is based on indicators of understanding the concept according to Anderson & Krathwohl (2001). The tool is within the form of a multiple choice test totaling 50 questions with 5 answer choices which will previously be tested for validity and reliability. The test instruments used are valid and reliable questions to measure expertise of the concept of the immune system material. hypothesis testing the usage of independent t-test with assist of SPSS version 25. The lattice test instruments for students' understanding of the concept of the immune device are provided in Table 2.

Table 2. Immune System Material Concept Understanding Instrument Grid

Question Indicator	Aspects of Conceptual Understanding						Number of Questions
	C1	C2	C3	C4	C5	C6	
Describe non-specific (natural) defense mechanisms of the body	1, 2	3*, 4	5		6, 7, 8		8
Detailing the components of specific (adaptive) immune responses	9	10, 11	13		12, 14		6

Describe the interaction between antigen and antibody	15	16*	17, 18	19*	20	21*	7
Describe the cells involved in the immune response			22, 23	24	25, 26		5
Explain the mechanism of humoral immune response and cellular immunity				27	28*, 29, 30	31, 32*	6
Explain the various types of immunity, programs, and types of immunization	33	34*	35*, 36		37, 38, 39	40*	8
Analyze the factors that affect the immune system		41	42, 43		44, 45*		5
Analyze immune system disorders	46	47*	48	49		50*	5

Number of questions	6	8	11	12	8	5	50
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*Questions that are not valid and reliable

Concept comprehension test questions on the experimental and control class are assessed by the subsequent formula:

$$Score = \frac{score\ obtained}{maximum\ total\ score} \times 100$$

The scores received by students in the experimental and control class are then interpreted into categories for assessing conceptual understanding according to Kartika (2018) as proven in Table 3

Table 3. Interpretation of Concept Understanding Values

Scores	Category
85.00 - 100	Very good
70.00 - 84.99	Well
55.00 - 69.99	Enough
40.00 - 54.99	Low
0.00 - 39.99	Very low

(Kartika, 2018)

Student scores can also be used to see an increase in conceptual understanding for each indicator using the following formula:

$$Score = \frac{score\ obtained}{maximum\ total\ score} \times 100\%$$

The percentage of scores obtained is then interpreted into the criteria for indicators of understanding the concept according to Adhani & Rupa (2020) as shown in Table 4

Table 4. Percentage Interpretation of Concept Understanding Indicators

Percentage	Category
$x \leq 30\%$	Low
$30 \leq x \leq 60\%$	Medium
$x \geq 61-100\%$	High

(Adhani & Rupa, 2020)

The increase in students' conceptual understanding after the implementation TGT learning model is determined through the interpretation by the <g> gain index value. According to Meltzer (2002), the equation for the gain index value is as follows:

$$<g> = \frac{posttest\ score - pretest\ score}{max\ score - pretest\ score}$$

The calculation results are interpreted using the gain index <g> according to Hake (1998) as in Table 5

Table 5. Gain Index Interpretation

Gain Index	Interpretation
$g > 0.70$	High
$0.30 < g \leq 0.70$	Medium
$g \leq 0.30$	Low

(Hake, 1998)

Results and Discussion

Based on the research, data had been received inside the form of pretest and posttest results for understanding the concept of the immune system in the experimental class using TGT learning model using Kahoot and the control class using the PBL learning model.

Data at the outcomes of tests on understanding the concept of the immune system were obtained from pretest data (before the implementation of learning) and posttest data (after the implementation of learning). The data in table 6 indicates that the class that applies the TGT learning model indicates higher outcomes than the class that applies the PBL learning model.

Referring to Table 6 descriptive statistics, an increase in understanding of the concept became acquired in the experimental class (TGT) and the control class (PBL). Improved understanding of the concept can be seen by comparing the distinction among the mean posttest and pretest. The experimental class (TGT) had an average pretest of 44.80 and a posttest of 92.22 so that an average gain score of 47.42 was obtained. The control class (PBL) had an average pretest of 46.36 and a posttest of 86.90 so that the average gain score became 40.54. The average posttest score for the experimental class (TGT) turned into better than the control class (PBL) with a difference of 5.32.

Table 6. Descriptive Statistics

Information	TGT Class Pretest	TGT Class Posttest	PBL Class Pretest	PBL Class Posttest
Minimum Score	16.22	81.08	32.43	75.68
Maximum Score	70.27	100.00	64.86	100.00
Mean Score	44.80	92.22	46.36	86.90
Score	54.05	18.92	32.43	24.32

Range				
Number of Samples	33.00	33.00	33.00	33.00

The average score based at the posttest inside the experimental class has a higher score on the seven item indicators than the eight item indicators. In contrast, the control class only had higher scores on one item indicator, namely describe the interaction between antigen and antibody, as shown in Table 7. It could be seen that the average posttest outcomes for the experimental class (TGT) have been better than the control class (PBL) on the 7 item indicators out of the 8 item indicators tested. The seven indicators of the item are the body's non-specific (natural) defense mechanisms with a value of 89.61 to 88.31, components of the specific (adaptive) immune response with a value

of 92.42 to 88.89, cells involved in the immune response with score of 93.18 versus 85.61, mechanisms of response of humoral immunity and cellular immunity with a value of 93.18 versus 87.88, type of immunity, program, and type of immunization with a value of 93.33 versus 86.06, factors that affect the immune system immunity with a value of 93.18 compared to 85.61, and disorders of the immune system with a value of 91.92 compared to 75.76. The average posttest outcomes for the control class (PBL) have been better than the experimental class (TGT) on 1 of the 8 item indicators tested. One indicator of this question is the interaction between antigen and antibody with a value of 92.42 compared to 91.67

Table 7. Average of Each Immune System Problem Indicator

Question Indicator	Experiment Class (TGT)				Control Class (PBL)			
	Pretest	SD	Posttest	SD	Pretest	SD	Posttest	SD
Describe non-specific (natural) defense mechanisms of the body	46.75	25.16	89.61	6.51	49.78	24.80	88.31	4.77
Detailing the components of specific (adaptive) immune response	43.94	22.16	92.42	3.18	51.01	23.58	88.89	7.82
Describe the interaction between antigen and antibody	46.97	14.54	91.67	10.90	40.91	13.21	92.42	5.80
Describe the cells involved in the immune response	28.03	5.74	93.18	9.70	40.91	6.31	85.61	5.18
Explain the mechanism of humoral immune response and cellular immunity	34.85	26.71	93.18	8.70	39.39	23.10	87.88	8.92
Explain the various types of immunity, programs, and types of immunization	48.48	29.69	93.33	8.94	50.30	21.92	86.06	12.23
Analyze the factors that affect the	69.70	11.06	93.18	4.55	59.85	20.16	85.61	13.41

Question Indicator	Experiment Class (TGT)				Control Class (PBL)			
	Pretest	SD	Posttest	SD	Pretest	SD	Posttest	SD
immune system								
Analyze immune system disorders	35.35	0.00	91.92	8.75	28.28	19.25	75.76	23.67

The level of students' concept understanding categories according to Kartika (2018) is used to classify students' pretest and posttest scores in the experimental (TGT) and control (PBL) classes. Based on the data presented in Table 8, the domination of the student category in the results of the posttest scores of the experimental class and the control class is in the very good category.

The outcomes of the students' pretest and posttest can be categorized into very good, good, sufficient, low, and very low primarily based on the categories of conceptual understanding in Table 8. In the posttest results of the TGT class and the PBL class have the identical highest frequency in the very good category. Even so, the posttest outcomes of the

experimental class (TGT) can be said to be better than the control class (PBL) primarily based on the frequency of students inside the very good category, the TGT class has 27 students while the PBL class only has 20 students. This is because the syntax in the TGT learning model is more effective in increasing students' understanding of concepts (Slavin & Madden, 2021). in keeping with those outcomes, research carried out by (Rohmah & Wahyudin, 2016), the TGT type learning model assisted by using online game media indicates good potential for increasing conceptual understanding because it emphasizes students actively building understanding.

Table 8. Grouping of Students based on Concept Understanding Category

Score	Category	Total students			
		Experiment Class (TGT)		Control Class (PBL)	
		Pretest	Posttest	Pretest	Posttest
85.00 - 100	Very good	-	27	-	20
70.00 - 84.99	Well	2	6	-	13
55.00 - 69.99	Enough	5	-	8	-
40.00 - 54.99	Low	16	-	17	-
0.00 - 39.99	Very low	10	-	8	-

The achievement score for each indicator of conceptual understanding was obtained from student scores on each indicator divided by the maximum score per indicator and then analyzed based on Adhani & Rupa (2020) to determine mastery of each indicator as shown in Table 9.

Improved understanding of the concept can also be seen based on the indicators of understanding the concept in Table 9. The indicators of understanding the concept are divided into six indicators, that is remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5) and creating (C6). The posttest results of the

experimental class (TGT) placing the evaluating indicator (C5) as the lowest percentage of 87.01% and placing the understanding indicator (C2) as the highest percentage of 96.21%. These results are in keeping with the research of Irmayanti et al., (2017), that the level of difficulty of questions on the cognitive aspect of C5 is included in the very high level of difficulty due to inadequate understanding of material concepts. The posttest outcomes of the PBL class placing the applying indicator (C3) as the lowest percentage of 81.56% and placing the remembering indicator (C1) as the highest percentage of 92.93%. This is related to the research of Tamba et.al (2020), that students' difficulties in cognitive aspect

questions C3 are due to the broad and abstract nature of the material. Even so, the lowest percentage in the posttest outcomes of the TGT class and the PBL class is not a problem because all indicators of conceptual understanding are in the high category. Overall, the posttest outcomes of the TGT class were higher than those of the PBL class. This is because using the TGT learning model makes the learning atmosphere more enjoyable so that students pay more attention and are more active when discussing.

The results obtained based on the table above are due to differences in syntax between learning models. In the presentation syntax in class. The Teams Games Tournament (TGT) cooperative learning model has several stages consisting of: presentation, team building, games, tournaments, and team recognition (Slavin, 2015). In the presentation syntax in class, the teacher presents material on the immune system through a projector in a short, concise, and clear manner. In this syntax, the teacher stimulates students to actively ask and answer questions given by way of the teacher. The learning process emphasizes in many ways and situations that students must be more active than the teacher (Hermawan & Rahayu, 2020). In the teamwork syntax, students discuss and seek information so they can work well together when working on student work sheet, competing in academic game syntax and tournament syntax. Groups are heterogeneous to ensure that all team members are actually learning. Heterogeneous group learning situations can highlight interactions within groups such as exchange of opinions, questions and answers, debates between students, and allow students to accept other students with different background abilities (Liberna, 2015).

In the syntax of academic games (games), the teacher retells the rules of

the game and prepares the Kahoot which is displayed through the projector. The results of the academic game rankings are instantly displayed on the projector screen. Students look very excited to be the team with the highest score. The existence of a leaderboard that shows the score of each student and the order in which they are ranked can inspire students to continue to compete and work on questions quickly and thoroughly (Asria et.al., 2021).

In the tournament syntax, between groups students will compete with other students outside the group. The tournament uses a Kahoot which is displayed on a projector screen and each student's device. Students look very enthusiastic to compete in a healthy manner to be the group with the highest score. Game-based learning media can stimulate students to participate during learning activities, eliminate boredom and laziness, provide feelings of fun, comfort, and humor so that they can develop students' intellectual intelligence (Hidayati & Aslam, 2021).

The last syntax is team recognition (group rewards). On this syntax the teacher offers prizes to the group with the best final score, the final score is the accumulated value collected from the syntax of academic games and tournaments. Success can make students more confident in future learning situations (Dečman et.al., 2022). Giving awards is done so that students are motivated to learn and always have the desire to be the best (Arianti, 2019). In line with Ulfia & Irwandani's (2019), giving awards from teachers will make students more active in learning the material that has been given.

Table 9. Comparison of the Percentage of Achievement of Concept Understanding Indicators

Indicator	Experiment Class (TGT)				Control Class (PBL)			
	Pretest	Category	Posttest	Category	Pretest	Category	Posttest	Category
C1	55.05%	Medium	94.44%	High	51.01%	Medium	92.93%	High
C2	55.30%	Medium	96.21%	High	65.91%	High	90.91%	High
C3	40.00%	Medium	92.73%	High	40.00%	Medium	81.56%	High
C4	42.04%	Medium	92.80%	High	40.53%	Medium	86.74%	High
C5	38.96%	Medium	87.01%	High	41.56%	Medium	85.71%	High
C6	48.48%	Medium	89.39%	High	65.15%	High	92.42%	High

The gain score is the distinction among the outcomes of the posttest and pretest of students from the experimental class (TGT) and the control class (PBL). The TGT class has an average gain score that is greater than the PBL class. The data is presented in Figure 1.

Referring to Figure 1, it is able to be seen that the average value in the TGT class is higher than the average value in the PBL class, namely 47.42 compared to 40.54. The average value of the gain score is used to see an increase in students' understanding of concepts while the average value of N-Gain is used to see the effectiveness of implementing the learning model.

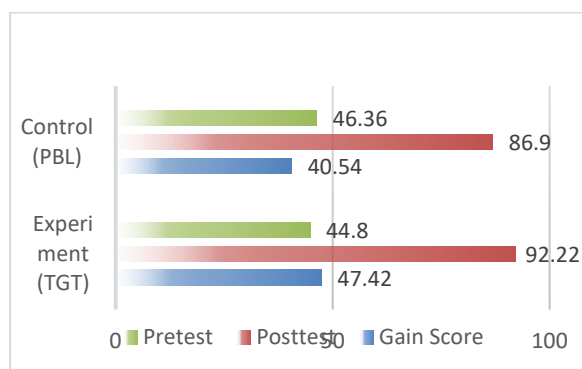


Figure 1. Average Pretest, Posttest, and Gain Score

Referring Table 10, average N-Gain value on the experimental class (TGT) using Kahoot is higher than the average N-Gain value on the control class (PBL), which is 0.85 compared to 0.75. Even though the two learning models are the same category, namely high, the difference in these numbers indicates that the TGT using Kahoot is more effective than the PBL. The results of this study are also related to Putra (2015), that the modified TGT learning model has a more effective impact than pure TGT. Additional variations make the TGT learning model more suitable (Santosa, 2018). TGT class using Kahoot are more effective than PBL class, this could be seen from the large N-Gain score received in Table 10. N-Gain value category refers to (Hake, 1998). Average value of the gain score is used to see an increase in students' understanding of concepts while the average value of N-Gain is used to see

the effectiveness of implementing the learning model. Average N-Gain value in the TGT class using Kahoot is higher than the average N-Gain value in the PBL class, which is 0.85 compared to 0.75

Table 10. Categories of N-Gain Score for Experiment and Control Class

Learning model	N-Gain	Category
Teams Games Tournament (TGT) using Kahoot	0.85	High
Problem Based Learning (PBL)	0.75	High

The results of the prerequisite test show that the research data are normally distributed and homogeneous, then the data is tested by hypothesis testing using the independent t-test at a significance level of $\alpha = 0.05$ or 5% using the SPSS version 25. The results of the independent t-test on the posttest data of the TGT class and PBL class obtained a significance value (sig. 2-tailed) that was smaller than the significance level of $0.02 < 0.05$ so that it rejected H_0 , this means that there is an influence the TGT uses Kahoot on students' conceptual understanding of the immune system material. Data from the independent t-test results presented in Table 11

Based on Table 11, the outcomes of the independent t-test on the pretest data for the TGT class and PBL class showed no significant difference in the pretest outcomes for understanding the concept of the immune system in the two classes, so it can be said that the two classes have an equivalent understanding of the concept, before the implementation of the learning process. Equivalent initial abilities are natural because the two classes have not received treatment and learning materials (Santoso, 2019). The initial abilities of the two classes that were balanced indicated that both classes were eligible for treatment (Darma & Firdaus, 2014).

Based on the results of the independent t-test in Table 11, the Gain Score for the TGT class and PBL class obtained a significance value (sig. 2-tailed) that is smaller than the significance level, namely $0.035 < 0.05$ so that it rejects H_0 , which means an influence of the TGT using Kahoot on students' conceptual understanding of the immune system material.

Conclusion

Primarily based on the outcomes of data analysis and discussion, the conclusion obtained is an influence of the TGT using Kahoot on students' conceptual understanding of the immune system material. The collaboration between the syntax in the TGT and the game-based student response system (GSRS) learning media in the Kahoot application makes students more active, enthusiastic in learning, eliminates boredom, and provides a pleasant feeling so the students' understanding concept of the immune system increases significantly compared to using the PBL.

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