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Application of the Team Games Tournament (TGT) Type Cooperative Learning Model to Students' Understanding of Concepts in Stationary Wave Material

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ABSTRACT

This research explains the application of the Team Games Tournament (TGT) Cooperative Learning Model on students' understanding of the concept of standing waves. The Teams Games Tournament (TGT) model is a team-based learning strategy where students are grouped into teams of four or five members of varying achievement levels. The steps involved in implementing the TGT cooperative model include class presentation, grouping, games, tournament, and team recognition. The research design used is Quasi Experiment with a quantitative approach. The subjects of this research were students of class XI science 4 using a purposive sampling technique. The research instrument includes multiple-choice questions in the form of pre-tests and post-tests, and data analysis techniques involved T-test and N-Gain analysis. The research findings indicate differences in student learning outcomes before and after the implementation of this model. Hypothesis testing using the T-test showed that the calculated $t_{count} > t_{table}$ (11.000 > 2.262), thereby accepting the alternative hypothesis (H_1). Additionally, the N-Gain results indicated a moderate improvement category. These results demonstrate that the Team Games Tournament (TGT) cooperative learning can enhance students' understanding of the concept of standing waves for the 11th-grade science class. In conclusion, the TGT learning model was perceived by students as an engaging and effective learning process that improves understanding of the standing waves concept.

Keywords : Cooperative Learning; Stationary Wave; TGT; Understanding Concept

I. INTRODUCTION

The learning process in every primary and secondary educational institution should be interactive, inspirational, enjoyable, challenging, and motivating for students to actively participate. It should also provide ample space for initiative, creativity, and independence in accordance with their talents, interests, and needs. Sanjaya [1] suggests that learning is designed to educate students, meaning that the learning process should be student-centered. Therefore, learning is more oriented towards activities that enable students to achieve learning outcomes that integrate cognitive, affective, and psychomotor aspects, as well as the physical and psychological development of learners [2]. This ministerial regulation indicates that active student involvement in learning is imperative.

Mulyasa [3] states that learning is considered successful and of high quality if at least the majority of students are actively involved, both physically, mentally, and socially, in the learning process, while demonstrating high enthusiasm for learning, a strong desire to learn, and self-confidence. Based on this, the efforts of teachers to foster student engagement are crucial because student engagement determines the success of the learning process. Sudjana & Nana [4] indicate that the higher the level of student learning activity, the greater the likelihood of teaching success.

Physics, as one part of Science, plays a crucial role in shaping quality students. Physics comprises knowledge, ideas, and concepts acquired through experiences via the scientific process [5]. It relates to aspects of products, scientific processes, and attitudes. Concepts, theories, and laws of physics are products obtained through scientific processes such as experimentation, measurement, and discussions involving direct

participation of learners in these activities [6]. Gunawan [7] states that some abstract physics concepts often pose challenges for teachers in delivering materials to students. This results in a lack of interest among students in receiving the learning, leading to difficulties in understanding the concepts presented to them.

The high school physics subject was developed concerning the characteristics of natural sciences, namely by directing students to be able to carry out observations, and experimentation and think and behave scientifically. This is based on the main objectives of science and physics, namely observing, understanding, appreciating, and interpreting natural phenomena involving matter and energy. Physics is a branch of science that studies the properties and symptoms found in inanimate objects [8]. According to Wahyuni, in Minarty [9] states that in physics, students study natural phenomena and inanimate objects that are both concrete and abstract, and abstract concepts tend to be more difficult to learn than concrete concepts.

One of the physics materials that is difficult for students to understand is waves. Waves are one of the class XI high school physics materials that are important to master and understand well. According to Serway & Jewett, in Jumadin [10] also argue that wave material is abstract material. Several opinions state that wave material in physics is still considered difficult by students because the material is abstract. For this reason, we need a way to make it easier for teachers to present wave material simply and clearly which is directly linked to real problems in life. So students can easily understand the abstract concept of waves.

The abstract nature of wave material is what makes students need to understand concepts rather than just memorize formulas. Therefore, the role of the teacher is crucial in delivering lesson material. In the learning process, the teacher acts as a facilitator whose task is to guide and stimulate students, so that they can actively engage in discovering and constructing their own knowledge to solve the problems being studied in learning. Hence, the researcher chose stationary wave material as one of the variables in this study.

A Standing Wave is a wave whose amplitude does not vary at the points it passes through, formed by the interference of two waves—incident and reflected—each having the same frequency and amplitude but opposite phases. Standing waves find various practical applications in science and technology. In musical instruments such as guitars and violins, standing waves on strings produce tones of specific frequencies. In physics and engineering, resonance in cavities of standing waves is used to enhance the efficiency of devices like resonators and microwave filters [11].

Recent research on standing waves often focuses on applications in the fields of acoustics and photonics. For instance, standing waves are used in the development of more sensitive sensors and more efficient optical communication devices [12]. Additionally, studies on standing waves in metamaterial materials offer the potential to create devices with properties not found in nature [13].

Various research has been carried out in the field of education regarding students' understanding of concepts of all ages, and levels of education, and in various fields such as Science, Engineering, and Social Affairs. Understanding concepts, according to Smith & Ragan, includes more than just rote memorization, and requires the ability to apply what has been learned previously in various types of unexpected experiences, as stated Saricayir [14]. "An important problem faced by the world of education to date is how to strive to build understanding," said Brook and Brooks in Sugiarti [15]. It is very important for students to understand what is being taught, know what is being communicated, and have the ability to understand the material.

Further according to Korn [16] in NCTM (The National Council of Teachers of Mathematics), it is shown why teaching understanding of a concept is highly beneficial. In the 21st century, students need to have conceptual understanding to develop and effectively solve problems as adults in an increasingly changing environment.

According to the author Kennedy [17], understanding concepts is one of the achievements or outcomes in cognitive learning, where "learning outcomes are statements of what a student is expected to know, understand and/or be able to demonstrate after completion of a process of learning." Learning outcomes provide an overview of how much a student knows and understands a subject after the learning process has occurred.

According to Anderson & Krathwol [18], Benjamin Bloom classifies learning outcomes into three categories, namely affective, cognitive, and psychomotor. The ability to restate ideas or principles that have been learned and intellectual abilities is known as conceptual understanding. This cognitive area consists of six levels: remembering, understanding, applying, analyzing, assessing, and creating. One must complete the six levels in stages, starting from simple to complex. If someone fails to complete a simple level, they will have difficulty continuing to more complex cognitive levels, such as applying, analyzing, assessing, and creating.

Saricayir [14] states that success in education is very dependent on the role of teachers in managing their classes well, including expertise in choosing effective learning methods to increase students' understanding of concepts. The author Sudaryono [19] reveals that Winkel and Mukhtar define understanding as the ability of a

person to comprehend or understand something after it is known or remembered; this includes the ability to grasp the meaning of the material learned, which is expressed by describing the main content of a reading or transforming presented data from one form to another. Suharsimi [20] states, "In understanding concepts, this describes how a person can retain, differentiate, estimate, explain, expand, conclude, generalize, provide examples, rewrite, and predict." Utami [21] also explains that "understanding something can be formed by building relationships between prior knowledge and new knowledge that have connections from a categorization of several similar things".

According to Sagala [22], "the concept itself is the result of an individual's or a group's thinking expressed in a definition, thereby generating knowledge products including principles, laws, and theories." Meanwhile, according to Medin, "a concept consists of integrating information presented by linking previous knowledge to construct an integrated representation" [23].

According to Vygotsky, conceptual understanding can also be applied in the context of socio-cultural constructivist learning theory, which emphasizes that learning is an internal process that develops when children interact with their environment, both with adults and their peers. According to Cagatay & Demirciohlu [24], Vygotsky's sociocultural constructivist view has been defined by Tharp and Gallimore as 'guided reinvention', where individuals are guided by more experienced peers or teachers in their learning process. This approach is reflected in the cooperative learning model, where students work together in small groups and help each other in solving problems. Ozsoy [25] explains that in cooperative learning there are various methods, such as Learning Together, Teams-games-tournament, Group Investigation, Constructive Controversy, and Jigsaw. This article will specifically analyze one method, namely Teams Games Tournament (TGT), to assess whether this method influences increasing students' understanding of concepts.

Therefore, in ongoing learning activities, appropriate models and methods are needed. The learning model used must be interesting and able to make students play an active role in it. If the models and methods used are interesting, then students will view physics as an interesting and important subject to study so that they have great motivation and desire the TGT Type Cooperative Learning Model to learn. This will increase student achievement of competency learning outcomes. Learning outcomes are something obtained after carrying out learning activities. Learning outcomes include three aspects, namely cognitive, affective, and psychomotor aspects. If learning outcomes can be achieved well then it can be interpreted that students' conceptual understanding of the material being taught reaches a high score.

Findings from field observations in a classroom in Yogyakarta include: 1) students are not yet actively engaged in group assignments; in each group, only 1-2 students are working while others are chatting; 2) some students cannot express their own opinions; 3) when the teacher explains, students do not feel inclined to ask questions and tend to accept what the teacher says without much inquiry; 4) academically low-achieving students tend to be passive during the learning process.

One of the determining factors for success in learning physics is the use of appropriate models. An example of a learning model that can be used is the cooperative learning model. The cooperative learning model is a learning model that provides opportunities for students to work together to complete structured learning tasks. Especially for Team Games Tournament (TGT) type cooperative learning, apart from the previously mentioned characters, students' cooperative characters can also be developed. TGT is a type of cooperative learning that can motivate students not to be passive and not get bored in the learning process. Micheal [26] reveals that Teams Games Tournament (TGT) was initially developed by David De Vries and Keith Edwards at Johns Hopkins University as a cooperative learning method. Students play academic games with other team members to contribute points to their team's score. Students play games at "tournament tables" with three others, based on past records. This method encourages students to compete, cooperate with other students, and become more active and creative in learning Veloo & Chairhany [27]. Therefore, TGT-type cooperative learning is suitable for several of the problems that have been described. The learning objectives are formulated sharply with one correct answer and there are games so that students are more active and don't get bored quickly during physics lessons. This learning model is oriented towards individual work in groups. This means that each individual is responsible for understanding the concept with the assistance of the group members that have been formed.

"According to Johnson Smith, the cooperative learning model builds at least five essential components: 1) positive interdependence, 2) face-to-face interaction among students, 3) individual and group accountability, 4) interpersonal and small group skills, and 5) group processing skills" [24]. In cooperative learning models, various methods can be applied in the classroom, one of which is the Teams Games Tournament (TGT) method, a variant of cooperative learning that incorporates game elements and involves all students. The games

conducted naturally include content-related elements, such as quiz games with questions related to the material and this method.

Teams Games Tournament (TGT) is one of the team-based learning strategies designed by Robert Slavin for mastering subject matter. Students are grouped into teams of four or five members from all levels of achievement. Slavin has found that TGT enhances basic skills, student achievement, and positive interaction among students.

There are several steps in using the TGT learning model that need to be considered. According to Slavin [28], the steps involved in the regular TGT cycle are as follows: The first stage is class presentation. This stage is used by teachers to convey lesson material through direct teaching or discussions led by the teacher. Class presentations are also used by teachers to convey the learning techniques that will be used, so that students can carry out each activity in the TGT steps well.

Next is the second stage of forming a group (team). Teams or groups consist of 4 to 5 students whose members are heterogeneous in terms of students' academic abilities, gender and ethnicity. The main function of this team is to ensure that all team members really learn.

The third stage is games. Games consist of questions designed to test the knowledge students gain from class presentations and group study. The fourth stage is the Tournament. The tournament is held every time a unit of learning material has been completed. Students play academic games by competing with team members who have the same abilities.

The fifth stage is Team Recognition. The team that shows the best performance will receive an award. Just like in a competition, the team that collects the most points/scores will get the title of overall champion, then the next champions are in sequence according to the number of points/scores they have achieved.

The advantages of the Teams Games Tournament (TGT) cooperative learning model, according to Shoimin & Aris [29], are as follows: 1) it not only highlights academically gifted students in learning, but also encourages active participation and significant roles for students with lower academic abilities within their groups; 2) it fosters camaraderie and mutual respect among group members; 3) it enhances student enthusiasm in learning, as teachers promise group recognition; and 4) it makes learning more enjoyable for students due to game activities and tournaments.

Based on the strengths of the TGT cooperative learning model, it can be considered as an alternative approach to enhance student engagement. Due to its dominant role in the learning process, students in each group are encouraged to master the material and actively contribute during group work, thereby enabling them to contribute to their group's score when called upon to present their answers. Therefore, the TGT cooperative learning approach is suitable for addressing various educational challenges. The learning objectives are formulated sharply with one correct answer and there is a game so that students are more active and do not get bored quickly during physics lessons. This learning model focuses on individual work within groups, meaning each individual is responsible for understanding the concepts with assistance from group members who have been formed.

In this way, they will directly improve their learning activities to be able to understand physics concepts so they can win tournaments and get rewards or awards. Stationary wave material is material that is calculated and understood so that the TGT method can be used as a solution to problems in studying stationary waves.

II. METHOD

This type of research uses a Quasi Experiment with a quantitative approach. Quasi-experiment is the use of methods and procedures to conduct observations in a structured study similar to an experiment, but with participants lacking control over conditions and experiences due to limited random assignment, including comparisons or control groups [30].The quasi-experiment used in this study is the Quasi-Experiment: One-Group Pretest-Posttest Design, which is a quasi-experiment where one group is measured and observed before and after treatment is administered, as depicted in the following table [31]:

Table 1. One-Group Pretest-Posttest Research Model

The One-Group Pretest-Posttest Design		
O	X	O
Pre-test	Treatment	Post-test

In One-Group Pretest-Posttest Design, the dependent variable is measured for a single group before (pretest) and after (posttest) a treatment is administered. After the treatment is given to the group, the values before and after the treatment are compared. The advantage of this experiment is that we can compare the values before and after the treatment on the same participants. This research did not use a comparison class. This is

because researchers want to know the results of applying a learning model to one class by comparing the conditions before and after treatment. The pretest is carried out at the beginning of learning, after the students are given treatment implementing the TGT learning model. Next, all students were given a final test (posttest) to determine the extent of the influence of the TGT model on student learning outcomes.

This research was conducted at MAN 3 Sleman Yogyakarta with research subjects namely class XI science 4 students, totaling 10 students. The researcher used 11th-grade science class students as subjects because this class was the place where the researcher carried out practical learning activities. So, researchers simultaneously took data for this research. This research is dedicated to improving mastery of physics concepts, especially regarding stationary waves.

The sampling technique used in this study is the purposive sampling technique. According to Arikunto [32], purposive sampling is a technique where the sample is not based on strata, random selection, or region but is determined based on a specific purpose. The purposive sampling method is a sampling procedure that selects samples with certain considerations. The sample selection criteria used by the researcher are, first, students from class XI Science 4 at MAN 3 Sleman Yogyakarta, and second, students who showed improvement in their pre-test and post-test results. Based on these criteria, the sample taken in this study consists of 10 students from class XI Science 4 at MAN 3 Sleman Yogyakarta.

The instrument used in this research was multiple choice questions in the form of a pre-test and post-test, totaling 5 questions in each test. The data from the pretest and post-test results will be tested using the T-test (t-test) with the help of statistics software, namely SPSS. The paired T-test (paired t-test) is a hypothesis testing method where the data used is not independent (paired). The characteristic most often found in paired cases is that one individual (research object) received 2 different treatments. Even though they used the same individuals, researchers still obtained 2 types of sample data, namely data from the first treatment and data from the second treatment. The hypothesis of this case can be written:

$$H_0 = \mu_1 - \mu_2 = 0 \quad (1)$$

$$H_1 = \mu_1 - \mu_2 \neq 0 \quad (2)$$

H_a means that the actual difference of the two means is not equal to zero.

a. Paired T Test Equation

$$t_{hit} = \frac{\bar{D}}{SD/\sqrt{n}} \quad (3)$$

Where

$$SD = \sqrt{var} \quad (4)$$

$$var(S^2) = \frac{1}{n-1}\sum_{i=1}^{n}(xi - \bar{x})^2 \quad (5)$$

b. Interpretation

To interpret the t-test test, you must first determine:

- Significance value α

- Df (degree of freedom) = N – k, especially for paired sample t-test df = n–1

Compare the value of $thit$ with $t_{tab} = \alpha ; n-1$

If : $t_{count} > t_{tab} \rightarrow$ significantly different (H_0 rejected)

$t_{count} < t_{tab} \rightarrow$ not significantly different (H_0 is accepted)

The results of this test lead to hypothesis testing. The research hypothesis is:

H_0: There is no influence of the Cooperative TGT learning model on improving conceptual understanding.

H_1: There is an influence of the Cooperative TGT learning model on improving conceptual understanding.

Next it will be analyzed using Normalized Gain or N-Gain. Normalized-Gain is the difference between the post-test and pre-test results. The results of N-Gain are used to analyze whether this learning model is effective for 11th-grade science class students. If learning is effective then it can be used as a reference to be applied in the learning process. However, if the opposite is true then this model cannot be applied to learning. The calculated average N-gain value can use the following equation.

$$N\ GAIN = \frac{Post\text{-}test\ Score - Pre\text{-}test\ Score}{Ideal\ Score - Pre\text{-}test\ Score} \quad (6)$$

To see the percentage of effectiveness of the learning model, see the following N-Gain effectiveness interpretation table:

Table 2. Interpretation of N-Gain Effectiveness

N-GAIN SCORE DIVISION	
N-GAIN VALUE	**CATEGORY**
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$g < 0,3$	Low

(Meltzer [33])

III. RESULTS AND DISCUSSION

This research was conducted at MAN 3 Sleman Yogyakarta in the second semester of the academic year 2023/2024, located at Jl. Magelang No. KM 4, Kutu Dukuh, Sinduadi, Mlati, Sleman, Special Region of Yogyakarta. The study aimed to determine the extent to which the implementation of the Team Games Tournament (TGT) cooperative learning model could enhance students' understanding of stationary wave material. The researcher chose the Team Games Tournament (TGT) cooperative learning model because it provides opportunities for students to collaborate in completing structured learning tasks. Additionally, the TGT cooperative learning model can develop students' cooperative character. TGT is one type of cooperative learning that can motivate students to be active and avoid boredom during the learning process.

Based on the application of the Team Games Tournament (TGT) cooperative learning model, it can be described as follows. The first stage is classroom presentation. In this step, the researcher utilized varied teaching methods and media to deliver the lesson, such as using a projector to display powerPoint slides. An indicator of student engagement during this activity is asking questions to the teacher. At this stage, some students have made efforts to answer questions and express their opinions during the researcher's Q&A and class discussions. However, there are also students who have not paid attention to the researcher; they are still engaged in other activities like playing with stationery. This is because the material presented by the teacher did not spark the students' curiosity, causing them to feel uninterested in learning. Furthermore, students with lower academic abilities are not involved in learning activities such as expressing opinions and ideas. This is because these students feel embarrassed and are not accustomed to expressing opinions or asking questions. Therefore, the researcher directly appointed these students to try to express their opinions, answer, and ask questions with the aim that students who feel shy about expressing their opinions and asking questions have the same opportunity as students who are accustomed to expressing opinions and asking questions. This relates to the role of the teacher as a motivator and facilitator in cooperative learning, ensuring that students can learn in a fun, joyful, enthusiastic, non-anxious, and open environment conducive to expressing opinions [34].

The second stage is learning in teams. In this step, teams have been formed comprising students with high, moderate, and low academic abilities, as one of the characteristics of cooperative learning Arends in Trianto [35]. Each team works on Group Work Sheets (GWS) provided by the teacher and discusses to prepare games and tournaments. At this stage, not all students are seen collaborating effectively within their teams. This is because students with high academic abilities dominate during the completion of GWS, leaving students with low academic abilities and shy students silent and uninvolved. The completion of GWS tends to be slow for several teams. This is due to the unclear time constraints set by the teacher. Therefore, the teacher gives additional scores to teams that complete GWS on time. It is hoped that with the additional scores, students will not waste time during team learning activities.

The third stage is Games. In this step, the teacher has prepared games involving student teams. The teacher also sets rules for the games to proceed smoothly. At this stage, some students appear less enthusiastic about participating in the games, possibly because the games are confined to worksheets, such as solving problems.

The fourth stage is Tournament. In preparing for the tournament phase, the teacher arranges for students to compete based on their academic ability categories. Students enjoy the tournament atmosphere as they compete with peers of similar academic abilities. However, the tournament activity was not entirely conducive, and some students still did not fully understand the tournament procedures. This was because the teacher communicated the rules and procedures of the tournament orally only.

The fifth stage is Team Recognition. In this step, the teacher awards rewards to students who achieve scores based on specific criteria. In addition to rewarding the winning team, the teacher also motivates all students that cooperation during team learning is crucial, encouraging them to share knowledge with peers who may not yet understand the material. It is hoped that by providing this motivation for active participation, student indicators will improve in the future.

Before implementing this learning model, the researcher conducted a pretest to assess students' level of understanding of stationary wave concepts. The pretest consisted of 5 multiple-choice questions. Subsequently,

to measure the extent of concept comprehension after the instructional material was provided, the researcher conducted a posttest consisting of 5 multiple-choice questions.

The data in this study was determined through pre-test results and data through post-test results. Pretest and posttest data can be seen in table 2.

Table 3. Pre-Test and Post-Test Data.

No.	Pre-Test	Post-Test
1.	20	40
2.	20	50
3.	20	50
4.	30	60
5.	20	60
6.	10	40
7.	20	70
8.	30	70
9.	10	30
10.	20	60

The data in table 2 was analyzed using the t-test using SPSS software. The results of the analysis can be seen in table 3.

Table 4. Paired Samples Test

	Paired Differences					t	df
				95% Confidence Interval of the Difference			
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper		
Pre-test & Post-test	-33.00000	9.48683	3.00000	-39.78647	-26.21353	-11.000	9

Table 3 shows a t-test result of 11.000. The next step is to find the t-table value, which is determined based on the degrees of freedom (df) and the significance level (a/2). From Table 5, it is known that the degrees of freedom (df) is 9 and the significance level (a) is 0.05, making the significance level 0.05/2 which equals 0.025. This value is used as a reference to find the t-table value in the t-distribution table. Therefore, the t-table value is 2.262. It can thus be concluded that the calculated t-count of 11.000 > t-table of 2.262. Therefore, since the calculated t-value of 11.000 > the tabulated t-value of 2.262, it can be concluded that H0 is rejected and H1 is accepted, indicating that this improvement is not merely due to chance, but rather due to the implemented learning intervention. This demonstrates that the method used can be relied upon to enhance students' understanding of this topic.

Next, the analysis will use Normalized Gain to determine whether this learning model is effective for students in class XI Science 4. The results of the N-gain test of students' conceptual understanding based on pretest-posttest data in class XI IPA 3 are presented in Table 4.

Table 5. Concept Understanding N-gain Test Results

Class XI Science 4	Pre-Test	Post-Test	N Gain	Category
	20	53	0,42	Medium

Based on table 4, the results of the average N-gain analysis of conceptual understanding in class XI IPA 3 is 0.42, which falls into the medium category based on the N-gain (g) criteria: $g > 0.3$ is considered low, $0.3 \leq g \leq 0.7$ is considered medium, and $g > 0.7$ is considered high.

Based on the research results, it is evident that the applied teaching method is effective in enhancing students' understanding of stationary wave material. This is supported by the T-test results showing a significant difference between pretest and posttest scores, as well as the N-gain results indicating moderate improvement. The average increase in scores from pretest to posttest demonstrates that some students were able to master the material after receiving more interactive and focused learning. The implementation of the TGT cooperative learning model, according to Shoimin & Aris [29], not only highlights academically strong students in learning but also engages lower-achieving students to actively participate and play a significant role within their groups. Additionally, it fosters camaraderie and mutual respect among group members and boosts students' enthusiasm for learning, as teachers promise rewards to groups. Moreover, students enjoy the learning process more due to the inclusion of games and tournaments.

In table 3, it is observed that there was an improvement in students' pretest and posttest results. The pretest yielded a mean score of 20, while the posttest yielded a mean score of 53. This indicates an increase of approximately 33% from the pretest to the posttest results. However, Table 3 shows that some students' scores

are still well below the passing grade (KKM) for the Physics subject, which is below 75. This could be due to factors such as the complexity of the material, making it difficult for students to comprehend. This statement is supported by Serway & Jewett in Jumadin [10], who state that wave material is abstract. Other opinions also suggest that wave material in physics is still considered difficult by learners.

The average N-gain result of 0.42, which falls into the medium category, indicates a reasonably good improvement in students' understanding. This medium category improvement shows significant progress. Out of 10 students, 8 achieved a medium N-gain category, and 2 achieved a low N-gain category. The N-gain values in the medium category indicate that there is still room for further improvement. This could be due to various factors, such as limited learning time or individual differences in students' learning abilities. Therefore, a more in-depth and sustained approach may be necessary to achieve more optimal results.

Thus, it can be concluded that the implementation of the cooperative learning model, Teams Games Tournament (TGT), increases student engagement. This is because the TGT learning model aligns with the characteristics of students who enjoy playing, are motivated by challenges, and prefer learning in groups. This learning model also encourages students to engage in both physical activities, such as observing, writing, and reading, and mental activities, such as problem-solving, analyzing, and decision-making. Consequently, this approach fosters the development of student intelligence across the three domains of assessment: cognitive, affective, and psychomotor [36]. Ultimately, it can be stated that to enhance student activity, engagement, and skills, a teacher can employ a learning model that suits the characteristics of the subject matter and the teaching materials used in the learning process, one of which is the Teams Games Tournament cooperative model.

IV. CONCLUSION

Based on the results of this study, it can be concluded that the applied teaching method is effective in improving students' understanding of standing waves. The t-test analysis shows a significant difference between pretest and posttest scores, while the N-gain calculation indicates a moderate improvement in understanding.

Students' understanding of a subject matter serves as the foundation for them to solve encountered problems, and with a solid conceptual understanding, students can ascend to more complex cognitive levels. Through cooperative learning models, such conceptual understanding can be cultivated, based on Vygotsky's theory that conceptual understanding can also be interpreted within constructivist learning theory, which is reflected in cooperative learning activities. The Teams Games Tournament (TGT) method is one form of cooperative learning that significantly contributes to learning success. This method involves students actively participating in shaping their own knowledge and that of their peers with lower abilities, thereby avoiding passive listening as in traditional learning. TGT incorporates game elements and engages all learners, encouraging them to fully participate in the learning process.

The results of this research have several important implications for educators and curriculum developers. However, the study also has limitations such as time constraints in implementing the TGT cooperative learning model which may affect the final outcomes. Additionally, considering the small sample size could restrict the generalization of the research findings to a larger population. Therefore, continuous evaluation and adjustment of the learning process are necessary to ensure sustained improvement in understanding.

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