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Review Article

Comparison of the Cooperative Learning Models STAD and TGT on Learning Activities and Outcomes in Physics for Vocational High School Students on the Topic of Energy and Its Changes

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Abstract: The low level of student learning activity is often found in school learning activities, which has an impact on poor learning outcomes. This study aims to examine the significant comparison of learning activities and physics learning outcomes of vocational high school students using the cooperative learning models STAD (Student Teams Achievement Division) and TGT (Teams Games Tournament), as well as to describe student responses after the implementation of both models on the topic of energy and its changes. This research is a true experimental study with a posttest-only control group design. The population in this study consisted of 186 students, and the sample was determined using a cluster random sampling technique. Data collection methods included observation, tests, questionnaires, interviews, and documentation. The classical assumption test used was the normality test, followed by statistical analyses using the Independent Sample T-test and the Mann-Whitney U-test. The results of the analysis of student learning activity data using the Independent Sample T-test showed a Sig. (2-tailed) value of 0.699 > 0.05, while the analysis of learning outcome data using the Mann-Whitney U-test showed a Sig. (2-tailed) value of 0.806 > 0.05. These results indicate that there is no significant difference between the two learning models in terms of their effect on student learning activities and physics learning outcomes. In addition, the analysis of student responses showed that the implementation of the STAD and TGT models received a very good response. Thus, it can be concluded that while there is no significant difference between the two models, both are effective in generating student interest and positive engagement in learning physics.

Keywords: Learning Activity; Learning Outcomes; Responses; STAD Models; TGT Models

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1. Introduction

Physics is one of the subjects considered difficult by students (Subiki et al., 2022). Students also perceive physics as a boring subject that makes them uninterested in learning it. This can be seen from students' behavior in the classroom, such as talking to themselves, lacking focus during lessons, or the class becoming noisy when the teacher delivers the material (Arista & Rahma, 2020). In addition, many students struggle to understand physics concepts and require strong mathematical comprehension.

The learning of physics is closely related to students' learning activities, making student engagement a crucial aspect of physics education itself (Maryani, 2022). However, teachers often position students merely as listeners and recipients of material, while the teacher dominates the lesson using the lecture method. As a result, students tend to be less active or even passive in the learning process. Low learning activity can be observed through the lack of student inquiries during lessons, minimal participation in answering questions, and the absence of routine group discussions (Anggara & Rakimahwati, 2021). This situation is also caused by teacher-centered learning.

Poor learning activity negatively impacts learning outcomes. Conversely, if learning activity is high, students tend to achieve better learning outcomes (Sutrisno & Yusri, 2021). Learning outcomes represent the final point of a process carried out during the learning phase, and they should result in changes in students' behavior after instruction (Wahyuni et al., 2020). Therefore, to stimulate student engagement, teachers need to adopt more active and varied teaching models and strategies (Munthe, 2023). Additionally, ensuring successful learning requires teachers to select appropriate learning models suited to the subject matter, allowing students to respond positively after instruction. This is supported by Jafar (2021), who stated that an effective teacher must understand various teaching models suitable for the content being taught. Using an inappropriate teaching model can hinder students' comprehension of core material, ultimately affecting their learning outcomes and failing to meet graduation standards.

Based on an interview with an IPAS (Integrated Science) teacher at a vocational school (SMK) in Jember Regency, it was found that 60% of tenth-grade students scored below the minimum competency standard (KKM), which is 75, on IPAS topics related to physics. This condition results from students' lack of enthusiasm in learning, leading to passive engagement. Furthermore, research by Novianti et al. (2020) indicates that another factor affecting student engagement and learning outcomes is the lack of variation in teaching models applied by teachers.

This study focuses on cooperative learning models. According to Slavin (as cited in Sani, 2019), cooperative learning encourages students to actively and positively interact in groups. This learning model enhances students' engagement by fostering collaborative activities within a group setting (Fathurrohman, 2015). As a result, students can actively and enjoyably participate in classroom learning, which is expected to improve their learning outcomes. Teachers can utilize various cooperative learning models to encourage student participation and promote independent thinking rather than passive information reception.

Two of the most established and widely researched cooperative learning models are *Student Teams Achievement Divisions* (STAD) and *Teams Games Tournament* (TGT). Rusman (2018) explains that these two models have been extensively implemented, from elementary school to higher education, across subjects such as mathematics, language arts, social sciences, and natural sciences. STAD and TGT are highly similar; the key difference lies in their assessment methods—STAD uses individual quizzes, while TGT incorporates a game tournament (Slavin, 2005).

Both models are relevant for physics instruction and can be used by teachers to enhance students' learning outcomes. This is supported by research by Prayogi et al. (2024), which found that STAD significantly improves student learning outcomes across various subjects, including physics. Similarly, a study by Agustina et al. (2020) reported an increase in physics learning outcomes after implementing the TGT model.

Previous research conducted by Maulani et al. (2020) examined the impact of the STAD model on physics learning outcomes in vocational schools. The study demonstrated that STAD positively influenced student achievement. Additionally, a study by Erlinda (2017) provided evidence that the TGT model also enhanced students' learning activities and physics learning outcomes in vocational schools.

Based on the above discussion, both models have been shown to positively affect student engagement and learning outcomes. Therefore, further research is needed to compare these two learning models. This study is titled "Comparison of the Cooperative Learning Models STAD and TGT on Student Engagement and Physics Learning Outcomes in Vocational Schools on the Topic of Energy and Its Transformations."

The objectives of this research are to examine the significant differences in student engagement and learning outcomes in vocational school physics classes using the STAD and TGT models on the topic of energy and its transformations. Additionally, this study aims to describe students' responses after the implementation of these two models.

2. Proposed Method

This research was conducted at a vocational high school (SMK) in Jember Regency during the odd semester of the 2024/2025 academic year. This study employs a quantitative research approach using an experimental method with a true experimental design, specifically the posttest-only control group design. The subjects were divided into two classes: Experimental Class 1, which was taught using the STAD model, and Experimental Class 2, which was taught using the TGT model. After the learning process, both groups were given a posttest to compare their learning outcomes.

The population of this study consists of all tenth-grade students at a vocational high school in Jember Regency. The sample was selected from two representative classes, which were then assigned as Experimental Class 1 and Experimental Class 2. Sample selection began with a homogeneity test. If the population was homogeneous, the sample was selected randomly using the cluster random sampling technique. If the population was not homogeneous, two classes with the smallest difference in average scores were randomly selected.

The data collection techniques used in this research included: Observation: Conducted to collect data on students' learning activities during the learning process, assisted by six observers using an observation sheet. Unstructured interviews: Aimed at obtaining additional information. Tests: Used to measure students' cognitive knowledge through a posttest. Questionnaires: Used to measure students' responses after the implementation of the learning models. Documentation: Used to support the data obtained from observations.

The data analysis methods for learning activities and learning outcomes involved normality testing using SPSS software with the Kolmogorov-Smirnov test. Hypothesis testing was conducted using the independent sample t-test in SPSS if the data followed a normal distribution. If the data did not follow a normal distribution, the Mann-Whitney U test was used. Meanwhile, students' response data were analyzed using the Likert scale and score criteria.

3. Results and Discussion

This study is an experimental research conducted at SMK Negeri 2 Jember during the odd semester of the 2024/2025 academic year. The aim is to compare students' physics learning activities and outcomes between the experimental class 1 (using the STAD model) and experimental class 2 (using the TGT model) on the topic of energy and its transformations. The research was carried out over two weeks, covering permit processing, sample selection, learning activities, and posttest data collection.

The sample was determined through a homogeneity test based on previous physics test scores, using a One-Way ANOVA test with SPSS 25. The result showed a significance value of 0.501 (greater than 0.05), indicating that the samples were homogeneous. The result of the homogeneity test is presented in Table 1 below.

Table 1. Homogeneity Test Results

Test of Homogeneity of Variances			
Levene Statistic	df1	df2	Sig.
.841	4	169	.501

Based on Table 1, the significance value of 0.501 indicates that the data is homogeneous or from the same variance. After confirming normal distribution, samples were randomly selected through a lottery to determine the experimental classes. As a result, class X-TR (35 students) was assigned as experimental class 1, and class X-TKJ (34 students) as experimental class 2.

Students' Learning Activities

The first objective of this study is to examine the significant difference in students' physics learning activities at SMK Negeri 2 Jember on the topic of energy and its changes, using the STAD and TGT cooperative learning models.The data on students' learning activities were obtained from the observer's assessment during two meetings. The final score is calculated by summing the scores for each indicator, dividing by the total maximum score, and then multiplying by 100. The results of the observation of students' learning activities in experimental class 1 and 2 are presented in Table 2, showing the average for each activity indicator.

Table 2. Average final score for each learning activity indicator

No	Learning Activity Indicators	Average Final Score	
		Experiment 1	Experiment 2
1.	Paying attention to the teacher during the learning process (visual activity)	82,05	83,71
2.	Collaborating in group discussions (verbal activity)	90,87	88
3.	Listening to the teacher during the learning process (listening activity)	87,94	87,71
4.	Taking notes on key points from the teacher's explanation (writing activity)	81,76	83,14
5.	Showing enthusiasm and courage during the learning process (emotional activity)	93,52	89,42

Based on Table 2, the emotional activity indicator (enthusiasm and courage) has the highest average score, which is 93.52 in experimental class 1 and 89.42 in experimental class 2. Meanwhile, the writing activity indicator (taking notes on key points) has the lowest average score. The average score for each indicator in both classes is almost the same, indicating no significant difference. A summary of the students' learning activity data can be seen in Table 3.

Table 3. Summary of learning activity data

Class	Highest score	Lowest score	Average
Experiment 1	96	78	86,40
Experiment 2	96	78	86,41

Based on Table 3, the highest and lowest average scores in both classes are the same, with 96 for the highest score and 72 for the lowest score. The average final score in experimental class 1 is 86.40, while in experimental class 2 it is 86.41. Although the final score in experimental class 1 is slightly higher, the difference is not significant. The data was then analyzed to determine the significant difference in the average learning activity scores between the two classes using statistical testing with SPSS 25.

The normality of students' average physics learning activity scores was tested using the One-Sample Kolmogorov-Smirnov test. The results are presented in Table 4.

Table 4. Normality test of students' average physics learning activity scores

		Kelas Eksperimen 1	Kelas Eksperimen 2
N		35	34
Normal Parameters[a,b]	Mean	86.40	86.41
	Std. Deviation	5.242	4.819
Most Extreme Differences	Absolute	.130	.144
	Positive	.130	.144
	Negative	-.086	-.142
Test Statistic		.130	.144
Asymp.Sig.(2-tailed)		.140[c]	.073[c]

a. Test distribution is Normal
b. Calculated from data
c. Lilliefors Significance Correction

The normality test showed a Sig. (2-tailed) value of 0.140 for experimental class 1 and 0.073 for experimental class 2. Since both values are greater than 0.05, the data is considered normally distributed. The next step is hypothesis testing. Since the data is normally distributed, the analysis continues with a parametric statistical test using the Independent Sample T-test. The results are presented in Table 5.

Table 5. Results of independent sample t-test analysis on students' physics learning activities

Independent Sample Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std.Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
NILAI	Equal variances assumed	.150	.699	-.010	67	.992	-.012	1.213	-2.433	2.410
	Equel variances not assumed			-.010	66.800	.992	-.012	1.212	-2.430	2.407

The hypothesis test result in Table 5, shows a Sig. (2-tailed) value of 0.699 > 0.05, indicating no significant difference in learning activities between students taught using the STAD and TGT models. Therefore, the null hypothesis (H_0) is accepted and the alternative hypothesis (Ha) is rejected. This is in line with a previous study by Aka (2015), which stated that there is no significant difference in the learning activities of students who learn using the STAD and TGT models. The lack of significant differences between the two experimental classes is because students in both classes were actively discussing and presenting their work enthusiastically. Both models have similar steps, differing only in quizzes and games. Despite these differences, both models encouraged active participation in learning. This aligns with Aka's (2015) view that the quiz in STAD and the game tournament in TGT motivate students to solve questions accurately, maximizing the discussion time.

Learning Outcomes

The second objective of this study is to examine the significant difference in students' physics learning outcomes at SMK Negeri 2 Jember on the topic of energy and its changes, using the STAD and TGT cooperative learning models. The learning outcomes data was obtained through a posttest after the implementation of the STAD model in experimental class 1 and the TGT model in experimental class 2. The posttest was conducted to assess students' understanding of the topic of energy and its changes, using a written test consisting of 10 complex multiple-choice questions at cognitive levels C4 (analysis), C5 (evaluation), and C6 (creation). A summary of the learning outcomes is shown in Table 6.

Table 6. Summary of students' physics learning outcomes

Class	Number of students	Highest score	Lowest score	Average
Experiment 1	35	90	70	80,85
Experiment 2	34	90	70	81,17

Based on Table 6, the average posttest score of experimental class 2 is slightly higher (81.17) than experimental class 1 (80.85), with the same score range (70-90) in both classes. The data is then analyzed to determine the significant difference using statistical testing with SPSS 25. The students' physics learning outcomes data were tested for normality using the One-Sample Kolmogorov-Smirnov test, and the results can be seen in Table 7. below.

Table 7. Normality test of students' physics learning outcomes data

		Kelas Eksperimen 1	Kelas Eksperimen 2
N		35	34
Normal Parameters[a,b]	Mean	80.86	81.18
	Std. Deviation	5.621	5.911
Most Extreme Differences	Absolute	.361	.344
	Positive	.361	.344
	Negative	-.325	-.303
Test Statistic		.361	.344
Asymp.Sig.(2-tailed)		.000[c]	.000[c]

d. Test distribution is Normal
e. Calculated from data
f. Lilliefors Significance Correction

The normality test results show a Sig. (2-tailed) value of 0.00 for both classes, which is < 0.05. Therefore, the students' learning outcomes data in both classes are not normally distributed. Based on the normality test results, data analysis proceeded with the Mann-

Whitney U-test as the data is not normally distributed. The analysis results are shown in Table 8.

Table 8. The results of the Mann-Whitney U-test analysis of the physics learning outcomes.

Test Statistics[a]

	NILAI
Mann-Whitney U	578.000
Wilcoxon W	1208.000
Z	-.245
Asymp. Sig. (2-tailed)	.806

a. Grouping Variable: KELAS

Based on the hypothesis test results in Table 48, the Sig. (2-tailed) value is 0.806. Since the value is > 0.05, the null hypothesis (H0) is accepted and the alternative hypothesis (Ha) is rejected. Therefore, it can be concluded that there is no significant difference in the physics learning outcomes of students using the STAD and TGT cooperative learning models at SMK Negeri 2 Jember. This aligns with Triningsih (2021) study, which found no significant difference in learning outcomes using the STAD and TGT models on energy and its changes. However, it contrasts with Nurhayati's (2021) research, which found a significant difference in learning outcomes between TGT and STAD models in mathematics. The lack of significant difference in both classes is due to both models involving group discussions. This is consistent with Triningsih's (2021) research, which also highlighted group discussions in both STAD and TGT implementations. Additionally, both models share similarities, including material delivery, group formation, and rewards for the highest-scoring groups.

Student Responses

The third objective of this study is to describe the students' responses after the implementation of the STAD cooperative learning model in experiment class 1 and the TGT cooperative learning model in experiment class 2, with the topic of energy and its transformations. Student response data were obtained from questionnaires filled out by 35 students from class X-TR (experiment 1) and 34 students from class X-TKJ 1 (experiment 2) after each class received their respective treatments. The data was analyzed using descriptive techniques to assess student responses to the implementation of the STAD model in class 1 and the TGT model in class 2. The questionnaire consisted of 12 statements with a 1-5 score scale. The detailed data of student responses to the STAD and TGT models are presented in Table 9.

Table 9. The student response data

No.	Indicators	Experiment Class 1 (STAD))		Experiment Class 2 (TGT)	
		Percentage (%)	Category	Percentage (%)	Category
1.	Motivation	87	Very good	89	Very good
2.	Interest	83	Very good	83	Very good
3.	Response	82	Very good	82	Very good
4.	Satisfaction	83	Very good	83	Very good
The average for each class.		83,75	Very good	84,25	Very good

Based on the data presented in Table 9. all students in both experimental classes gave a very positive response, as they were motivated to participate in learning using the cooperative learning model STAD in Experimental Class 1 and TGT in Experimental Class 2. The percentage of positive responses was 87% in Experimental Class 1 and 89% in Experimental Class 2. This indicates that students were motivated during the learning process using the respective cooperative models. Overall, students became more enthusiastic during the lessons and expressed enjoyment in participating in learning activities with the applied cooperative models. Therefore, student responses in the motivation indicator category were classified as very good.

The application of the STAD and TGT cooperative learning models also received very good responses under the second indicator student interest. Students were more attentive during the teacher's explanations and showed a strong curiosity about the material being taught. Additionally, students in both experimental classes were actively involved in the learning process with the topic of energy and its transformations. For the interest indicator, student response scores in Experimental Class 1 were 83% and in Experimental Class 2 were also 83%, both categorized as very good.

For the third indicator student responses the use of cooperative models also received very good feedback. The students reported that these models helped them better understand the material and improved their learning experience. For this indicator, the response score in the STAD class was 82% and in the TGT class also 82%, both categorized as very good.

In the satisfaction indicator, students expressed that the material delivered during the implementation of each model met their expectations. They felt satisfied after learning with the STAD model in Experimental Class 1 and the TGT model in Experimental Class 2. The use of these models made it easier for them to retain what they had learned. The satisfaction indicator scores were 83% in both classes, categorized as very good.

Overall, the average student response score was 83.75% in Experimental Class 1 and 84.25% in Experimental Class 2. These results demonstrate that both learning models received a very good response from the students. This is further supported by the fact that these cooperative learning models had not been previously implemented at the school, making STAD and TGT potential solutions for encouraging student participation in the classroom.

These findings align with a study by Lestari et al. (2023), which found that the TGT model received a very good response from participants. Similarly, this research is in line with a study by Murdani et al. (2024), which concluded that the STAD model also received a very good response from students.

Conclusions

Based on the results of the study conducted at SMK Negeri 2 Jember, it can be concluded that there is no significant difference in students' physics learning activities or learning outcomes between the class using the STAD cooperative learning model and the class using the TGT model on the topic of energy and its transformations, with significance values of 0.992 for learning activities and 0.806 for learning outcomes. In addition, the responses of students at SMK Negeri 2 Jember after the implementation of the STAD cooperative learning model in class X TR and the TGT model in class X TKJ on the topic of energy and its transformations fell into the "very good" category.

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