



## The Effect of the STAD Cooperative Learning Model on Student Learning Outcomes in Reaction Rate Material

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### Abstract

The purpose of this research is to examine how student learning outcomes in reaction rate material are impacted by the Student Teams Achievement Division (STAD) cooperative learning model. The study used a quasi-experimental method with a posttest only nonequivalent control group design. Purposively, the sample was chosen, with 30 students in each of the two classes, XI SAINKES 4 as the experimental class and XI SAINKES 1 as the control class. Student Worksheets (LKPD) and twenty multiple choice post-test questions were among the tools utilized. Data were collected through written tests and documentation, then analyzed using normality tests, homogeneity tests, and hypothesis tests with independent sample t-tests using IBM SPSS Statistics 26. According to the findings, the experimental class's average post-test score was 74, whereas the control class's was 55.67. The hypothesis test showed a Sig. (2-tailed) value of 0,000 ( $p < 0.05$ ), so the alternative hypothesis was accepted. Thus, student learning outcomes in reaction rate material were significantly impacted by the use of the STAD cooperative learning model.

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## 1. INTRODUCTION

The educational process is a deliberate effort to transfer culture from one generation to the next. Education serves as a tool for the current generation to gain knowledge from previous generations. To date, education is still limited in its ability to explain itself fully due to the complex nature of its subject matter (Rahman et al., 2022). Education is seen as a crucial element in the progress of a country because it serves as a tool to create quality human resources. One way to improve the quality of human resources is to raise the bar for education. The main focus of efforts to improve the quality of education is on the competency of teachers, students, curricula, teaching strategies, learning materials, school environments, and learning facilities. Social progress is often reflected in educational development, and education has a very crucial role in achieving optimal human resource quality. Therefore, education should be able to create conditions that support and provide motivation to optimize and develop student potential,

increase activity and creativity, thus ensuring dynamics in the learning process (Sojo, 2022).

Education is, of course, inseparable from learning and learning outcomes. Learning and education are two things that are closely related. One essential skill that supports the development of the human intellect is learning. Learning can occur anywhere, at any time, and is an effort to change behavior within the parameters of knowledge, attitudes, and abilities. The learning process is one of the methods of imparting knowledge and assisting individuals to become better individuals. Through the learning process, an individual can gain knowledge and better opportunities for the future (Djamaluddin & Wardana, 2019). Through learning, each individual will have a good understanding and a directed perspective, so it will have a positive impact on social life and knowledge (Abrori & Sumadi, 2023).

Positive learning outcomes indicate that the learning process and learning itself were successful. Learning outcomes are the abilities that students acquire

after finishing a learning task. Students' learning outcomes will be influenced by the abilities they acquire after finishing the learning process (Kapisa, 2021). To achieve learning objectives effectively and efficiently, the right learning method is needed. One of the teaching methods is to use a cooperative learning model.

Designing an effective learning process that fosters student activity, critical thinking, and deep engagement remains a significant challenge in contemporary education (Aisyah et al., 2025). According to (Slavin, 2010), cooperative learning is a teaching method that has been used for a long time where teachers encourage learners to work together in various activities such as discussion and peer teaching. On the other hand, according to (Rusman, 2016), cooperative learning is a method in which students learn and work together in small groups of four to six members with a heterogeneous composition. In essence, cooperative learning can be defined as a collaborative attitude or behaviour in working or helping each other among members in an organised cooperative structure in groups consisting of two or more people, where the success of the work is strongly influenced by the participation of each group member (Solihatin & Raharjo, 2008). Cooperative learning can also be defined as the structure of shared tasks in an atmosphere of togetherness among group members. It is a learner-centred approach in which teachers use small groups to encourage learners to take responsibility for group activities and their own learning (Rolenza & Handayani, 2023).

Every learning model has advantages and disadvantages, including cooperative learning. Some of the advantages of cooperative learning model are: learners get more opportunities to improve cooperation with friends, develop activity, creativity, independence, critical attitude and ability to communicate with others. In addition, the teacher does not have to teach all the knowledge to the learners, only the main concepts, because through cooperative learning the learners can complete the knowledge themselves. However, cooperative learning also has some disadvantages, namely It requires more time, especially if students are not used to it, it requires more structured and systematic preparation, and if students are not used to and master this method, learning outcomes will not be optimal. The implementation of cooperative learning requires planning that includes choosing approaches, selecting appropriate

materials, forming student groups, introducing students to tasks and roles, and planning time and place (Suprihatiningrum, 2016).

There are different types of cooperative learning models. Although the basic principles remain the same, some types of cooperative models include Student Team Achievement Division (STAD), Puzzle, Team Games Tournament (TGT), Cooperative Integrated Reading and Composition (CIRC), Group Investigation, and Think Pair Share (Ponidi et al., 2021). The STAD cooperative learning model was applied in this study. When designing a learning process with STAD cooperative learning, there are four main steps involved: group organization, team study preparation, class instruction planning, and baseline and improvement score determination (Kouchak, 2012). STAD is one of the easiest cooperative learning methods to implement and is ideal for teachers who are just starting to use a cooperative approach (Slavin, 2015).

One such method of cooperative learning is called STAD (Student Team Achievement Division). Developed by Slavin in 1978, STAD allows the teacher to give instructions and learners to work in groups of five or six to discuss and help each other to complete the LKPD on the assigned material. After the lesson, each learner is given a quiz. Group scores are based on learners' previous scores and the group with the highest score is rewarded.

The STAD type cooperative learning model has several advantages, including this model can reduce individualistic behaviour among students, promote positive interactions and improve teamwork in groups, there are two types of learning responsibilities for students, namely learning independently and helping other group members learn, students can learn from each other from their peers (peer teaching), which is more effective than learning from the teacher, the teacher becomes more dynamic and focused as a facilitator, motivator and evaluator, and good performance and learning outcomes can be achieved by all group members (Rusman, 2011). The results of previous research by Kapisa (2021) show that student learning outcomes are greatly enhanced by the STAD cooperative learning approach. Similarly, the research conducted by (Devi et al., 2021) showed that the STAD type cooperative learning model had an impact on students' cognitive

learning outcomes. This research material differs from previous research material.

This study uses reaction rate as the material for the STAD cooperative learning model. According to (Indaharini, 2022) who states that the STAD model can be considered as one of the innovative learning options that can be applied according to the characteristics of chemistry learning, especially on the topic of reaction rate. Recent studies have also demonstrated that student-centered learning models significantly improve learning outcomes on reaction rate material, particularly when integrated with digital platforms or structured activities (Anandita et al., 2025). This supports the potential of cooperative models like STAD to enhance understanding of complex chemical concepts involving data analysis and mathematical reasoning. Reaction rate is an important aspect of chemistry learning. However, students often achieve unsatisfactory learning outcomes due to difficulties in understanding the content and ideas of reaction rates that require mathematical calculations. Therefore, in order to increase learning results, a teaching strategy that may help students properly comprehend the information and concepts of reaction rate is required. This issue should be addressed by the STAD cooperative learning approach.

## 2. METHOD

A quasi-experimental research design and quantitative methods were used in this study. The experimental and control groups weren't chosen at random, only nonequivalent control groups were post-tested. The design is shown in the following table.

Table 1. Research design

Class	Treatment	Posttest
Experimental	X	O <sub>1</sub>
Control	Y	O <sub>2</sub>

Description:

- O<sub>1</sub> = posttest for the experimental class
- O<sub>2</sub> = posttest for the control class
- X = STAD-type cooperative model
- Y = scientific learning model

This study involved all 143 students in class XI SAINKES (Science & Health) at SMAN 1 Parung in the 2023/2024 academic year. Overall, there were four classes: XI SAINKES 1, XI SAINKES 2, XI SAINKES 3, and XI SAINKES 4. There were thirty respondents from the XI SAINKES 4 class as the experimental class, while

thirty responded from the XI SAINKES 1 class who became the control class. Purposive sampling was used to select the research sample.

The instruments in this study used Learner Worksheets (LKPD) and 20 multiple choice posttest questions as student learning outcomes. In order to collect data for this study, tests and documentation were used. The multiple-choice written test used this study is intended to assess the treatment outcomes of the sample. This test consists of 20 questions, and the outline is shown in the table below.

Table 2. Instrument outline

Question Indicators	Question Number
Given a table of data from the experiment, students can correctly determine the rate equation of the reaction	1, 2, 10, 15, 18
Given a graph of the order of a reaction, students can correctly determine the overall order of the reaction	3
Students can correctly determine the order of the reaction	4
Given a reaction, students can correctly determine the rate equation of the reaction	5, 7
Students can correctly determine the rate equation	6, 11
Given a reaction and a reaction rate equation, students can correctly determine the overall order of the reaction	8, 20
Given a table of experimental data, students can correctly determine the order of the reaction	9, 13, 14
Given a table of data, students can correctly determine the correct statement from the table	12, 19
Given a table of data from an experiment, students can correctly determine the rate of reaction	16, 17

The data was analyzed using hypothesis and normality tests. Using the Kolmogorov-Smirnov equation and the choice criteria that the data is normally distributed if the significance value or p-value is greater than 0.05 and not normally disseminated if the p-value is less than 0.05, the test of normality was carried out using IBM SPSS Statistics 26 software. To test hypothesis, IBM SPSS Statistics 26 software is utilized. In order to determine whether the significance value is less than 0.05, unpaired samples are tested in test data with decision criteria.

## 3. RESULT AND DISCUSSION

### 3.1. Result

The posttest data analysis showed that the experimental group of students in class XI SAINKES 4 received an average score of 74, while the control group of students in class XI SAINKES 1 received an average score of 55.67. During the learning process, this study

used a cooperative learning model of the STAD type. The following is the posttest result data.

Table 3. Descriptive analysis

Class	Data Distribution	Score
Experimental	Lowest score	30
	Highest score	100
	Mean	74
	Median	80
	Mode	85
	Standard deviation	18.86
	Number of students	30
Control	Lowest score	20
	Highest score	90
	Mean	55.67
	Median	50
	Mode	50
	Standard deviation	17.40
	Number of students	30

In addition to using the posttest results, the experimental class also used the LKPD results to evaluate the material that had been taught with the LKPD results data contained in the following table.

Table 4. Descriptive analysis

Data Distribution	Score
Lowest score	85
Highest score	90
Mean	88.03
Median	88
Mode	88
Standard deviation	1.58
Number of students	30

The hypothesis, which inquires as to whether the STAD cooperative learning model affects student learning outcomes based on posttest scores, was evaluated using the t-test after the posttest results were obtained. The normality and homogeneity tests were performed as requirements before the t-test. A tabular presentation of the normality and homogeneity test findings is provided.

Table 5. Normality test results

Treatment	Class	Kolmogorov-Smirnov	Decision
Learning Outcome	Experiment	0.060	Normally Distributed
	Control	0.051	Normally Distributed

The experimental group's significance value is 0.060, while the control group's is 0.051, both of which are more than 0.05, according to the normality test table above. Using the Kolmogorov-Smirnov model (sig level:

5%) or 0.05, the normality test determined that the aforementioned data is normally distributed.

Table 6. Homogeneity test results

Treatment	Sig.	$\alpha$	Decision
Learning Outcome	0.946	0.050	Homogeneous

According to the homogeneity test table, if the results are larger than 0.05, the data is homogeneous, and if the results are less than 0.05, the data is not, which presents test findings with a significance level of 5% or 0.05. The learning outcome data's Sig. result was 0.946, indicating that the data is homogeneous.

The posttest results were judged to be homogeneous and regularly distributed based on the prerequisite test. The effect of the STAD cooperative learning model on student learning outcomes is then evaluated using the t-test for hypothesis testing. The results of the t-test calculation are shown in the given table.

Table 7. t-Test results

Data	Sig. Level	Sig.(2-tailed)	Conclusion
Learning Outcome	0.050	0.000	Ha accepted

Based on the t-test, which is carried out at a significance level of 0.05, one can conclude that  $H_a$  is accepted and  $H_0$  is rejected if the value is less than 0.05. However, if the value is more than 0.05,  $H_0$  is accepted and  $H_a$  is rejected. This could be in line with the t-test results at a centrality level of 0.05. If the Sig. (2-tailed) esteem of the learning results data is 0.000, it can be said that the STAD cooperative learning model influences understudy learning outcomes.

### 3.2. Discussion

According to the results, the control class, which employed scientific learning model, only managed to attain an average posttest score of 55.67, whereas the experimental class, which employed the STAD cooperative learning model, had an average score of 74. This significant difference (proven by a t-test  $\alpha = 0.05$ ,  $p = 0.000$ ) indicates that the experimental class achieved better learning outcomes. This advantage did not occur by chance, but was a direct result of the learning structure and dynamics created by the STAD model.

The success of the experimental class lies in the active role of students in the collaborative process. In the STAD model, students learn in small heterogeneous

groups, help each other understand the concept of reaction rate through LKPD discussions, and are responsible for the progress of the group. This process encourages peer teaching, where explanations from peers are often easier to understand than explanations from teachers, especially for complex material such as reaction rates involving experimental data analysis and reaction order calculations (Slavin, 2015). In contrast, the control class is typically teacher-centered, which means that there is little opportunity for students to interact with another and to deepen their understanding through discussion.

Another important factor in STAD success is motivation. The group reward structure motivates all students to contribute as much as feasible due to the fact that the score from each individual student contributes to the group performance. This incentive renders the students focused, engaged, and responsible throughout the learning process. As stated by Wulandari (2022), the STAD model creates a learning environment that supports cooperation and mutual assistance, especially in groups consisting of students with different abilities. This is very relevant to the conditions in the experimental class, where high-ability students voluntarily guide their friends, resulting in an even distribution of knowledge within the group.

In addition, Aryani (2022) emphasized that STAD is a learning model that is easy to implement, affordable, and effective in improving learning outcomes. In this study, the systematic structure of STAD, starting from the delivery of material, group discussion, presentation of results, to individual quizzes, provided clear steps that helped students focus on achieving learning objectives.

The application of LKPD in groups was also a determining factor in the success of STAD learning. Sudarsana (2021) found that STAD was very effective in improving learning outcomes because students were given the opportunity to solve problems collectively. A similar pattern occurred in this study, where LKPD containing contextual problems about reaction rates encouraged students to discuss, analyze data, and conclude concepts together. The average LKPD score for the experimental class was 88.03, indicating a high level of student engagement and understanding during the discussion process.

Furthermore, Murtihapsari et al. (2021) stated that STAD encourages students' literacy and evaluative abilities through group discussions. In this context, students not only memorized the reaction rate formula but also understood how the formula was derived from experimental data. More students in the experimental class correctly answered posttest questions requiring data analysis, such as figuring out the order of reactions and creating rate equations, which demonstrate this ability.

Therefore, STAD fosters a collaborative, inclusive, and highly motivated learning environment, which contributes to the experimental class's superiority rather than just having a different learning model. With this approach, students become active participants in the creation of knowledge rather than passive consumers. As a result, STAD is strongly advised for chemistry courses that call for analytical abilities and conceptual knowledge, such as reaction rates.

#### 4. CONCLUSION

According to the study's findings, students' learning outcomes in reaction rate material are significantly impacted by the STAD cooperative learning model. The control class only received a posttest average of 55.67, whereas the experimental class that used STAD received an average of 74. This difference shows that STAD is more effective than scientific learning model in improving student understanding. Therefore, the STAD model is recommended as an alternative effective learning strategy for reaction rate material at the high school level.

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