

# **An Application of the Cooperative Learning Model with Guided Discovery Approach Improves Student Learning Outcomes in an Educational Statistics Course**

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## **Abstract**

This study aims to determine the effectiveness of the application of the Cooperative Learning model with a guided discovery approach in improving student learning outcomes in the Statistics of Education course. The research used a quantitative approach with the type of Classroom Action Research (PTK) conducted in two cycles. The research subjects were fourth-semester students of the Pamulang University Economic Education Study Program in the 2024/2025 academic year. Data were collected through learning outcomes tests, student activity observations, and student response questionnaires to the learning model. The results showed that there was a significant increase in the average value of student learning outcomes, from 69.88 in the pre-cycle to 72.76 in cycle I, and increased to 81.26 in cycle II. The percentage of learning completeness increased from 52% to 86% at the end of cycle II. Observations also showed an increase in student activeness and collaboration in the learning process with the percentage of learning implementation reaching 94%. Most students gave a positive response to the use of the Cooperative Learning model with a guided discovery approach because it was considered to encourage active participation and better understanding of the material. Therefore, it can be concluded that the Cooperative Learning model with a guided discovery approach is effectively used in learning Statistics Education to improve learning outcomes and student involvement.

**Keywords:** Student Learning Outcomes, Cooperative learning, Education Statistics

## **Abstrak**

Tujuan penelitian ini untuk mengetahui efektivitas penerapan model pembelajaran Cooperative Learning dengan pendekatan penemuan terbimbing (guided discovery) dalam meningkatkan hasil belajar mahasiswa pada mata kuliah Statistika Pendidikan. Penelitian menggunakan pendekatan kuantitatif dengan jenis Penelitian Tindakan Kelas (PTK) yang dilaksanakan dalam dua siklus. Subjek penelitian adalah mahasiswa semester IV Program Studi Pendidikan Ekonomi Universitas Pamulang tahun ajaran 2024/2025. Data dikumpulkan melalui tes hasil belajar, observasi aktivitas mahasiswa, dan angket respon mahasiswa terhadap model pembelajaran. Hasil penelitian menunjukkan bahwa terjadi peningkatan signifikan pada nilai rata-rata hasil belajar mahasiswa, dari 69,88 pada pra siklus menjadi 72,76 pada siklus I, dan meningkat menjadi 81,26 pada siklus II. Persentase ketuntasan belajar meningkat dari 52 % menjadi 86 % pada akhir siklus II. Observasi juga menunjukkan peningkatan keaktifan dan kolaborasi mahasiswa dalam proses pembelajaran dengan persentase keterlaksanaan pembelajaran mencapai 94%. Sebagian besar mahasiswa memberikan respon positif terhadap penggunaan model Cooperative Learning dengan pendekatan penemuan terbimbing (guided discovery) karena dinilai mendorong partisipasi aktif dan pemahaman materi yang lebih baik. Oleh karena itu dapat disimpulkan bahwa model pembelajaran Cooperative Learning dengan pendekatan penemuan terbimbing (guided discovery) efektif digunakan dalam pembelajaran Statistika Pendidikan untuk meningkatkan hasil belajar dan keterlibatan mahasiswa.

**Kata kunci:** Hasil Belajar Mahasiswa; Pembelajaran kooperatif; Statistika Pendidikan

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## **INTRODUCTION**

Education has a decisive role in the development and realization of the quality of human resources, especially for the development of the nation and state. As stated in Article 1 Paragraph 1 of Law Number 20 of 2003 concerning the National Education System, "Education is a conscious and

planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation and state" .

The success of the teaching-learning process in the context of learning is strongly influenced by the learning strategies and models applied by educators. Because according to Bruce Joyce (n.d) "The learning model is not only a way of teaching, but also a means to help students obtain certain learning outcomes more optimally.". The learning model not only plays a role in delivering material, but also determines the extent to which students are able to understand, process, and apply the knowledge gained. The learning process is the core of educational activities that determine the achievement of instructional goals. In an effort to improve the quality of learning, lecturers are required to be able to choose and apply learning models that are in accordance with the characteristics of students, subject matter, and learning context. The right learning model can increase students' active participation, build critical thinking skills, and encourage deeper mastery of the material.

According to Biggs, J & Tang C (2013), "Higher education requires students to be engaged in deeper and more complex forms of learning that involve critical thinking, problem-solving, and the ability to integrate and apply knowledge.". The process at the tertiary level is more complex because of the higher cognitive level of students. This is in line with Pertiwi, I., et al (2024) who stated that the learning process in higher education is different from the learning process in schools. Learning in higher education is not only about providing material on certain topics but must also provide learning experiences that allow students to develop independence in learning so that they can improve student learning achievement. So for teachers, namely lecturers, it is necessary to provide methods, models, and learning strategies that are varied, active, student-centered, and provide appropriate assignments. Various learning models have been developed to improve the effectiveness of learning, such as cooperative learning models, problem-based learning, discovery learning, and others. Each model has its own advantages that can be adjusted to the characteristics of students, teaching materials, and learning objectives. However, in practice, there are still many lecturers who are not optimal in applying innovative learning models and in accordance with student needs, resulting in low student participation and learning outcomes.

The Statistics of Education course is one of the important basic courses in the Economics Education Study Program. In the world of education, especially economic education, statistics play an important role as a tool in the data-based decision-making process. Mastery of statistics allows students to conduct educational research, evaluate policies, and understand economic and social phenomena objectively and measurably. Through this course, students will be introduced to the basic concepts of statistics, ranging from descriptive statistics to inferential statistics. Students will also learn how to organize data, create frequency distribution tables, calculate measures of concentration and dispersion, and apply statistical analysis techniques such as hypothesis testing and simple regression analysis. By understanding educational statistics, students are expected to be able to think critically, analytically,

and systematically in dealing with economic education issues, both theoretically and practically.

Educational statistics is one of the branches of statistics, and more broadly, statistics itself is a branch of applied mathematics. One of the characteristics of mathematics is that it has an abstract object, meaning that the object of mathematics is in the realm of the human mind, while its realization is by using objects that are in the environment around in real life. This is evident when students work on practice problems given by the lecturer, students take a long time to solve the problem and some students are still not focused and not ready to work so that the lecturer needs to reprimand them to remind the students. Some students have not been actively involved physically, mentally, and emotionally in the learning process. In addition, it was seen that some students passively listened to the lecturer's explanation. Although they seem to pay attention, these students have not shown activeness such as asking questions or submitting answers as a sign that they have understood the material presented by the lecturer. Only certain students are active in the learning process. On the other hand, there are students who are lazy and some students who talk to friends about things outside the lesson constantly even though they have been warned by the lecturer. Analysis of the learning outcomes of Statistics Education in the previous semester found that in category A by 23%, category B by 29% and category C by 48%. The average value of the learning outcomes of Statistics Education is 69.88 in the Moderate category. So that lecturers must make efforts so that the average student learning outcomes in Educational Statistics lectures are in the Good category. If students have good learning outcomes, it will have a positive effect on the student's cumulative grade point average. The data is presented in Table 1 below:

Table 1 . Data on Student Learning Outcomes in Educational Statistics Lectures

<b>Variables</b>	<b>Interval</b>	<b>Letter Grade</b>	<b>Criteria</b>	<b>Number of Students</b>	<b>Initial Condition</b>
<b>Learning outcomes</b>	$80 < X \leq 100$	A	Special	11	23 %
	$70 < X \leq 80$	B	Good	14	29 %
	$60 < X \leq 70$	C	Medium	23	48 %
	$50 < X \leq 60$	D	Less	0	0 %
	$0 < X \leq 50$	E	Failed	0	0 %
<b>Average</b>	69,88		Medium	48	

Furthermore, the results of interviews with lecturers and students revealed that so far, many educational statistics lectures are still teacher-centered, where students tend to be passive and only receive information without much opportunity to explore and discuss. This condition has an impact on the low learning outcomes of students due to the lack of a thorough understanding of the concept. Therefore, the application of innovative learning models, such as cooperative learning, is important to improve learning effectiveness.

Slavin, R.E. (1982) states that "Cooperative learning involves students working together in small groups to help each other learn academic content. The success of one student helps others succeed,

creating a shared responsibility for learning.". The theory emphasizes the cooperative learning model encourages students' active involvement in discovering and building knowledge through contextual learning experiences. The application of this model is believed to help students develop higher-order thinking skills, communication skills, and collaborative attitudes. There are several learning models that are considered effective in activating students in constructing their knowledge, one of which is the use of cooperative learning. Through cooperative learning, students learn together in groups to master and solve problems. By applying this model, learners can express their opinions or ideas to each other in their groups. Theoretically, learners can enrich their knowledge with each other. This is in accordance with what Heywood said, "two heads are better than one" and Aesop's opinion that "union gives strength" (Johnson et al, 1991). This statement can be interpreted that something or problem if studied or thought together (in groups) will be easier to learn or solve than if individually. In addition, understanding of concepts and principles will be easier for students to obtain if cooperative learning is applied in learning. "There is evidence that factual material will be remembered better if it is discussed in a cooperative structured group. Cooperative goal structured also facilitates mastery of concepts and principles and of creative processes (such as divergent thinking, risk-taking thinking, and entering into controversy)" (Johnson & Johnson, 2002a).

Many researchers have proven that the application of cooperative learning can result in higher individual learning achievement when compared to competitive learning (there is competition between students) or individuals when learning is not in groups (Johnson, D.W., Roger T. Johnson, & Stanne M.B, 2002b). Through cooperative learning, learners in small groups are guided to be able to investigate matters or problems related to the mastery of the expected competencies. Learners can build their knowledge together so that learning is not a transfer of knowledge from educators to students but rather interaction between students and with learning resources. After that, students present their group results in front of the class so that other students can also learn and provide responses or rebuttals to the group's results. In addition, students can also learn to express their opinions and practice courage. In this case, the lecturer acts more as a facilitator than as a conveyor of knowledge.

Based on the problems described above, this study aims to apply and evaluate the effect of cooperative learning models on student learning outcomes in Educational Statistics lectures. It is expected that the results of this study can be a reference for lecturers in choosing learning strategies that are more effective and in accordance with the needs of students.

## **METHOD**

The researcher used a quantitative approach to classroom action research (PTK) which involved two cycles. According to Arikunto (2013), "Classroom Action Research is an activity carried out by teachers in their own classrooms by designing, implementing, reflecting, and revising actions to improve or improve the quality of learning". Classroom Action Research is intended to overcome a

problem or improve learning in the classroom. Therefore, the purpose of this research is to change the initial situation or condition towards the expected condition (improvement oriented).

Researchers want to know the effectiveness of implementing the Cooperative Learning model in improving student learning outcomes in the Educational Statistics course. The research subjects were 24 fourth semester students of Economic Education Study Program of FETT Pamulang University who attended the Statistics of Education lecture. The selection of subjects was carried out purposively based on active involvement in the course. Based on the observation, information was obtained that during learning activities, students' attention was often diverted to other things that had nothing to do with learning and tended to interfere with learning activities such as chatting with friends. This of course disturbs the concentration of other students who are paying attention to the explanation of the lecturer. So the lecturer must be able to package learning interestingly so that students are more interested in participating in learning.

The research setting was carried out in the even semester of the 2024/2025 academic year. The learning model applied is Cooperative Learning with a heterogeneous small group approach, where students are divided into groups of 3-4 people. Learning activities are carried out through group discussions, problem solving, and presentation of group work results. Data collection techniques are carried out using:

1. Learning outcome tests (pretest and posttest) to measure the improvement of understanding of statistical concepts.
2. Observation of student learning activities was carried out during the learning process using a validated observation sheet.
3. Student response questionnaires to the application of the Cooperative Learning model to determine perceptions and satisfaction levels.

According to Okpokunu, E. (2005), the research procedure includes the stages of this class action research including planning, acting, observing, and reflecting. Each cycle lasted for two meetings. This research model is simply presented in Figure 2.

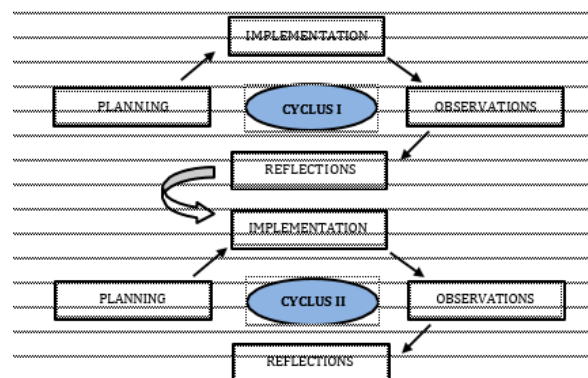


Figure 1. Classroom Action Research Model

The details of the learning steps can be described as follows.

1. Cycle I

a. Action Planning

The activity carried out at the action planning stage is to develop a design that will be implemented, in accordance with the initial findings and initial ideas. Action planning is made so that the implementation of research can run as expected. The design that will be implemented refers to the STAD type cooperative learning model. At this planning stage, several activities are carried out, including: (1) Making RPS and SAP according to the material taught through STAD type cooperative learning; (2) Making Student Activity Sheet (LKM) with *guided discovery* approach; (3) Making *quiz* (individual test); (4) Making observation sheet for the implementation of STAD type cooperative learning with *guided discovery* approach; (5) Making evaluation questions; and (6) Making student response questionnaire.

b. Implementation of Action and Observation

At this stage, the lecturer implements the STAD type cooperative learning design with *guided discovery* approach as planned. A plan is flexible and open to changes in accordance with what happens in the learning process in the classroom towards improvement. Learning that is carried out refers to the stages in cooperative learning type STAD with *guided discovery* approach. Students were grouped based on pretest scores and gender. Learning with the STAD type *cooperative learning* model includes several steps, namely: class presentation, group learning, test (quiz), individual score improvement, group award. So the learning steps are as follows.

Table 2. Learning steps

<b>STAD</b>	<b>Guided Discovery</b>
<i>Phase 1: Class Presentations</i>	<i>Stimulation Problem Statement</i>
<i>Phase 2: Teams</i>	<i>Data Collection Data Processing Verification Generalitation</i>
<i>Phase 3: Test or quiz</i>	
<i>Phase 4: Score increase in the individual</i>	
<i>Phase 5: Group award</i>	

c. Observation

Observation is conducted during the learning process in the classroom as an effort to determine the course of learning. Observation or observation is carried out by observers (teaching team) during learning activities. Observation guidelines were prepared based on the steps of the STAD type cooperative learning model with a guided discovery approach. Observers observed and recorded everything that happened during learning in the classroom.

d. Analysis and reflection:

### 1) Reflection

Reflection is the final activity in each cycle which aims to evaluate the results of the actions that have been taken and is a mirror of the results of research in each cycle. Activities at this stage begin with collecting all research data which includes observation data of the learning process, test results data for each cycle, and curiosity questionnaire data for each cycle. At this stage the researcher assisted by the observer discussed the observation data of the learning process, the test results data for each cycle, and the student response questionnaire data for each cycle. The data obtained at the observation stage was analyzed based on the problems that arose, shortcomings, and everything related to the action then reflected. The results of this study are very basic data for developing action activities in the next cycle.

### 2) Action impact

After getting action in the form of a STAD type cooperative learning model with a *guided discovery* approach, it is expected that student learning outcomes will increase. If this expectation has not been obtained, the next cycle will be carried out.

## 2. Cycle II

If the actions in cycle I have not shown an increase in learning outcomes, then the second cycle is continued. Cycle II was carried out based on reflections on the first cycle. Some things that have not been done in cycle I will be done in cycle II. The work stages in the next cycle follow the work stages of cycle I. The activities carried out in cycle II are intended as a refinement or improvement of the cooperative learning model type STAD with a *guided discovery* approach. If based on reflection it is necessary to repeat, the cycle can be repeated. The cycle will be stopped if student learning outcomes have improved.

Data collection techniques and instruments used in this study include observation sheets, learning achievement tests, and student response questionnaires.

The indicators of success in this study are the achievement of improved student learning outcomes, which can be described as follows:

- a. The increase in student response is seen from the increase in the percentage of student satisfaction. The increase in the percentage of student response can be seen from comparing the results of the questionnaire before class action research with the end of cycle 1 or the end of cycle 2 with cycle 1. This research is said to be successful if it reaches the target set at the beginning of the research.
- b. This research is said to be successful if the lecturer's activities and student activities reach the predetermined target of  $\geq 90\%$ .
- c. There is an increase in learning outcomes in the form of student scores compared to the test scores in each cycle. This study is said to be successful if the percentage of student learning outcomes that meet the  $KKM \geq 75\%$  with a minimum KKM of 71 (B grade criteria).

The data analysis technique used quantitative descriptive analysis. The data obtained in this study are in the form of quiz result data, observation data of learning implementation, student response questionnaire results, student test result data, and documentation in the form of photos. The average value of student learning outcomes before and after the action is compared to see the improvement. The minimum completeness criteria (KKM) is set at 71. As for calculating the percentage of students who reach KKM, the formula is used:

$$\text{persentase} = \frac{\text{banyaknya siswa yang mencapai KKM}}{\text{banyaknya siswa kelas}} \times 100\% \quad (1)$$

Furthermore, it is said that there is an increase in student achievement if there is an increase in the average test score in each cycle and at least 75 % students reach the KKM score. In addition, the observation results were analyzed to evaluate the activeness and collaboration between students during the learning process.

## RESULT AND DISCUSSION

### *Research Result*

This classroom action research was conducted in two cycles, each consisting of planning, action implementation, observation, and reflection stages. The main objective of this study was to improve student learning outcomes through the application of the *Cooperative Learning* model with a *guided discovery* approach in the Statistics of Education course.

This research was carried out in two cycles, with two meetings in each cycle adjusting to the Educational Statistics lecture schedule. Cycle I and II consisted of 2 meetings each with the time allocation for each meeting of 2 x 50 minutes. The actions taken in each cycle are as follows:

#### 1. Action Planning

This activity aims to plan and prepare everything before carrying out the research. The activities carried out during the planning of cycle I include: preparation of learning devices (RPS, SAP, LKM, Quiz), preparation of research instruments (tests, observation sheets of learning implementation), formation of study groups). Planning activities in cycle II are basically the same as cycle I but there are several additions based on reflections from cycle I including:

- a. Lecturers pay more attention so that group discussions run optimally by always monitoring and going around the class when group discussions take place.
- b. If a student asks the lecturer a question, the lecturer does not directly answer the student's question but rather gives necessary instructions so that the student can automatically answer the question he or she is asking.
- c. Lecturers plan the time distribution for each activity well so that all activities can be carried out and no learning steps are missed. learning using the STAD type cooperative model with a

*guided discovery* approach can run optimally.

## 2. Implementation and Observation of Action

At this stage the lecturer carried out the action in accordance with the SAP that had been prepared by the lecturer. During the research, the researcher was assisted by an observer (*teaching team*), who understood about the STAD type cooperative learning model with a *guided discovery* approach and had read the learning implementation observation sheet. During the learning activities, the observer participated and accompanied the students in group learning. Cycle I and II were conducted in 2 meetings each, with each meeting lasting  $2 \times 50$  minutes.

## 3. Learning Outcome and Observation Data

### a. Student Learning Outcomes

The test was given at the end of the cycle to determine student learning outcomes after learning using the STAD type cooperative model with a *guided discovery* approach. The test questions consisted of 4 *essay* questions. In this test, students are said to be complete if the scores obtained by students reach the Minimum Completeness Criteria (KKM) of 71 (Grade B Criteria).

Based on the learning outcomes of students in cycle I who have completed as many as 32 people with a percentage of 64%. So it can be seen that the number of students who completed the first cycle has not reached 75% of all students. So improvements need to be made in the next cycle. Furthermore, in cycle II, 43 people were completed with a percentage of 86%, which means that it has reached more than 75%. The description of the percentage of learning outcomes is presented in Table 2. as follows:

Table 3. Percentage of Learning Outcome Completion

	Average Value	Number of Students Completed	Percentage of Completion
Pre Cycle	69,88	25 out of 48 students	52 %
Cycle I	72,76	32 out of 50 students	64 %
Cycle II	81,26	43 out of 50 students	86 %

Based on the table above, it can be seen that the increase occurred from pre-cycle to cycle I (difference of 2.89 points), and again increased significantly in cycle II by 8.5 points. This shows that the *Cooperative Learning* model with a *guided discovery* approach is effective in improving student learning outcomes in the Statistics of Education course. The increase in the average value of learning outcomes can be illustrated in the following figure.

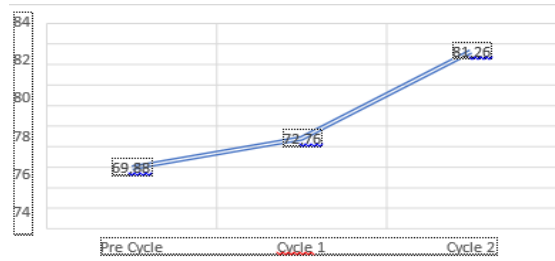


Figure 2. Increase in Average Value of Learning Outcomes

b. Learning Implementation Observation Results

Observations during the learning process showed an increase in student activity and participation from cycle to cycle. Students seemed more active in group discussions, more involved in problem solving, and showed an increase in the ability to express opinions. Based on the results of observations conducted during 2 meetings in cycle I and 2 meetings in cycle II by an observer, the implementation of learning using the STAD type cooperative model with a *guided discovery* approach has been well implemented in accordance with the criteria used. The observation results of the learning implementation in cycle I were still at an average of 84%, meaning that it was still below the 90% achievement. Then in cycle II, the implementation of learning has reached 94%. In detail, the percentage of implementation is presented in Table 8 below.

Table 4. Percentage of *Learning Implementation* using *Cooperative Learning* with *guided discovery* approach

	Cycle I (average)	Cycle II (average)
Meeting 1	80 %	93 %
Meeting 2	88 %	95 %
Percentage of learning implementation	84 %	94 % (archived)

The results of the percentage of learning implementation above have not yet reached perfect results because there are still some activities that are not implemented. In cycle I, activities that were not carried out included: students did not respond to group presentations, especially groups that got questions from groups presenting in front of the class, lecturers did not make summaries related to presentation or discussion activities that had been carried out by students, lecturers did not check the level of student understanding by asking short questions related to the material to students, not all students finished doing the exercise questions on the LKS and lecturers did not arouse student motivation by conveying the benefits of the material to be learned. Whereas in cycle II, activities that were not carried out included: not all students finished doing all the practice questions on the LKS and the lecturer did not check the level of student understanding by asking short questions related to the material to the students. The comparison of the percentage of learning implementation between cycles at each meeting is as follows.

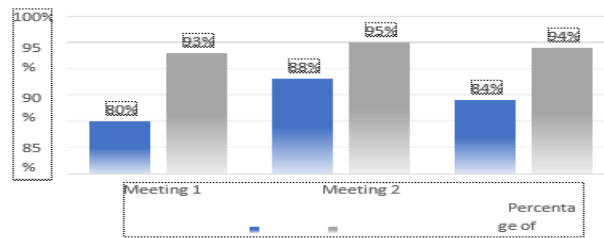


Figure 3. Comparison of Percentage of *Learning Implementation using Cooperative Learning with guided discovery approach*

### c. Student Response Results

Student response data is obtained from a questionnaire. Questionnaires were distributed to students after the implementation of learning using *Cooperative Learning* with a *guided discovery* approach. The number of respondents in this study was 50 people with the total number of respondents multiplied by one hundred percent.

Ideally students have a positive impact in every learning activity after the application of the *Cooperative Learning* learning model with a *guided discovery* approach. Based on the results of student responses to the Statistics Education lecture, the results obtained in the category strongly agree by 11%, the category agreed by 46%, the neutral category by 23%, the category disagreed by 16% and the category strongly disagreed by 4%. In line with research conducted by Indah Pertiwi (2023), it is known that learning mathematics using the STAD type cooperative model with a guided discovery approach has been able to increase the curiosity of Pamulang University students. Questionnaires given to students after the implementation of the action showed that most students gave a positive response to the application of the *Cooperative Learning* model. They felt easier to understand the material, felt motivated because they were learning with friends, and considered the class atmosphere to be more fun and interactive.

### Discussion

Based on research findings, the implementation of the cooperative learning model has demonstrated a positive impact on improving student learning outcomes. This can be seen in the increase in average student learning scores after the model's implementation, as well as increased active participation during the learning process.

The implementation of the cooperative learning model allows students to study in groups, exchange information, and collaborate on assignments. These activities encourage active student engagement, strengthen conceptual understanding, and foster social skills such as communication, responsibility, and tolerance. For example, in the implementation of the STAD (Student Teams Achievement Divisions) model, students are given the opportunity to study individually and in groups. Rewards for the best-performing groups motivate students to help each other and encourage team performance. Analysis shows that students are more motivated to learn and demonstrate a better

understanding of the material compared to before the model was implemented.

Furthermore, the cooperative learning model also helps address the gap in participation in the classroom. Students who were previously passive become active because they are encouraged to contribute in small groups. Lecturers also act as facilitators, guiding discussions, providing guidance, and ensuring all students are involved in learning activities. However, the implementation of this model is not without challenges. Some challenges identified include limited time allocation, difficulty managing groups, and significant differences in student abilities. However, these challenges can be minimized through careful planning, initial student training, and effective classroom management.

Thus, it can be concluded that the cooperative learning model is effective in improving learning outcomes and student engagement. Consistent implementation tailored to student characteristics and subject matter can result in a more meaningful and enjoyable learning process

## **CONCLUSION**

Based on the analysis of six mini-research reports conducted by students in the context of Fuzzy Logic, it can be concluded that most students demonstrated strong abilities in various aspects of mathematical reasoning. They were able to propose conjectures, perform mathematical manipulations, construct evidence, and justify the validity of their proposed solutions. Furthermore, students demonstrated strong skills in validating arguments and identifying relevant patterns for generalizations.

However, several challenges emerged in some of the reports. For example, in a report on scholarship eligibility in Bondowoso Regency, students failed to draw relevant and more specific conclusions, reflecting the research objective of the mini-research, which was to determine scholarship eligibility in greater detail. Another report, on electricity cost prediction, demonstrated difficulty in identifying the correct patterns among the variables used, resulting in inconsistent results. This highlights the importance of selecting more relevant variables and a deeper understanding of the data used in decision-making.

Overall, despite some difficulties in applying more complex mathematical reasoning, these reports indicate that students have good potential in utilizing fuzzy logic to solve the problems they face. Therefore, to improve the quality of students' mathematical reasoning, it is necessary to emphasize the selection of relevant variables, as well as developing skills in drawing more precise conclusions and verifying results more thoroughly.

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