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Discovery Learning Model: A Solution to Improve Learners' Mathematical Generalization Ability

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Abstract

Mathematical generalization ability is an aspect that students must master in mathematics. This study aims to analyze the effectiveness of the application of the discovery learning model on students' mathematical generalization ability. This research uses a quantitative approach with experimental methods, using a quasi-experimental design with a non-equivalent control group design. The research sample consisted of two classes in one of the high schools in Indonesia, Data were collected through pretest and posttest tests, and analyzed using normality test, homogeneity test, and t-test. The normality test used SPSS with Kolmogorov-Smirnov. The results of the analysis presented show that the pretest and posttest data in the experiment are normally distributed, it can be seen that the significance value of the pretest of the experimental class and the control class is 0.44. this shows that the significance value> 0.05 which means Ho is accepted. The results showed that there was a significant increase in students' mathematical generalization ability in the experimental class compared to the control class. The average posttest score of the experimental class is higher than the control class, indicating that the discovery learning model helps students understand mathematical concepts better through independent exploration and analysis. Thus, it can be concluded that the discovery learning model is effective in improving students' mathematical generalization ability, and can be an alternative learning method that is more interactive and innovative in teaching mathematics.

INTRODUCTION

Education in Indonesia is still dominated by the view that knowledge is a collection of facts that must be memorized. Learning in the classroom still focuses on the teacher as the only source of knowledge with the lecture method still being the main choice of learning method. The learning process that occurs is one-way, which only emphasizes the cognitive aspects of students, while the effective aspects and psychomotor aspects of students are less considered. Learners only "know" and do not "experience" what they learn.

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Teachers are still dominant while students are resistant, teachers are still players while students are spectators, and teachers are active while students are passive. The old paradigm is still attached because of habits that are difficult to change, the teacher teaching paradigm is still maintained and has not changed to the paradigm of students learning (Anggoro, 2016; Magfirah & Paliso, 2019).

Education in schools favors students because of the habit of being spectators in the classroom, they are already comfortable with receiving conditions and are not trained to give. Apart from the habit that has been attached and ingrained so that it is difficult to change, this condition is possible because the teacher's experience is still limited about how students learn and how to teach students. As a result, it is the teacher who plays more of a role in the learning process. Such learning does not develop students' reasoning skills, does not invite creative and critical attitudes, makes students less active, and is boring. The impact is that students' attitudes towards lessons, especially math lessons, tend to be negative, which in turn can result in low student learning outcomes (Arrosyad et al., 2023; Heryan, 2018; Hidayah, 2023; Noor & Abadi, 2022; Sagitarini et al., 2023; Sari et al., 2018; Sulaiman et al., 2021).

The cause of low student learning outcomes is actually not easy to know for sure, because many factors determine the quality of learning outcomes (Ardila & Hartanto, 2017; Nuraeni & Syihabuddin, 2020; Oktaviani et al., 2020). The factors that cause low student learning outcomes are caused, among others, by internal and external factors. Especially in the field of mathematics, one of the factors that determine the quality of mathematics learning outcomes is students' attitudes towards mathematics (Nabillah & Abadi, 2019). The results of the third international mathematics and science study conducted on students in Indonesia on the average mathematics score achieved was only 397 far below the international average in the third international mathematics and science study which reached 500 the value achieved by students in Indonesia is also lower when compared to several other countries in the Asian region such as Taiwan with an average score of 598, South Korea (597), Singapore (593), Japan (570) and even Malaysia (474). While the 2006 Program for International Student Assessment report, Indonesia ranks 52 out of 57 countries. While the results of math scores on the national examination, at all levels and levels of education are always glued to low numbers.

The low mathematical ability of students has an impact on their low mathematics learning achievement. one of the trends that causes a number of students to fail to master well the subject matter in mathematics due to students not using logical reasoning in solving given mathematical problems or problems. the weakness of students' mathematical abilities is seen from their learning outcomes. For example, errors in solving math problems are caused by errors in using deductive logic. one of the tendencies that causes some learners to fail to master well the subject matter in mathematics due to students' lack of using logical reasoning in solving given mathematical problems or problems (Anggraini et al., 2023).

Many factors affect the quality of mathematics learning. One of the factors that influence it is the accuracy in the application of the learning model used by the teacher. In addition, the low mathematical ability of students is also due to the fact that teachers still do not fully understand learning as an effort to make students learn (Jusniani & Nurmasidah, 2021; Muthmainnah & Purnamasari, 2019; Nurhikmayati, 2017; Prayitno, 2015). this can be seen in the field of teacher dominance in learning is still the choice of teachers so that students are more passive in learning. daily learner activities consist of watching the teacher solve

problems on the blackboard, then asking students to work alone in the textbook or student worksheet provided.

The quality of mathematics learning is influenced by the model used by the teacher, the accuracy of the application of the learning model is very important, but many teachers still tend to dominate the learning process. The low mathematical ability of students because learning has not focused on efforts that make students really focus so that students can be actively and critically involved. Teachers as educators in this case must be able to apply a model that can integrate the character of curiosity that is exploratory, creative, critical, dare to try, namely being able to do Self Efficacy, honest, responsible for tasks, cooperation, discipline, hard work, able to organize themselves, and cooperate with others.

The mathematical ability of learners tends to be weak will have a negative attitude towards mathematics, otherwise learners who have good mathematical abilities tend to have a positive attitude towards mathematics. However, it can also happen the other way around, students who have a negative attitude towards mathematics will tend to have weak math skills while students who have a positive attitude towards mathematics will tend to have good math skills. Students who have a positive attitude towards mathematics tend to have good math skills. This is because students will learn math not because of coercion, but because of their needs. Meanwhile, students who have good math skills tend to be successful in their lives. So it is possible that students who have a positive attitude towards mathematics tend to be successful in their lives.

One of the mathematical abilities that plays an important role in the success of students is the ability to generalize. This is because mathematics and generalization are two things that cannot be separated because mathematics is understood through pattern recognition, relationship formulation, and the application of general principles in various situations. In the learning process, generalization helps learners to not only memorize concepts, but also understand the structure and logic behind them. This ability allows students to identify patterns from specific cases, formulate more abstract rules or concepts, and apply them to new, more complex problems. Thus, the development of generalization ability is essential to build a deep and applicable understanding of mathematics. subjects with high ability in reasoning can solve geometry problems well (Astiati, 2020). Where in the aspect of identifying problems can find known and questionable elements. In the aspect of compiling alternative solutions can compile solutions and find several other alternatives in solving the given problem.

The low mathematical generalization ability of students and the dislike of mathematics lessons by students cannot be separated from the learning activities carried out in the classroom (Johar & Hanum, 2019). In learning, students should be given a very broad opportunity to explore and discover mathematical concepts themselves by being heavily involved in the ongoing mathematics learning process. Teachers should choose and use strategies, approaches and methods that are fun for students, methods that involve students actively in learning, both mentally, physically and socially. For this reason, a new learning strategy that empowers student centered learners is needed. A learning strategy that does not require students to memorize facts but a strategy that encourages learners to construct knowledge in their own minds.

The active involvement of students in learning is expected to be more enjoyable for students, more meaningful and students understand the concepts they learn and remember the concepts longer. Active learning causes the memory of what is learned to be more durable, and knowledge becomes

broader than passive learning. In addition, learning will be more meaningful for students if they are active in various ways to construct or build their own knowledge. So it is necessary to look at learning methods or strategies that involve students actively and emphasize the learning process to the activities of students in learning.

A progressive learning method that emphasizes students' activities in learning is the discovery learning method (Azis, 2020). The discovery learning method allows students to rediscover concepts, theorems, formulas, rules and the like in groups or individually. This is the most natural way for learners to more easily understand the material being studied, so that lessons will be easier to remember. The discovery learning model provides free opportunities for students to learn to do mathematical work activities, students are given the opportunity to develop their own learning strategies as well as interact and negotiate with fellow students and with the teacher, the difference in the research that the author examines is the context and subject of research conducted on groups of students with certain characteristics such as background and learning environment then the variable studied is the positive attitude of students in mathematics and then the methodological approach used by combining methods (Hulu & Telaumbanua, 2022). Through such activities it is possible that learners do not feel pressured, are not anxious, their confidence appears and are motivated to learn mathematics. If this really happens in learning mathematics, it is not impossible that students' positive attitude towards mathematics will grow. This is important, because a positive attitude towards mathematics is positively correlated with math learning outcomes. So it is suspected that the discovery learning model can increase positive attitudes towards mathematics.

METHODS

The approach used in this research is a quantitative approach. The research method used in this research is the experimental method. The experiment used in this research is a quasi-experimental design. The quasi-experimental design has a control group, but is not fully effective in controlling external variables that can affect the course of the experiment (Engkizar et al., 2024; Fitriani et al., 2022; Hasanah et al., 2019; Sandra et al., 2024). The research design used was Non-equivalent Control Group Design. In this design, the experimental group and control group are randomly selected. The experimental group is given treatment, while the control group does not receive treatment. Both groups then ended with posttests to measure learning outcomes. Population in research refers to all objects, individuals, or things that have similar characteristics and become the subject of measurement or observation. The population in this study were students of State Senior High Schools in Central Lampung Regency, Lampung Province.

The research sample consisted of two classes in one of the high schools in Indonesia, with one class as an experimental class that applied the discovery learning model and one class as a control class with conventional learning methods. with each class selected 36 students to be sampled. The instruments used include test instruments and observation sheets. Test instrument to measure reasoning ability, observation sheet to see the learning process. Test instruments in this study in the form of final test questions geometry material. The goal is to determine the reasoning ability of students after treatment. As for testing the validity and reliability of an instrument is done by testing the instrument. This is done with the aim of the instrument has been valid and reliable.

The data analysis technique in this test uses item validity, testing is done using product moment analysis techniques. internal reliability test using the Cronbach's Alpha formula. And test the level of difficulty of the index used at the level of difficulty. With data collection techniques in experimental research in the form of tests, questionnaires, observation and documentation. This research is an experimental study that uses two independent samples, so the data obtained is first carried out normality test and homogeneity test, as a test of analysis requirements, namely, data normality test and homogeneity test (Agusti et al., 2018; Anggraeni et al., 2025; Kastira & Irwan, 2023; Permadani et al., 2025; Syafril et al., 2021).

RESULT AND DISCUSSION

This research was conducted in a senior high school, using 2 math and science classes in eleventh grade. The two classes were divided into experimental classes using discovery learning and control classes using ordinary learning. In this study took place as many as 4 meetings, 2 pretest and posttest meetings and 2 more meetings were conducted for the provision of material. At the first meeting students were given a pretest in the form of a description question as an initial test to determine the mathematical generalization ability of students both in the experimental class who learned using the discovery learning model and the control class who learned using ordinary learning. Then at the last meeting students were given a posttest in the form of description questions as a final test to determine the ability of mathematical generalization for both experimental and control classes. The data obtained from the pretest and posttest results are presented descriptively in the following table.

Table 1. Descriptive statistics of mathematical generalization ability of experimental classes

Statistical Data	*Pretest*	*Posttest*
N	32	32
Average	4,96	10,30
St. Deviation	1,32	1,43

Based on table 1 descriptive statistics of students' mathematical generalization ability in the experimental class whose learning by applying the discovery learning model obtained a low pretest average score compared to the posttest average score with a difference of 5.34, seen from these scores students experienced a significant increase after being given the implementation of learning with the discovery learning model compared to the previous learning.

Table 2. Descriptive statistics of mathematical generalization ability of control class

Statistical Data	*Pretest*	*Posttest*
N	32	32
Average	4,68	7,92
St. Deviation	1,52	1,34

Based on table 2 descriptive statistics of students' mathematical generalization ability in the control class obtained a low pretest average score compared to the posttest average score with a difference of 3.24, seen from these scores students experienced an increase in generalization ability, but

some other students still had difficulty in solving the mathematical problems provided.

Descriptive statistics of students' mathematical generalization ability in experimental classes using discovery learning have higher pretest and posttest scores compared to control classes, the difference in pretest scores between experimental and control classes is 0.28, and the difference in posttest scores between experimental and control classes is 2.38. This shows that the experimental class has greater pretest and posttest scores than the control class students. Experimental research here uses two independent samples, so the data obtained is first carried out normality test and homogeneity test, as a test of analysis requirements. Table 3 below shows the data from the normality test using the Kolmogorov-Smirnov test on students' mathematical generalization ability.

Table 3. Statistical results of normality test

Test	Group	*Kolmogorov-Smirnov*			Description
		Statistic	Df	Sig.	
Pretest	Experiment	0.097	32	0.200	Ho Accepted
	Control	0.098	32	0.200	Ho Accepted
Posttest	Experiment	0.129	32	0.179	Ho Accepted
	Control	0.130	32	0.172	Ho Accepted

Based on the analysis results presented in table 3, it shows that the pretest and posttest data in the experiment and control are normally distributed. Furthermore, the homogeneity test of the variance of the pretest and posttest scores in both classes was carried out to see the homogeneity or similarity of the variance of the experimental and control class data. The following is a recapitulation of the homogeneity test.

Table 4. Statistical results of homogeneity test

Test	Group	*Homogeneity Test*			Description
		Statistic	Df	Sig.	
Pretest	Experiment	0.002	1	0.963	Ho Accepted
	Control				
Posttest	Experiment	0.056	1	0.814	Ho Accepted
	Control				

Based on the analysis results presented in table 4, it shows that the pretest and posttest data in the experiment and control are normally distributed and homogeneous. Thus, because the data is normally distributed, a parametric statistical test is carried out, namely the independent sample t test.

Table 5. Test statistic results

Test	Group	*Statistical Test (Test t)*		Description
		Sig.	α	
Pretest	Experiment	0.44	0.05	Ho Accepted
	control			
Posttest	Experiment	0.42	0.05	Ho Accepted
	control			

Based on the analysis results presented in table 5 above, it can be seen that the significance value of the pretest of the experimental class and control

class is 0.44. this shows that the significance value> 0.05 which means Ho is accepted. this it can be concluded that there is no difference in the average pretest of the two class groups. Furthermore, based on the results of the analysis presented in the table, it can be seen that the significant value of the posttest of the experimental class and the control class is 0.42, this shows that the significance value is> 0.05, which means Ho is accepted. this it can be concluded that there is an increase after the implementation of the discovery learning model on students' mathematical generalization.

Based on the research results, it can be concluded that the discovery learning model in improving students' mathematical generalization ability is more effective than conventional learning. This finding is in line with various theories which state that discovery learning is able to provide a deeper learning experience, allowing students to actively build their own knowledge through exploration and investigation. In this study, both groups of learners were given a pretest to measure their initial ability in mathematical generalization. After that, the experimental group underwent learning with the discovery learning model, while the control group used the usual learning method. The posttest results showed that the learners in the experimental class experienced a more significant improvement compared to the learners in the control class.

The advantages of the discovery learning model can be explained through the stages that have been identified in this study. In the stimulation stage, learners are given lighter questions that direct them to think critically. discovery learning is a series of activities in learner-centered learning and involves the ability of learners to find systematically, critically and analyze so that they can formulate their own findings which include cognitive, affective and psychomotor aspects (Muhammad & Juandi, 2023). Discovery learning is not only able to improve students' metacognitive abilities but also able to improve students' communication skills and learning outcomes. In Discovery Learning, the material is not delivered in a final form but students are encouraged to identify what they want to know, followed by finding information themselves and then organizing or forming (constructively) what they know and understand in a final form (Fazriansyah, 2023).

In the problem statement stage, students are given the freedom to identify available problems. discovery learning is a learning strategy that tends to ask students to make observations, experiments, or scientific actions to get conclusions from the results of these scientific actions. In the data collection stage, learners actively collect relevant information, analyze, and process data processing before drawing conclusions generalization. discovery learning is also a process to understand a concept from the material actively and independently to then obtain a conclusion. In the verification stage, students can test the conclusions they have made using various alternative arguments (Kanah & Mardiani, 2022).

This study successfully showed that the discovery learning model has a positive impact on mathematics learning, especially in improving students' mathematical generalization ability. By providing opportunities for students to think independently and develop their own learning strategies, this model not only improves conceptual understanding but also builds positive attitudes towards mathematics. The discovery learning model in this finding indicates that its application needs to be expanded in various learning contexts to encourage students to become more active and independent learners. Teachers should also act more as facilitators who guide students in discovering and building their own understanding. Thus, this learning model can contribute to improving the quality of education, especially in mathematics.

CONCLUSION

This study shows that the application of the discovery learning model has a positive effect on students' mathematical generalization ability. The results of statistical analysis showed a more significant increase in posttest scores in the experimental class compared to the control class. The discovery learning model allows students to be more active in discovering mathematical concepts themselves, thus improving their understanding and critical thinking skills. Thus, it can be concluded that discovery learning is an effective method in improving students' mathematical generalization ability compared to conventional learning methods. This shows the importance of using more interactive and exploration-based learning methods in learning mathematics.

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