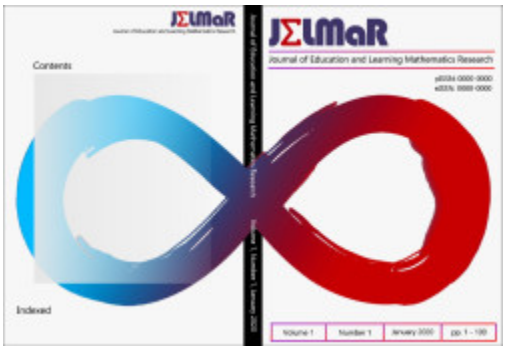

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Impact of Discovery Learning Model on Students' Critical Thinking Skills in Mathematics Learning

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***Abstract**: Critical thinking abilities and mathematical content are closely related since students must use critical reasoning, analysis, and problem-solving techniques to grasp mathematical ideas. However, field data reveals that many students still experience difficulties in developing adequate mathematical critical thinking abilities. This study aims to investigate the influence of implementing the Discovery Learning model on students' mathematical critical thinking skills. The research employed a quantitative approach with a quasi-experimental design. The population included all grade X students at SMAN 1 Driyorejo in the academic year 2024/2025. Through purposive sampling, two classes were selected as research samples: class X-1 as the control group taught using conventional learning methods such as lectures and repetitive practice, and class X-5 as the experimental group that received instruction through the Discovery Learning model. Data were collected through a posttest administered after the learning intervention. The instrument consisted of five story-based questions centered on arithmetic sequences, designed to assess students' critical thinking in mathematics. The data analysis process began with the normality test using the Chi-Square method, followed by a homogeneity test using the F-test to validate statistical assumptions. Upon meeting these requirements, the t-test was conducted to examine the research hypothesis and compare the posttest results of both groups. The findings revealed that the Discovery Learning model had a significant positive impact on students' mathematical critical thinking skills. Therefore, it is recommended that this model be utilized more broadly across various subject matters and educational levels to foster deeper engagement and critical thinking among students.*
Keywords: discovery learning, arithmetic sequence, critical thinking ability

INTRODUCTION

Since the 21st century is a time of globalization and rapid technological advancement, the ability to think critically is a valuable skill that every student should possess in order to adapt and compete on a global scale. The ability to think critically is a methodical procedure that enables students to arrange and ascertain their own opinions and evaluate each choice in a suitable manner (Nabela et al., 2020). By thinking critically, students can make decisions or solve problems through a process of evaluation and reasoning (Haryani, 2023). However, according to Lakusa et al. (2022), teachers ask students to list, describe, define, and explain more often than they do to interpret, analyze, evaluate, and draw conclusions during the learning process. This prevents pupils from honing their critical thinking abilities, which results in less than ideal learning outcomes.

Mathematics materials and critical thinking skills have a strong relationship because understanding mathematics materials requires critical thinking skills, while critical thinking can be honed through mathematics learning (Situmorang et al., 2023). Critical thinking ability is a very important skill in mathematics learning because it helps students analyze, assess, and solve problems logically (Herdiani et al., 2024; Maftuh et al., 2021; Ndahawali et al., 2020). Students who have mathematical critical thinking skills are able to develop their intellectual potential, increase confidence in solving math problems, and are more courageous and do not hesitate to face real problems in everyday life (Nabela et al., 2020). Therefore, in order to attain the best learning outcomes, it is crucial that students utilize and develop critical thinking skills, particularly when learning mathematics.

But in reality, many pupils still struggle with mathematical critical thinking. According to field observations, pupils' performance in meeting the learning criteria for

mathematics is still comparatively low, particularly when it comes to their critical thinking abilities. A number of variables contribute to students' poor critical thinking abilities: (1) the questions frequently only ask for formula memorization or the application of repetitive exercises; (2) the content is unrelated to real-world situations, making it difficult for students to develop critical thinking skills on problems they face on a daily basis; and (3) teacher-centered learning strategies discourage students from voicing their opinions, which hinders the growth of their critical thinking abilities. Creating an efficient classroom learning process is essential to overcoming this.

One way to help pupils develop their critical thinking abilities when studying mathematics is through the use of the discovery learning approach (Edi & Rosnawati, 2021; Nugraha et al., 2022; Septiani et al., 2023). The Discovery Learning model is a learning model that can encourages pupils to learn by identifying important concepts independently (Bahtiar et al., 2022; Suryadi & Cholifah, 2023). The stages of the Discovery Learning model according to Syah in Nugraha et al. (2022) includes: (1) stimulation, (2) problem statement, (3) data collection, (4) data processing, (5) verification, (6) generalization. Through these processes, students can take charge of their education on their own, actively participate in problem-solving and idea expression, and stimulate critical and creative thinking in order to solve the teacher's challenges (Nugraha et al., 2022). It is anticipated that this method will greatly enhance pupils' critical thinking abilities.

Previous studies have shown that the Discovery Learning model can improve students' critical thinking skills. In the research of Laeni et al. (2022) found that the Discovery Learning approach affected the critical thinking skills of grade X students with reference to the physics lessons on momentum and impulse. Furthermore, according to research by Rohmawati & Zevender's research (2022) using the Discovery Learning model instead of traditional learning methods to teach economics to grade X students is more successful in enhancing their critical thinking abilities. A study by Septiani et al. (2023) found that the Discovery Learning approach effectively improved seventh-grade students' critical thinking skills in social arithmetic topics. These studies show how the Discovery Learning methodology may be used to improve students' critical thinking skills in a variety of areas and academic levels.

Even though a lot of research has been done, not many of them explicitly look at how Discovery Learning affects students' ability to think critically about arithmetic sequence content. Furthermore, not much research has been done on the use of this model at the high school level, particularly at SMAN 1 Driyorejo. Therefore, the goal of this study is to determine how grade X students' critical thinking skills about arithmetic sequence content are impacted by the Discovery Learning approach.

METHOD

This study employed a quasi-experimental design and a quantitative methodology. All 390 grade X students from SMAN 1 Driyorejo's 11 classes during the 2024–2025 academic year made up the study population. The sample selection was carried out by purposive sampling, which is the determination of non-randomized samples based on the recommendation of pamong teachers with the consideration that the ability of students in each class is relatively balanced. Following the selection process, class X-5, consisting of 35 pupils, was chosen as the experimental group to receive instruction utilizing the Discovery Learning paradigm. Meanwhile, class X-1, which also had 35 students, served as the control group and was taught following the traditional model, which included repeated exercises and lectures.

An instrument for this study was a test with five narrative-style questions about arithmetic sequence content. The posttest conducted after the learning intervention, was administered to both groups: the experimental group, which experienced the Discovery Learning model, and the control group, which received conventional instruction centered

on repetitive exercises and direct lectures. A validation method was initially conducted by specialists, specifically math instructors and lecturers, to guarantee the instrument's viability. Upon validation, the subsequent phase involved gathering data by administering posttests to students in both groups. Before beginning data analysis, a statistical precondition test is conducted, specifically the homogeneity test using the F-test and the normality test using the Chi-Square test. If all assumptions are correct, use the t-test to determine whether the experimental group and the control group differ significantly.

RESULT AND DISCUSSION

The study analyzed data obtained from students' posttest scores. The assessment of student answers is based on a scoring rubric that includes four indicators of critical thinking skills: (1) interpreting, which is measuring students' understanding of the problems in the problem; (2) analyzing, which is the pupils' capacity to recognize ideas in the issue; (3) evaluating, which is applying the right problem solving method; (4) inferring, which is making appropriate conclusions. The following is the data on the results of the implementation of the posttest by both classes.

Table 1. Data on Mathematical Critical Thinking Ability Posttest Results

Data Description	Experimental Group	Control Group
Student Count	35	35
Sum of Values	3120	2922
Mean	89,143	83,486

Following the collection of posttest data, an analysis precondition test comprising the normality and homogeneity tests is conducted. The results of the posttest's normality test using Chi-Square are shown in the table below.

Table 2. Normality Test Results Posttest Mathematical Critical Thinking Skills

Data Description	Experimental Group	Control Group
x^2_{count}	4,446	4,286
x^2_{table}	11,070	11,070
Conclusion	Normally distributed	Normally distributed

According to the results of the normality test, the experimental group's value of $x^2_{count} < x^2_{table}$ is $4{,}446 < 11{,}070$, while the control group's value is $4{,}286 < 11{,}070$. These results show that the posttest results for the students' critical thinking abilities satisfied the requirements for a normal distribution. The *F*-test was used for the subsequent homogeneity test when the normalcy assumption was satisfied. The table below displays the homogeneity test results.

Table 3. Homogeneity Test Results Posttest Mathematical Critical Thinking Ability

Data Description	Experimental Group	Control Group
Varians	60,890	63,198
F_{count}	1,037	
F_{table}	1,772	
Conclusion	Homogeneous	

According to the results presented in the preceding table, the score $F_{hitung} < F_{tabel}$ achieved $1{,}037 < 1{,}772$ at a significance level of $\sigma = 0{,}05$. This outcome demonstrates that the two groups' posttest execution of critical thinking abilities has a homogeneous variance. This indicates that the study's data originates from a group with consistent traits.

The following hypothesis test is carried out using the t-test when the data is homogeneous and regularly distributed. The table below displays the t-test findings for the students' critical thinking skills posttest.

Table 4. *t*-Test Results of Mathematical Critical Thinking Ability Posttest

Data Description	Experimental Group	Control Group
N	35	35
t_{count}	3,004	
t_{table}	1,995	
Conclusion	H_0 rejected	

The results of the *t*-test indicate that, at a significance level of 0,05, $t_{hitung} > t_{tabel}$, particularly $3{,}004 > 1{,}995$, indicating a significant difference between the experimental group using the Discovery Learning model and the control group using the conventional learning model. This difference results from the way the learning models are applied in the two classes. This study suggests that students' mathematical critical thinking abilities are impacted by the discovery learning methodology.

In this learning, pupils who received instruction using the Discovery Learning model was more successfully than those who received instruction using a conventional learning model. The experimental group's average score of 89,143 and the control group's score of 83,486 demonstrate this. As a result the Discovery Learning methodology encouraged students to actively explore concepts, recognize patterns, and solve problems on their own, the experimental group achieved a higher score. Throughout the educational process, students are also instructed to comprehend the issue, gather and evaluate information, perform experiments, and make deductions. These activities contribute to developing critical thinking skills, which include interpreting (understanding the problems in the problem), analyzing (identifying concepts carefully), evaluating (using appropriate solution methods), and inferring (drawing appropriate conclusions). On the other hand, because the learning activities were teacher-centered, the control group, which adhered to the traditional learning model through lectures and repetitious exercises, tended to remain passive.

The results of this study are in line with research by Laeni et al. (2022) that shows how grade X students' critical thinking skills in relation to impulse and momentum content in physics classrooms are impacted by the Discovery Learning strategy. Futhermore, Rohmawati & Zevender (2022) demonstrate that, when compared to traditional learning models, the Discovery Learning approach is more successful in enhancing the critical thinking abilities of grade X pupils studying economics. Additionally, a study by Septiani et al. (2023) shown that the Discovery Learning methodology was successful in enhancing seventh-grade students' critical thinking abilities regarding social arithmetic content in mathematics instruction. These studies demonstrate that students' critical thinking abilities might gain from the Discovery Learning model. This model's application to the study's arithmetic sequence content demonstrates that students can develop comprehension gradually and on their own, which eventually helps them become more adept at critical thinking. This reinforces that discovery-based learning strategies are not only suitable to be applied in certain contexts, but also effectively used to overcome learning challenges that require conceptual understanding and logical reasoning, such as in mathematics.

CONCLUSION

Based on the results of the research conducted, it can be concluded that the Discovery Learning model has a positive effect on students' mathematical critical thinking skills. By using this model, students can explore concepts, actively engage in their education, and develop critical thinking skills such as interpretation, analysis, evaluation, and inference.

This finding supports the hypothesis that the use of learning models that emphasize independent concept discovery can improve the quality of students' understanding and problem solving compared to conventional learning models that are teacher-centered.

As a result of this study, it is suggested that teachers take into account the Discovery Learning model as a substitute when creating classes that develop students' critical thinking abilities, particularly in mathematics. In order to generate more comprehensive and practical findings for the field of education, it is suggested that future research expand the scope of educational materials and levels and consider other factors such as student learning preferences and the use of learning media that support the process of discovery.

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