

## The Effect Of The Open Learning Model On Student's Understanding Of Mathematical Concepts In The Topic Of Arithmetic Sequences And Series At State High School 1 Simpang Empat, 10th Grade, Using The Geogebra Application

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### Abstract

This study aims to determine the effect of the Open-Ended Learning model assisted by the GeoGebra application on student's understanding of mathematical concepts regarding arithmetis sequences and series in 10th grade at SIMPANG EMPAT State High School 1. This study uses a quantitative method with a quasi-experimental design. The research design employed is a *pretest-posttest control group design*. The study population consisted of all 10th-grade students at SIMPANG EMPAT State High School 1, while the sample comprised two classes selected using *purposive sampling*, an experimental class and a control class. The research instrument was a test of student's mathematical conceptual understanding. Data analysis techniques included normality test, homogeneity tests, and t-tests. The results of the study indicate that the GeoGebra-assisted open learning model has a significant effect on students' mathematical concept understanding. This is demonstrated by the hypothesis test results, which show that  $t_{\text{calculated}} > t_{\text{table}}$  at a 5% significance level. Thus, the GeoGebra assisted open learning model can improve students' mathematical concept understanding of arithmetic sequences and series.

**Keywords:** *Open Learning, Mathematical Concept Understanding, GeoGebra, Arithmetic Sequences and Series.*

## INTRODUCTION

Mathematics is one the subjects that plays a crucial role in developing students' logical, systematic, critical, and creative thinking skills. Mathematics instruction is not only focused on computational skills but also emphasizes the understanding of mathematical concepts (Insani, 2020). Conceptual understanding serves as the primary foundation for solving various mathematical problems and applying them in everyday life.

One area of mathematics that requires a solid conceptual understanding is arithmetic sequences and series. Students often find this topic difficult because it involves number patterns, generalization, and the abstract use of formulas (Fatimah et al., 2024). Many Students simply memorize formulas without understanding the underlying concepts, which leads to poor mathematical conceptual understanding (Nurfad et al., 2020).

This problem can be addressed through the implementation of a learning model that provides students with the opportunity to explore ideas and discover concepts independently. One such learning model is the *open-ended learning* model (Putri et al., 2025). The open-ended learning model provides students with the opportunity to solve problems using various strategies and solutions, thereby enhancing their mathematical thinking skills.

Tabel 1. Syntax of the Open-Ended Learning Model

| Learning Stages                                             | Teacher Activities                                                             | Student Activities                                        |
|-------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------|
| Phase 1:<br>Orientation<br>(presenting open-ended problem). | The teacher presents an open-ended problem that can be solved in various ways. | Students receive the problem, read it, and understand it. |
| Phase 2:<br>Exploration                                     | The teacher gives students the freedom to explore various                      | Students explore, identify information, try their own     |

|                                                  |                                                                                                                                                        |                                                                                                                                       |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
|                                                  | strategies for solving the problem.                                                                                                                    | strategies, and look for many possible answers.                                                                                       |
| Phase 3: Group Discussion                        | The teacher encourages students to present their results and the strategies they used, and the teacher facilitates the group discussion.               | Students explain the results of their discussions, compare strategies, and evaluate different solutions                               |
| Phase 4: Presentation of Discussion Results      | The teacher asks students to present the results of their group discussions.                                                                           | Students present the results of their group discussions, and other students respond or ask questions of the presenter.                |
| Phase 5: Drawing Conclusions and Generalizations | The teacher facilitates students in drawing conclusions together, relating the results to mathematical concepts, and reflecting on the thought process | Students summarize the results, explain the reasons for their choice of strategies, and connect them to broader mathematical concepts |

In addition to instructional models, the use of technology-based learning media can also help improve students' conceptual understanding (Nopitasari, 2017). The GeoGebra application is one such interactive learning tool that can visualize mathematical concepts dynamically and engagingly. GeoGebra helps students understand mathematical patterns and relationships through visual representations (Sari, 2017).

Previous research has shown that the use of GeoGebra can enhance the effectiveness of mathematics learning and help students understand concepts more deeply (Dalimunthe, 2024). Additionally, research on arithmetic sequences and series has shown that innovative learning models can improve students' ability to understand mathematical concepts (Setiana & Ngazizah, 2022).

Based on the above discussion, the researcher is interested in conducting a study titled "The Effect of the Open Learning Model on Students' Mathematical Conceptual Understanding of Arithmetic Sequences and Series at State High School 1 Simpang Empat, 10th Grade, Assisted by the GeoGebra Application."

## RESEARCH METHODS

This study employs a quantitative approach using a (*quasi experimental*) research design. The specific research design utilized is a *pretest-posttest control group design*.

Table 1. Reseach Design

| Class       | Pretest        | Treatment      | Posttest       |
|-------------|----------------|----------------|----------------|
| Eksperiment | O <sub>1</sub> | X <sub>1</sub> | O <sub>2</sub> |
| Control     | O <sub>1</sub> | X <sub>2</sub> | O <sub>2</sub> |

Explanation:

O<sub>1</sub> : Pretest

O<sub>2</sub> : Posttest

X<sub>1</sub> : Open Learning Model

X<sub>2</sub> : Direct Learning Model

The study population consists of all 10th-grade students at Simpang Empat State High School 1 for the 2025/2026 academic year. The study sample consists of two classes: an experimental class and a control class.

Data collection was conducted using a mathematical concept comprehension test in the form of open-ended questions. Before use, the instrument was tested for validity, reliability, difficulty level, and discriminative power.

Data analysis was conducted using:

1. Normality test
2. Homogeneity test
3. Hypothesis testing using the t-test

## RESULTS AND DISCUSSION

### Research Results

Based on the pretest and post-test results, the students' average scores were as follows:

Tabel 2. Average Pretest and Post-test Scores

| Class        | Pretest Average | Post-test Average |
|--------------|-----------------|-------------------|
| Experimental | 58,33           | 63,07             |
| Control      | 55,8            | 59,07             |

These results indicate that the improvement in students' mathematical conceptual understanding in the experimental class was greater than that in the control class.

Based on the *pretest* results, the average score obtained by the experimental class was 58.33, while the average score obtained by the control class was 55.8. After the intervention and the *post-test*, the experimental class achieved an average *post-test* score of 63.07, while the control class achieved an average score of 59.07. Subsequently, normality and homogeneity tests were conducted.

Table 3. Results of the Normality Test for *Pretest* Data

| Class       | $\alpha$ | N  | L<br>calculated | L <sub>table</sub> | Notes                |
|-------------|----------|----|-----------------|--------------------|----------------------|
| Eksperiment | 0,05     | 30 | 0,147           | 0,161              | Normally Distributed |
| Control     | ,05      | 30 | 0,136           | 0,161              | Normally Distributed |

$L_{calculated} = 0,147 < L_{table} = 0,161$  Based on the results in Table 3, for the experimental class, the following values were obtained:  $L_{calculated} = 0,147$ , with  $N = 30$  and  $\alpha = 0,05$  for the control class, the following values were obtained  $L_{table} = 0,161$ , and for the control class, the following values were obtained:  $L_{calculated} = 0,136 < L_{table} = 0,161$ . . Therefore, the *pretest* results indicate that the sample is normally distributed.

Table 4. Results of the *Posttest* Data Normality Test

| Class      | $\alpha$ | N  | L<br>calculated | L <sub>table</sub> | Notes                |
|------------|----------|----|-----------------|--------------------|----------------------|
| Experiment | 0,05     | 30 | 0,155           | 0,161              | Normally Distributed |
| Control    | ,05      | 30 | 0,140           | 0,161              | Normally Distributed |

Based on the results in table 4, the experimental class yielded a value of  $L_{calculated} = 0,155 < L_{table} = 0,161$ , while the control class yielded a value of  $L_{calculated} = 0,140 < L_{table} = 0,161$ . It can therefore be concluded that the *posttest* data indicate a normally distributed sample.

Next, to test for homogeneity of variances in the *pretest* and *posttest* data, the F-test was used as follows:

Table 5. Results of the *Pretest-Posttest* Data Homogeneity Test

| Clasa           | $\alpha$ | N  | $F_{calculated}$ | $F_{table}$ | Notes       |
|-----------------|----------|----|------------------|-------------|-------------|
| <i>Pretest</i>  | 0,05     | 30 | 0,84             | 1,86        | Homogeneous |
| <i>Posttest</i> | 0,05     | 30 | 1,60             | 1,86        | Homogeneous |

Based on the calculations in table 5, the *pretest* data yielded a  $F_{hitung} = 0,84 < F_{tabel} = 0,186$  and the *posttest* data yielded a  $F_{hitung} = 1,60 < F_{tabel} = 0,186$ . So that the *pretest* and *post-test* data obtained  $F_{calculated} = < F_{table}$ , it can be concluded that the sample data from the *pretest* and *posttest* have equal variances, or are homogeneous.

Based on the normality test using the Liliefors test, the data from both classes were found to be normality distributed. Furthermore, the results of the homogeneity test showed that both groups had homogeneous variances.

Table 6. Hypothesis

| Class      | $\underline{x}$ | N  | $T_{calculated}$ | $t_{table}$ |
|------------|-----------------|----|------------------|-------------|
| Experiment | 63,067          | 30 | 2,345            | 2,002       |
| Control    | 59,067          | 30 |                  |             |

Proposed hypothesis:

- $H_0$  : There is no effect of implementing the open learning model on students' mathematical concept comprehension skills when using the GeoGebra application.
- $H_1$  : There is an effect of the open learning model on students' mathematical concept comprehension with the assistance of the GeoGebra application.

The results of the hypothesis testing using the t-test are as follows:  $t_{calculated} = 2,344$  (*Post-test*)  $t_{calculated} = 1,436$  (*Pretest*) dan  $t_{tabel} = 2,002$  (*Pretest*)  $t_{tabel} = 2,002$  (*Pretest*). Since  $t_{calculated} > t_{table}$  (*Posttest*)  $t_{calculated} > t_{table}$  (*Pretest*)  $H_0$  is rejected and  $H_1$  is accepted. Thus, the open ended learning model assisted by the GeoGebra application has an effect on students' understanding of mathematical concepts.

### Discussion

Students' ability to understand mathematical concepts at Simpang Empat State High School 1 is relatively low, as evidenced by the large number of students who still struggle to understand problems and are unable to solve problems that differ from the examples provided when presented with contextual problems. Most students are only able to memorize formulas without deeply understanding their meaning; this occurs because teachers still use learning models that lack variety or tend to be *teacher-centered*, which results in students being passive in the learning process.

Due to this monotonous learning environment, students do not demonstrate active engagement in solving the problems they are given. Furthermore, technology is underutilized as a learning aid; students merely receive information provided by the teacher. The lack of educational media to foster enthusiasm and create a pleasant learning atmosphere causes students to feel even more bored.

In light of these issues, the researcher conducted a study aimed at improving students' understanding of mathematical concepts by comparing a class using the Open Learning model-Class X-1, serving as the experimental group-with a class using the Direct Instruction model-Class X-4, serving as the control group-to observe the changes that occurred in both classes after the interventions were implemented.

When learning about arithmetic sequences and series, students do not merely memorize formulas but also understand the patterns of term formation through the exploration of open-ended problems. For example, regarding the concept of the  $n$ th term in an arithmetic sequence:

$$U_n = a + (n-1)b$$

And the sum of the first  $n$  terms of an arithmetic series:

$$S_n = \frac{n}{2} [2a + (n-1)b]$$

The researchers prepared *pretest- post-test* tests that had already been administered to students in higher-grade classes at the same school and had undergone validity, reliability, difficulty level, and item discrimination tests to ensure that the questions were suitable for use as data collection instruments. At the beginning of the session, students from both classes were given a post-test after they had been assigned different treatments: the experimental class used the open learning model, and the control class used the direct learning model.

After the pretest and post-test data were obtained, normality and homogeneity tests were conducted, and the results showed that the data samples were normally distributed and had homogeneous variance. Next, a t-test was conducted to test the hypotheses. Since  $t_{\text{calculated}} > t_{\text{table}}$   $H_0$  was rejected and  $H_1$  was accepted ; thus, it can be concluded that the open learning model has an effect on students' mathematical conceptual understanding occurred because the open learning model provides students with the opportunity to develop various problem-solving strategies. Students became more active in discussing, expressing their opinions, and constructing concepts independently.

With the help of the GeoGebra application, students can interactively visualize patterns of term progression, making mathematical concepts more concrete and easier to understand. The use of GeoGebra also increases students' interest in learning because the learning process becomes more engaging and dynamic. These results are consistent with previous research indicating that the use of GeoGebra can improve students' understanding of mathematical concepts in mathematics learning. Furthermore, the open learning model helps students develop creative and flexible thinking skills in solving mathematical problems, Student can discover various alternative answers and problem-solving strategies, making the learning process more meaningful.

## CONCLUSION

Based on the research results and discussion, it can be concluded that the open learning model supported by the GeoGebra application has an effect on students' understanding of mathematical concept regarding arithmetic sequences and series in 10th grade at SMA Negeri

1 Simpang Empat. This is evidenced by the higher average learning outcomes of students in the experimental class compared to the control class, as well as the results of the hypothesis test, which show that  $t_{\text{calculated}} = 2,344$  (Posttest)  $t_{\text{calculated}} = 1,436$  (Pretest) and  $t_{\text{table}} = 2,002$  (Pretest)  $t_{\text{table}} = 2,002$  (Pretest) therefore  $t_{\text{calculated}} > t_{\text{table}}$  (Posttest) and  $t_{\text{calculated}} > t_{\text{table}}$  (Pretest). Thus  $H_0$  is rejected and  $H_1$  is accepted. Thus, the GeoGebra-assisted open learning model can be used as an after native approach to mathematics instruction to improve students' understanding of mathematical concepts.

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