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Implementation of GeoGebra-Assisted Mathematics Instruction to Improve Understanding of Dilatation

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ABSTRACT

This study aims to examine the implementation of GeoGebra-assisted mathematics learning in improving students' understanding of the concept of dilation. GeoGebra is a mathematics software that integrates visual, algebraic, and geometric representations to support interactive learning. Instruction was conducted using the discovery learning model with a scientific approach, which includes the stages of introduction, stimulation, problem identification, exploration, analysis, verification, and generalization. During the learning process, students were given the opportunity to visually observe objects undergoing dilation, manipulate them using GeoGebra, and reflect on their observations through class discussions. Research data were obtained through learning activities, worksheet results, and practice problems. The results indicate that the use of GeoGebra helps students understand the concept of dilation more deeply, particularly regarding changes in the size, shape, and position of objects. Additionally, students are able to connect graphical, algebraic, and geometric representations within the context of dilation. GeoGebra-assisted learning encourages active student engagement, enhances interaction during discussions, and strengthens the ability to apply concepts in problem-solving. Thus, GeoGebra can be used as an effective learning medium to improve students' understanding of the concept of dilation through a visual and interactive approach.

Keywords: GeoGebra, GeoGebra-based worksheets, dilation, conceptual understanding

INTRODUCTION

The rapid development of technology and information demands mastery of scientific knowledge capable of helping humans manage and develop it wisely. One of the disciplines playing a strategic role in this context is mathematics. According to Firdausi & Asikin ((2018) mathematics lessons are taught at every level of education in Indonesia with the aim of developing logical, analytical, critical, and creative thinking skills as preparation for facing the rapid development of knowledge and technology in the future. Mathematics is not merely about presenting theories or merely memorizing concepts; rather, it must be oriented toward developing skills that require problem-solving (Andiyana, 2018; Sapitri,

Utami, & Mariyam, 2019; Moma, 2016) . In reality, mathematics is still considered a difficult and intimidating subject for most students (Zakaria et al., 2012) . This is due to many factors, such as a lack of student interest, inappropriate teaching methods, and the difficulty of the material being taught. One of the mathematical topics that students often find difficult to understand is mathematical concepts, which require a solid understanding as well as creative thinking to solve problems.

The objectives of mathematics education, according to Juwita, Amidi and Zahid,(2019) , are to train students in critical thinking, comprehension, reasoning, communication, creativity, and problem-solving in everyday life. Other opinions also state that the objectives of mathematics education in elementary school, junior high school, and even up to the university level are to prepare students to adapt to their ever-changing lives through training focused on the fundamentals of critical thinking—logical, accurate, honest, creative, and efficient-effective (Saragih & Napitupulu, 2015) . Irawan & Surya,(2017) also state that mathematics learning is important as a means of logical thinking, problem-solving, and creativity development. Therefore, improving the understanding of mathematical concepts is one of the main focuses in the learning process

One approach that can be employed is the discovery learning model using a scientific approach and the Geogebra software (Purwaningrum, 2016; Rangkuti et al., 2023) . This model enables students to learn actively through more effective and engaging methods. Previous research, according to(2021) indicates that the discovery learning model with a scientific approach and the Geogebra software can enhance students' understanding of mathematical concepts. However, most of this prior research has been conducted with high school students and has not yet been extensively applied to junior high school students.

In addition to learning models, another way to improve skills involves learning media. The 21st century is closely linked to the era of the Fourth Industrial Revolution, which demands that society possess the ability to think creatively and adapt to rapid technological advancements (Maskur et al., 2020) . GeoGebra is a technology that assists teachers in the mathematics teaching and learning process and serves as a tool for understanding concepts; GeoGebra is also an online community consisting of regular users who contribute and share their own teaching materials for free (Novitasari et al., 2021) . The use of GeoGebra in mathematics teaching and learning is an effective learning method, and it is particularly useful in the topics of geometry, algebra, and calculus. This is also consistent with the research by Rangkuti et al., (2023) , which shows that the use of GeoGebra can improve student performance in the teaching and learning of geometric transformations, helping students to explore concepts in greater detail and assisting them in building and developing their knowledge of geometric transformations.

GeoGebra is an application specifically designed for use in mathematics instruction. GeoGebra has the capability to create 2D and 3D graphics. Mathematics learning media using GeoGebra is an excellent resource for improving student learning outcomes. Therefore, studentsmust be able to understand

symbols such as warnings and graphs. This tool can help improve students' understanding of mathematical concepts. When teaching mathematics using GeoGebrabased tools, a teacher is also needed to help students understand any problems that may arise and to guide them toward the correct solution.

Several studies have shown that the use of GeoGebra can improve student learning outcomes and understanding, particularly regarding geometric transformations (Rangkuti et al., 2023) . Through interactive visualizations, students can explore concepts in greater depth and build meaningful understanding. However, in practice, many teachers have yet to make optimal use of GeoGebra in classroom instruction.

Based on this description, research is needed to examine in greater depth the implementation of GeoGebra-assisted mathematics learning in improving students' conceptual understanding, particularly regarding dilation at the junior high school level. This study is expected to contribute to the development of innovative and effective learning strategies and serve as a reference for teachers in utilizing technology as a learning medium.

METHOD

The classroom implementation uses the discovery learning model with a scientific approach, which is a teaching model comprising the stages of discovery learning as outlined by (Asri & Noer, 2015) : (1) providing stimuli, (2) identifying problems, (3) collecting data, (4) processing data, (5) verifying, and (6) generalizing. These stages are also integrated with the scientific approach in learning, which includes observing, questioning, associating, experimenting (experimenting), and networking across all subjects, thereby encouraging students to better present the phenomena they have studied based on this scientific approach (Ghozali, 2017) . This approach aims to develop students' scientific thinking skills and encourage active engagement in the learning process. Instruction is conducted based on the Lesson Plan (RPP) and Student Worksheets (LKPD) designed in accordance with the discovery learning model and the scientific approach supported by the GeoGebra software. Content is delivered through interactive and communicative learning activities, fostering a two-way relationship between teachers and students. Teachers act as facilitators who provide guidance, support, and reinforcement throughout the learning process. Meanwhile, students are encouraged to actively observe, ask questions, explore using GeoGebra, analyze data, and draw conclusions about the concepts being studied. Through this process, it is hoped that students will be able to build an independent and meaningful understanding of theconcept of dilation. By applying the discovery learning model based on a scientific approach and the GeoGebra software, the learning process is expected to become more effective, contextual, and capable of enhancing students' understanding of mathematical concepts.

RESULTS AND DISCUSSION

In the classroom implementation of the activity to investigate dilation using GeoGebra, the researcher followed steps designed in accordance with the lesson plan, which utilized the discovery learning model with a scientific approach. The steps of the activity were as follows:

Activity Steps	Teacher and Student Activities
Introduction: The teacher introduces the concept of dilation to the students and provides a general overview of how dilation works. The teacher explains the objective of this activity, which is to understand the concept of dilation through the use of Geogebra.	Teacher: "Today we will learn about dilation using Geogebra. Dilation is a change in the size and shape of an object. Who here has heard of dilation before?" Student 1: "I've heard of dilation, but I don't really understand how it works." Teacher: "Alright, today we'll use Geogebra to help us understand dilation. The goal is to visually see how dilation works. What do you hope to gain from this activity?"
Preparation (providing a stimulus):, Every student must have access to a computer or laptop with Geogebra installed. The teacher ensures that all students have downloaded and installed Geogebra before the activity begins	Teacher: "Make sure you've all downloaded and installed Geogebra on your computers or laptops. Is anyone having trouble downloading or installing it?" Student 2: "I've already downloaded and installed Geogebra, so I'm ready." Teacher: "Great, make sure Geogebra is open and ready to use when we start the activity."
Exploration (identifying the problem): The teacher distributes a Geogebra link or file containing a dilation example to the students. Students are asked to open Geogebra and load the provided dilation example.	Teacher: "Now, please open Geogebra and load the dilation example I provided. We'll explore this example together." Student 3: "I've opened Geogebra. Where can I find the dilation example you mentioned, sir?" Teacher: "You can click on the link I shared or open the file I shared. If you have any trouble, let me know, and I'll help."
Exploration (data collection): Students are asked to examine the example of dilation that has been loaded in Geogebra.	Student 4: "Wow, the object changes size automatically when I move the scale. This is really interesting!" Teacher: "Yes, Geogebra allows us to manipulate objects easily. What did

They are asked to observe the changes that occur in objects undergoing dilation, such as changes in size and shape. Students can use Geogebra tools, such as scaling, translation, and rotation, to manipulate objects and observe the changes that occur.	you notice when you moved the object's scale?" Student 4: "When I increase the scale, the object gets bigger. When I decrease it, the object gets smaller." Teacher: "Great, you've understood the basic concept of dilation. What else did you notice?"
Analysis (data processing): Students are asked to answer several reflective questions about the dilation they observed. The teacher facilitates a class discussion about the students' observations. Students can share their experiences with classmates and compare their results.	Student 1: "I noticed that objects undergoing dilation also change shape." Teacher: "That's right; dilation can affect the shape of objects as well. Does anyone want to add anything or have any other questions about your observations?"
Application (verification): The teacher gives students practice problems on dilation. Students are asked to apply their knowledge of dilation, gained from the activity using Geogebra, to solve math problems involving dilation. The teacher provides feedback and guides the students in completing the practice problems.	Teacher: "Now, I'm going to give you some practice problems on dilation. Please use Geogebra and your knowledge of dilation to try to solve these problems." Student 2: "Do we have to use Geogebra to solve these problems?" Teacher: "Of course, Geogebra can help us visualize and understand the concept of dilation better. If you have any trouble solving the problems, don't hesitate to ask questions or ask for help
Conclusion (generalization): The teacher summarizes the concept of dilation that was learned during the activity. Students are given the opportunity to ask questions if there is anything they do not understand. The teacher emphasizes the importance of using Geogebra to understand mathematical concepts visually and interactively.	Teacher: "Are there any questions regarding today's lesson before we wrap up?" Student: "No, sir." Teacher: "In summary, for today's lesson, dilation is one of the geometric transformations involving displacement that involves not only a change in position but also a change in size; the scale and the center of dilation will affect the final result of the dilated image of a building."

By using Geogebra in lessons on dilation, students can observe and manipulate objects directly, allowing them to gain a deeper understanding

of the concept. The use of Geogebra also enables students to see the connections between graphical, algebraic, and geometric representations in the context of dilation.

Based on classroom implementation, there are advantages and disadvantages to using the discovery learning model with a scientific approach and Geogebra-based worksheets; this is also consistent with the advantages identified by Latifi et al. (2021) , namely: 1) Interactive and Dynamic: Geogebra-based worksheets allow students to interact directly with the material and manipulate objects within mathematical models, thereby making it easier for students to understand the concept of dilation. 2) Clear Visualization: Geogebra can clearly display visualizations of complex dilation concepts in a way that is easy for students to understand, there by helping students grasp difficult concepts. 3) Customization: Geogebra-based worksheet media can be tailored to students' needs and levels of understanding. This allows students to learn at their own pace, taking into account their prior skills and knowledge. 4) Developing Critical ThinkingSkills: Geogebra-based worksheets can help students develop critical thinking skills and sharpen their analytical abilities. Students can see the connections between different mathematical concepts and apply critical thinking to solve problems.

Limitations in its implementation, as noted in the research by , include: 1) Accessibility limitations: Geogebra-based worksheets require access to devices and an internet connection, which may not be available to all students. 2) Technical skills: Students with no prior experience with Geogebra or similar technologies may take longer to understand how to use this software. 3) Reliance on Technology: Occasionally, technical errors or issues with the Geogebra software can hinder students' learning process and disrupt their concentration on the material.

CONCLUSION

Based on the research findings and discussion presented, it can be concluded that the implementation of GeoGebra-assisted mathematics learning through the discovery learning model with a scientific approach is effective in improving students' understanding of the concept of dilation. The learning process is carried out through the stages of introduction, stimulation, problem identification, exploration, analysis, verification, and generalization, which encourage students to actively engage in discovering and understanding concepts independently. The use of GeoGebra allows students to directly observe changes in the size, shape, and position of objects undergoing dilation through interactive visualization. Through exploration and manipulation of objects, students can build a deeper

conceptual understanding. In the analysis stage, discussions and the sharing of observations among students further strengthen conceptual understanding through social interaction and shared reflection.

In the application phase, students were able to apply the concept of dilation they had learned to solve mathematical problems more accurately with the help of GeoGebra. This demonstrates that the learning process not only enhances theoretical understanding but also the ability to apply concepts in problem-solving contexts. Based on this, GeoGebra-assisted mathematics learning provides an effective visual and interactive approach to help students observe, manipulate, and apply the concept of dilation. This approach has proven capable of strengthening students'conceptual understanding in a meaningful and sustainable way, making it a viable alternative for mathematics learning strategies at the junior high school level.

REFERENCES

Amidi, & Zahid, M. Z. (2016). Developing Mathematical Creative Thinking Skills Using a Problem-Based Learning Model Supported by E-Learning. 10th National Mathematics Seminar, 586–594.

Andiyana, M. Arfan, Maya, R., & Hidayat, W. (2018). Analysis of Junior High School Students' Mathematical Creative Thinking Skills in Solid Geometry. AKSIOMA: Journal of the Mathematics Education Program, 1 (3), 80. https://doi.org/10.24127/ajpm.v7i1.1316

Asri, E. Y., & Noer, S. H. (2015). Guided Discovery Learning in Mathematics Instruction. Proceedings of , 891–896.

Firdausi, Y. N., & Asikin, M. (2018). Analysis of Students' Creative Thinking Skills in Terms of Learning Styles in the Eliciting Activities (MEA) Model. Faculty of Mathematics and Natural Sciences, State University of Semarang, Semarang usiyusrotin@gmail.com, 1, 239– 247.

Ghozali, I. (2017). The Scientific Learning Approach in Improving Student Academic Achievement. Jurnal Pedagogik, 04(01), 1–13.

Hakim, F., & Masrura, S. I. (2021). Discovery Learning with Geogebra to Improve Mathematical Conceptual Understanding. JARTIKA | Journal of Educational Technology and Innovation Research, 4 (1), 119–128. https://doi.org/10.36765/jartika.v4i1.415

Irawan, A., & Surya, E. (2017). Application of the open-ended approach to mathematics learning in the sub-subject of rectangles. International Journal of Sciences: Basic and Applied Research, 33(3), 270–279.

Juwita, R., Utami, A. P., & Wijayanti, P. S. (2019). Development of Worksheets Based on the Open-Ended Approach to Improve Students' Mathematical Creative Thinking Skills. Prima: Journal of Mathematics Education, 3 (1), 35. https://doi.org/10.31000/prima.v3i1.814

Latifi, M., Hattaf, K., & Achtaich, N. (2021). The effect of dynamic mathematics software Geogebra on student achievement: The case of differential equations. Journal of Educational and Social Research, 11 (6), 211–221. https://doi.org/10.36941/jesr-2021-0141

Maskur, R., Sumarno, Rahmawati, Y., Pradana, K., Syazali, M., Septian, A., & Palupi, E. K. (2020). The effectiveness of problem-based learning and aptitude-treatment interaction in improving mathematical creative thinking skills under the 2013 curriculum. European Journal of Educational Research, 9 (1), 375–383. https://doi.org/10.12973/eu-jer.9.1.375

Moma, L. (2016). Development of an Instrument for Mathematical Creative Thinking Skills for Junior High School Students. Delta-Pi: Journal of Mathematics and Mathematics Education, 4(1), 27–41.

Novitasari, D., MS, A. T., Hamdani, D., Junaidi, & Arifin, S. (2021). Development of GeogebraBased Worksheets to Improve Understanding of Mathematical Concepts. Jes-Mat, 7(1), 1– 16.

Owusu, R., Bonyah, E., & Arthur, Y. D. (2023). The Effect of GeoGebra on University Students'Understanding of Polar Coordinates. Cogent Education, 10 (1). https://doi.org/10.1080/2331186X.2023.2177050

Purwaningrum, J. P. (2016). Developing Mathematical Creative Thinking Skills Through Discovery Learning Based on the Scientific Approach. Refleksi Edukatika, 6 (2), 145–157. https://doi.org/10.24176/re.v6i2.613

Rangkuti, R. K., Suprihatiningsih, S., Rahayu, S., & Razy, M. A. (2023). DEVELOPMENT OF GEOGEBRA-ASSISTED MATHEMATICS LEARNING MEDIA TO IMPROVE STUDENTS' MATHEMATICAL CONCEPT UNDERSTANDING. 5(1), 29–44.

Sapitri, Y., Utami, C., & Mariyam, M. (2019). Analysis of Students' Mathematical ProblemSolving Skills in Solving Open-Ended Problems on Circles from the Perspective of Learning Interest. Variable, 2 (1), 16–23. https://doi.org/10.26737/var.v2i1.1028

Saragih, S., & Napitupulu, E. (2015). Developing a student-centered learning model to improve high-order mathematical thinking ability. International Education Studies, 8 (6), 104–112. https://doi.org/10.5539/ies.v8n6p104

Zakaria, E., Zain, N. M., Ahmad, N. A., & Erlina, A. (2012). Mathematics anxiety and achievement among secondary school students. American Journal of Applied Sciences, 9 (11), 1828–1832. https://doi.org/10.3844/ajassp.2012.1828.1832