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The Influence of Google Lens-Assisted Discovery Learning Model on Improving Students' Mathematical Connections

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Abstract. This study aims to analyze the effect of the Discovery Learning learning model assisted by Google Lens on improving students' mathematical connections. This study used a quasi-experimental method with a Non-equivalent Control Group Design involving high school/vocational high school students in Lhokseumawe City. The sample consisted of an experimental group using Google Lens and a control group using conventional learning. The results showed a significant increase in mathematical connection skills in the experimental group compared to the control group. Students' perceptions of the use of Google Lens were also positive, with indicators of increased learning motivation and engagement. These findings provide implications for the implementation of technology in mathematics learning.

Keywords: Discovery Learning, Google Lens, Mathematical Connections, Educational Technology

1. Introduction

The use of technology in education, especially in mathematics learning, has grown rapidly and become one of the important aspects of 21st century learning innovation. The integration of technology such as Google Lens in the Discovery Learning learning model offers a more interactive and contextual approach to teaching mathematics, which has long been considered a challenging area by most students. Through artificial intelligence (AI)-based technology, Google Lens can recognize objects in the real world and connect them with relevant information, which can be directly utilized in the learning process. This approach is believed to have great potential to improve the understanding and relevance of mathematical concepts learned by students with real applications in everyday life.

Mathematical connections are essential skills for students to connect mathematical concepts to each other and to real-world applications. This skill involves a deep understanding of how different concepts in mathematics relate to each other and can be applied in practical contexts. Research shows that students who have good mathematical connection skills tend to be more successful in solving complex problems because they are able to see mathematics as a whole, rather than as separate topics (Boaler, 2019). In addition, this ability is essential for building the foundation of critical and analytical thinking needed in a variety of academic fields and professions.

However, in practice, many students have difficulty in developing mathematical connection skills, especially because traditional learning methods often emphasize memorization and procedures rather than deep conceptual understanding. This poses a challenge for teachers to find a learning approach that not only encourages students to master mathematical concepts but also understand the relationships between these concepts. One solution that can help overcome this challenge is through the Discovery Learning model.

Discovery Learning is a learning model rooted in constructivism theory, where students play an active role in the learning process through exploration and discovery activities. This model not only focuses on the transfer of knowledge from teachers to students but also encourages students to develop their own understanding of the material being studied. In Discovery Learning, students are expected to interact directly with learning materials, observe, identify patterns, make hypotheses, and draw conclusions based on their own observations and learning experiences. This approach aims to deepen

conceptual understanding and improve students' critical thinking skills and problem-solving abilities (Minervino & Tricárico, 2021).

In mathematics learning, Discovery Learning allows students to find connections between abstract concepts and real-world situations. However, without supporting visual aids, students often struggle to relate the theories they learn to practical applications outside the classroom. This is where technology like Google Lens comes into play. Google Lens is an artificial intelligence-based application that allows users to recognize real-world objects and get additional information about them instantly. Using their phone's camera, students can point Google Lens at objects in their environment, which the application then analyzes to display relevant information that can be used in learning.

In the context of Discovery Learning, Google Lens provides an opportunity for students to relate the math concepts they learn in class to objects they encounter in the real world. For example, when students are learning about geometric shapes or the concept of proportion, they can use Google Lens to scan real objects, such as buildings or objects around them, and see how these concepts are applied in real structures. This allows students to make mathematical connections in a direct and concrete way, strengthening their understanding of the relationships between concepts in mathematics.

Discovery Learning has significant benefits in mathematics learning, especially in improving students' conceptual understanding and critical thinking skills through active involvement in the exploration and discovery process. This model allows students to construct knowledge independently, develop problem-solving skills, and understand the interrelationships between mathematical concepts in a broader context. When enriched with visual technologies such as Google Lens, Discovery Learning not only makes it easier for students to relate abstract concepts to real-world applications, but also increases their motivation, engagement, and independence in learning. Overall, the integration of technology in Discovery Learning opens up opportunities for more relevant and interactive learning methods, which significantly strengthen students' mathematical connections and help them master mathematics in a more contextual and meaningful way.

Although there have been many studies exploring the use of technology in mathematics education, there are still limited studies that specifically evaluate the effect of Google Lens in the Discovery Learning model. Research by Sulistyo (2023) shows that visual-based applications can play an important role in helping students understand abstract concepts better. However, further research is still needed to understand the extent to which these applications can improve students' mathematical connections and how students perceive the use of this technology in mathematics learning.

This study focuses on analyzing the effect of using Google Lens in the Discovery Learning learning model on improving students' mathematical connections, as well as understanding students' perceptions of the use of this technology in the mathematics learning process. Specifically, this study aims to identify whether the integration of Google Lens in mathematics learning can provide significant improvements in students' mathematical connection skills compared to conventional learning methods, and whether this application can increase students' motivation, engagement, and understanding. By answering these questions, this study is expected to be able to contribute to the development of more effective and relevant technology-based learning strategies, which support the improvement of students' mathematical understanding in depth and sustainably .

2. Methodology

This study used a quasi-experimental method with a Non-equivalent Control Group Design, which involved two groups of students without random grouping (isnawati, 2020; Sugiyono, 2013). This design was chosen because the study was conducted in the context of an established class, so that random distribution of students was difficult. With this design, researchers can compare the effect of the independent variable, namely the Discovery Learning learning model assisted by Google Lens, on the dependent variable, namely students' mathematical connection skills.

The subjects of the study consisted of students of SMK Kesehatan Darussalam in Lhokseumawe who were divided into two groups: an experimental group and a control group, each consisting of 30 students. The experimental group followed mathematics learning with the Discovery Learning model supported by Google Lens as a visual aid, while the control group underwent conventional learning

without additional technological assistance. The selection of students in each group was based on the similarity of initial ability levels to maintain the validity of the comparison results between groups.
The research procedure consisted of three main stages: pre-test, intervention, and post-test. In the first stage, namely the pre-test, both groups were given an initial test to measure students' mathematical connection abilities before the treatment, to ensure that their basic abilities were comparable. Then, in the intervention stage, the experimental group underwent Discovery Learning assisted by Google Lens. Students used Google Lens to scan objects or texts related to mathematical concepts, so that they could connect abstract concepts with relevant real situations. The control group, on the other hand, followed learning with conventional methods without technological support. In the final stage, namely the post-test, both groups were again given the same test as the pre-test to measure the improvement in mathematical connection abilities after the treatment.
The research instruments used consisted of two main tools: a mathematical connection test and a student perception questionnaire. The mathematical connection test was used to measure the increase in students' understanding of the relationship between mathematical concepts and their applications in real life, both before and after the intervention. Meanwhile, the student perception questionnaire was designed to explore students' views on the use of Google Lens in learning. This questionnaire covers four aspects: conceptual understanding, learning motivation, engagement, and ease of use, with a Likert scale from 1 (strongly disagree) to 5 (strongly agree).
Data analysis in this study was conducted using descriptive statistics and inferential statistics. Descriptive statistics were used to determine the average pre-test and post-test scores and the percentage increase in both groups. For the prerequisite test, a normality test and a homogeneity test were conducted to ensure that the data met the basic assumptions of statistical analysis. Furthermore, an independent sample t-test was used to test whether there was a significant difference between the experimental group and the control group after the intervention, with a significance level of 5% ($p < 0.05$). Through this analysis, researchers can conclude whether the use of Google Lens in Discovery Learning has a significant impact on improving students' mathematical connections compared to conventional methods.

3. Finding and discussion

3.1 Finding

3.1.1 Pre-test and Post-test Results

The results of this study were analyzed using pre-test and post-test to assess students' mathematical connection abilities in the experimental and control groups. The following is a comparison table of the pre-test and post-test results on the sample:

Table 1 comparison of pre-test and post-test results in both groups

Group	Pre-test average	Post-test average	Increase (%)
Experiment	65.4	82.7	26.4
Control	66.1	74.2	12.2

Based on the table above, a significant increase occurred in the experimental group with an average increase of 26.4%, compared to 12.2% in the control group. The t-test results showed that this difference was statistically significant ($p < 0.05$). seen in the Experimental group, Students who followed the Discovery Learning learning model assisted by Google Lens showed an increase in the average score from 65.4 in the pre-test to 82.7 in the post-test. This shows an increase of 26.4%. while in the control group students who followed the conventional learning model showed an increase in the average score from 66.1 in the pre-test to 74.2 in the post-test, with an increase of 12.2%.
Then based on the results of the t-test, it shows that the difference in improvement between the experimental group and the control group is statistically significant with $p < 0.05$. This confirms that the use of Google Lens in learning has a significant positive effect on students' mathematical connection abilities. For more details, see the following figure.

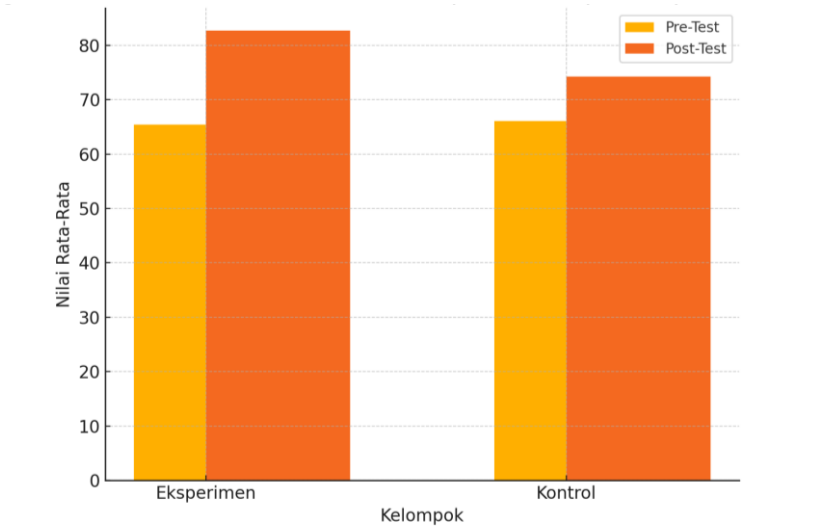

Figure 1. Average Improvement of Pre-Test and Post-Test in Experimental and Control Groups

The higher improvement in the experimental group indicates that the Google Lens application serves as an effective visual aid, allowing students to connect mathematical concepts with real-world objects. This approach supports the principle of Discovery Learning, where students are encouraged to explore and discover the relationships between mathematical concepts independently and interactively.

3.1.2 Student Perceptions of Using Google Lens

In addition to measuring the improvement of students' academic scores, this study also tries to see students' perceptions of the use of Google Lens in the learning process. The average results of students' perception scores in the four main aspects measured can be seen in table 2 below:

Table 2 average result of student perception score

Aspect	Average score
Understanding	4.6
Motivation	4.4
Involvement	4.5
Convenience	4.7

Overall, the results of these student perceptions show that Google Lens as a visual aid has a positive impact, not only on improving mathematical understanding but also on student motivation and engagement in the learning process.

The results of the student perception questionnaire regarding the use of Google Lens in mathematics learning showed very positive responses in four main aspects, namely conceptual understanding, learning motivation, involvement in learning, and ease of use (for more details see the illustration in Figure 2). The average student perception score in the conceptual understanding aspect reached 4.6, which shows that most students feel that Google Lens helps them understand mathematical concepts better. The visual features in this application make it easier for students to see practical applications of abstract concepts, so that they can relate mathematical theory to real-world situations more clearly.

In terms of learning motivation, an average score of 4.4 indicates that the use of Google Lens makes students feel more motivated to learn mathematics. The integration of this technology encourages students to actively explore the material independently, creating a more interactive and interesting

learning atmosphere. This has an impact on increasing students' intrinsic motivation, who feel interested in continuing to learn and digging deeper into the topics being studied.
The engagement aspect in learning also showed positive results with an average score of 4.5, which means that students feel more engaged when using Google Lens. This technology gives students the opportunity to actively participate in the teaching and learning process through the discovery and exploration of mathematical concepts. This increase in engagement shows that students tend to be more enthusiastic and more active when given tools that support visual learning.
Finally, the highest score was obtained in the aspect of ease of use, with an average of 4.7. This shows that students feel that the Google Lens application is easy to use and does not cause technical difficulties. This convenience makes it easier for students to access relevant information and run the application independently, so that there are no obstacles that prevent them from optimally utilizing this technology in learning mathematics.
Thus, it is clearly seen that the positive responses of students in this perception questionnaire indicate that Google Lens as a tool in Discovery Learning plays an important role in increasing students' understanding, motivation, involvement, and comfort in learning mathematics.

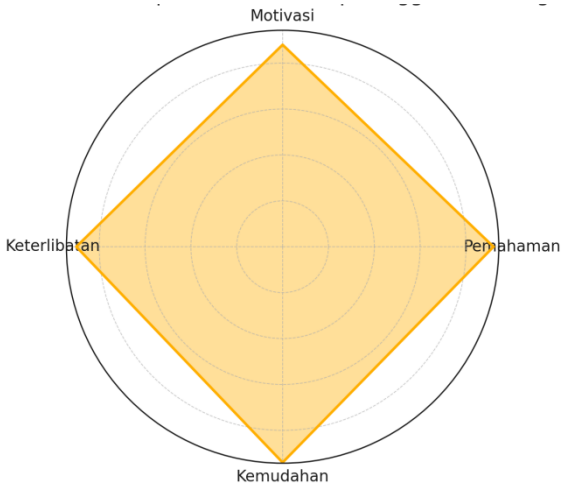

Figure 2. Average Score of Students' Perceptions of Using Google Lens

3.2 Discussion
The results showed a more significant increase in mathematical connections in the experimental group using Google Lens in Discovery Learning compared to the control group. An average increase of 26.4% in the experimental group, compared to 12.2% in the control group, indicated that the visual technology assistance from Google Lens enabled students to better understand the relationships between mathematical concepts. This increase is in line with research showing that technology-based visualization helps students understand abstract concepts better (Susilawati, et al. 2022).
The Discovery Learning model encourages students to be active in discovering and constructing their own concepts. With Google Lens, this process is reinforced through visual aids that allow students to connect mathematical theories to real-world situations. This technology provides a new way for students to explore relationships between concepts, in line with constructivism theory which emphasizes the importance of direct experience in learning (Vygotsky, 1978).
The use of Google Lens in the Discovery Learning model shows a significant impact on improving students' mathematical connections. In this study, Google Lens not only acts as a visual aid but also as an interactive medium that enriches the exploration of mathematical concepts. With the help of this technology, students can directly associate real objects they encounter around them with the mathematical concepts they learn in class. The image recognition feature in Google Lens allows students to accelerate the understanding process because they can see the direct application of abstract concepts in real contexts. This finding supports the results of Patel and Mehta's (2021) study, which

states that visual-based technology can help students overcome difficulties in connecting mathematical theory with practical applications.

This study also highlights how Google Lens helps students strengthen connections between concepts. In mathematical connections, students' ability to understand how one concept relates to another is fundamental to learning mathematics. These connections allow students to see mathematics as an interconnected system, rather than just a collection of separate topics. Google Lens plays a role by providing visualizations that show these connections in concrete terms, in line with cognitive learning theory that emphasizes the importance of visual representations in the development of students' knowledge schemas (Sweller, Ayres, & Kalyuga, 2011). Thus, learning using Google Lens supports students to better understand the connections in mathematics and relate them to everyday experiences.

In addition, these results indicate that Google Lens can improve students' critical thinking skills and problem-solving abilities. When using Google Lens, students not only observe the visualization of concepts but also engage in the process of analyzing and interpreting relevant information. This process requires students to think critically in evaluating the information provided and applying it to the mathematical problems they face. This is in line with research by Nunes et al. (2021), which shows that students who have strong mathematical connection skills have better problem-solving abilities.

Furthermore, the use of Google Lens also creates a learning environment that supports self-directed learning, where students actively participate in the exploration process and discover new knowledge. Discovery Learning enriched by Google Lens gives students more control over their learning process, encouraging independent exploration and discovery of solutions without relying entirely on teacher instructions. This not only strengthens mathematical connections but also encourages the development of students' independent learning abilities and critical thinking skills. This support for self-directed learning is confirmed by Cheng (2021), who found that artificial intelligence-based technologies such as Google Lens can improve students' independence in learning and their ability to understand complex concepts.

Overall, these findings confirm that the integration of visual technologies such as Google Lens in Discovery Learning not only enriches the learning experience but also serves as an effective tool in strengthening students' mathematical connections. The use of this technology opens up opportunities for more interactive and relevant educational approaches to students' learning needs in the digital age, where deep mathematical understanding and critical thinking skills are becoming increasingly important.

Then the questionnaire showed positive student responses to Google Lens in four main aspects: understanding, motivation, involvement, and ease. The high average perception score (4.4 to 4.7) indicated that students felt helped in understanding the material, were more motivated, and felt more involved in the learning process when using this technology. The highest score in the ease aspect (4.7) indicated that Google Lens was easy to use, so students could use it without experiencing significant technical obstacles.

In terms of motivation, the results of this study are in line with a study by Teo et al. (2020), which showed that the use of technology in mathematics learning increases student engagement and motivation. Google Lens allows students to learn independently and interactively, which leads to an increase in their intrinsic motivation. This higher motivation is important in mathematics learning because it helps students to be more courageous in facing challenges in solving mathematical problems.

4. Conclusion

This study shows that the implementation of the Google Lens-assisted Discovery Learning model has a significant effect on improving students' mathematical connections. The results of data analysis show that the experimental group that used Google Lens in the learning process experienced an increase in mathematical connection skills of 26.4%, much higher than the 12.2% increase achieved by the control group that followed conventional learning. The t-test confirmed that this difference was statistically significant ($p < 0.05$), indicating that the use of Google Lens had a real positive impact in supporting discovery-based learning.

The use of Google Lens in Discovery Learning facilitates students in understanding mathematical concepts more easily through visual aids and real-world contexts. This technology allows students to connect abstract concepts to real-world situations, which improves their ability to build relationships between mathematical concepts. By integrating Google Lens, mathematics learning becomes more interactive and relevant, and gives students the opportunity to be actively involved in the learning process.

In addition to the improvement in mathematical connection skills, students' perceptions of the use of Google Lens were also very positive. The perception questionnaire showed that students felt benefits in terms of understanding, learning motivation, engagement, and ease of use. The average score of students' perceptions in each of these aspects was quite high, indicating that Google Lens was not only effective in improving conceptual understanding but also encouraging student motivation and engagement during the learning process.

Overall, this study indicates that the Google Lens-assisted Discovery Learning model can be an effective method to improve students' mathematical connections. These results provide a strong basis for educators and curriculum developers to consider the integration of visual technologies such as Google Lens in mathematics learning. This integration is expected to not only improve students' understanding but also motivate them to learn more deeply and apply mathematical concepts in everyday life.

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