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EFFECT OF GEOGEBRA TOWARDS STUDENTS' INDEPENDENT LEARNING IN MATHEMATICS

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ABSTRACT

Mathematics learning independence can vary among students, with some showing greater initiative than others. This study analyzed the level of independence in learning quadratic functions among junior high school students who were using the GeoGebra application. The study involved 36 Year 9 students and employed a qualitative descriptive method. Data collection techniques included a questionnaire containing 30 positive and negative statements with eight indicators to determine how students respond to independent learning in mathematics using the GeoGebra application. The study found that using the GeoGebra application had a positive impact on learning mathematics, specifically in quadratic functions.

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INTRODUCTION

Learning independence refers to pupils' ability to develop a positive learning attitude and self-regulation skills during the learning process (Rahayu & Aini, 2021). Similarly, Zamnah

(2017) asserted that learning independence involves knowing effective learning strategies and how and when to use them, enabling students to regulate their learning effectively.

The attitude of student learning independence in solving a problem applied in mathematics learning is an important thing to do (Basir et al., 2021). This relates to what is needed in life to be more productive. In addition, in fostering an attitude of independent learning in students, they can solve a mathematical problem using their reasoning (Basir et al., 2021). In addition, motivation to solve a math problem independently is not easy, so the role of students' social environment is very influential in reducing the difficulties experienced by students in solving mathematical problems independently.

The social environment in which a student lives plays a critical role in shaping their learning process. In cases where the environment is not conducive to learning, it can hinder the student's progress. Thus, it becomes necessary to encourage or facilitate technology that directs students toward independent learning, fosters useful contributions, and increases their awareness while carrying out assignments (Belland, 2016). To promote the development of independent learning attitudes, cognitive structures, and successful learning outcomes, students require support in the form of scaffolding (Kusumadewi & Kusmaryono, 2019). In addition, the ability to guide conjectures to each student in solving a mathematical problem is also important (Maharani & Subanji, 2018).

Some assistance provided by scaffolding is tailored to the needs of students in a structured way to improve students' cognitive, including in the form of one-to-one scaffolding (between teachers and students), peer scaffolding (fellow students), and computer-based scaffolding (technology assistance) (Belland & Axelrod, 2019). One form of scaffolding assistance is through a well-designed GeoGebra Application, assisting students in manipulating images when visualizing mathematics teaching materials (Basir et al., 2021). The GeoGebra Application was created by a mathematician and programmer, Markus Honenwarter, in 2001 (Khasanah & Nugraheni, 2022). GeoGebra is also an open-source math program that is dynamic (Rahadyan & Halimatussa'diah, 2020). Accordingly, GeoGebra also plays an essential role in connecting geometry and algebra (Basir & Maharani, 2017).

The GeoGebra Application offers significant advantages as a technology-based teaching tool for learning quadratic functions, particularly in graphing quadratic functions. Using laptops or Android devices with the GeoGebra Application, students can explore and

manipulate quadratic function graphs, which fosters an attitude of independent learning. Self-regulated learning involves planning and self-monitoring cognitive and affective processes in completing an academic task, which is a key aspect of developing independent learning attitudes (Basir et al., 2021).

Harding et al. (2019) and Panadero (2017) have proposed several indicators of learning independence, such as taking learning initiatives, identifying learning needs, setting learning goals, perceiving learning difficulties as challenges, utilizing learning resources, selecting and applying learning strategies, evaluating learning outcomes, and having a positive self-concept. In addition, Hendriana Heris and Rohaeti Eti Euis (2018) have emphasized the importance of both soft and hard skills in promoting learning independence, namely: 1) students have the initiative in learning; 2) students have a habit of examining the needs of learning; 3) students can set their own goals or targets in learning; 4) students can see that learning difficulties are a challenge; 5) students can search for and utilize relevant sources; 6) students can choose and apply learning strategies; 7) evaluate the process and learning outcomes; 8) have self-efficacy/self-concept/self-ability. In line with these indicators, this study aimed to investigate whether the use of GeoGebra can enhance Year 9 students' learning independence in graphing quadratic functions. Specifically, we hypothesized that students who use the GeoGebra application would demonstrate higher learning initiative, goal-setting, resource utilization, and self-evaluation levels than those who manually draw quadratic function graphs. The GeoGebra application is expected to facilitate students' ability to graph quadratic functions more quickly and independently.

METHOD

This study employed a descriptive qualitative method. Narpila & Nababan (2022) argued that descriptive qualitative investigations aim to describe in depth the events that occur in the study subjects. It is a type of research where the conclusions obtained cannot be quantified by statistical methods or other tools (Jusra & Luthfiyah Aulia Iskandar, 2020). This study was conducted on 36 Year 9 students at one of the junior high schools in Medan, Indonesia. This research was conducted in February 2023. The descriptive method used in this study aimed to analyze students' independence in learning mathematics related to quadratic functions assisted by the GeoGebra Application. The instrument was a questionnaire on a learning independence scale consisting of 8 indicators (Hendriana Heris, Rohaeti Eti Euis, 2018), distributed using a Google form. The questionnaire comprised 30 positive and negative statements with four response options: Strongly Agree (SA), Agree (A), Disagree

(D), and Strongly Disagree (SD). This includes positive and negative phrases, each with a unique assessment score. Table 1 contains the results of the questionnaire assessment.

Table 1. Math Learning Independence Scale

Category	Scale	
	Negative	Positive
Strongly Agree	1	4
Agree	2	3
Disagree	3	2
Strongly Disagree	4	1

(Jumiati et al., 2019)

After the learning independence questionnaire data was collected, the next step was that the researchers analyzed the data from the learning independence questionnaire using the percentage formula in Microsoft Excel. A modified Likert scale that does not contain a "doubtful" answer is used for assessment in this study. Alifia & Pradipta (2021) asserted that the "doubtful" answer is not used to make it easier and more focused in producing answers from respondents.

Microsoft Excel was used to calculate data that was previously ordinal and converted into interval data based on the following percentage formula from Sudijono (Maryuliana et al., 2016).

$$P = \frac{f}{N} x\ 100\% \qquad (1)$$

Description:

P= The percentage of answers

f= Frequency

N= the number of respondents

From each indicator of the presentation value calculated, the values are grouped based on the criteria. Table 2 presents the criteria of the mathematics learning independence scale (Ali & Asrori in Khodijah & Setiawan, 2020).

Table 2. Criteria for Mathematics Learning Independence Scale

Percentage Group	Results
75.01 – 100.00	Very good
50.01 – 75.00	Good
25.01 – 50.00	Good enough
0.01 – 25.00	Not so good

RESULT AND DISCUSSION

The results of this study are the accumulated scale of mathematics learning independence of Year 9 students after learning the Quadratic Function using GeoGebra. The

study was carried out based on a learning independence survey which contains eight indicators (Hendriana Heris, Rohaeti Eti Euis, 2018). The learning process in a Year 9 class was carried out face-to-face, where educators combined manual learning followed by GeoGebra, with students drawing and calculating the peak points of the quadratic function graph using GeoGebra. The results obtained from the percentage of mathematics learning independence in the quadratic function material can be seen in Table 3.

Table 3. The Percentage of Students' Mathematics Learning Independence Attitude Scale

No	Indicators	Number of questions	Total Score	Percentage	Notes
1	Learning initiative	4	362	62.8%	Good
2	Analyzing the learning needs	4	375	65.1%	Good
3	Setting the learning goals	5	482	66.9%	Good
4	Understanding difficulties as challenges	4	413	71.7%	Good
5	Using and finding relevant information	3	256	59.3%	Good
6	Choosing and implementing a learning strategy	4	357	62.0%	Good
7	Evaluating the process and results of studying	2	227	78.8%	Very good
8	Self-efficacy/Self-concept/ Self-ability	4	386	67.0%	Good
Total		**30**	**2858**	**66.7%**	**Good**

Table 3 indicates that the Year 9 students' average percentage of responses to the questionnaire on their attitude towards learning quadratic functions with the assistance of GeoGebra reveals their learning independence to be good (66.7%). However, the results also indicate that students still require more guidance from educators in finding study materials independently, as evident from the lowest percentage in the fifth indicator (59.3%). On the other hand, the highest percentage is seen in the seventh indicator (78.8%), indicating that students are capable of reflecting on their learning and making necessary improvements. Figure 1 provides a detailed breakdown of the percentage for each indicator of learning independence.

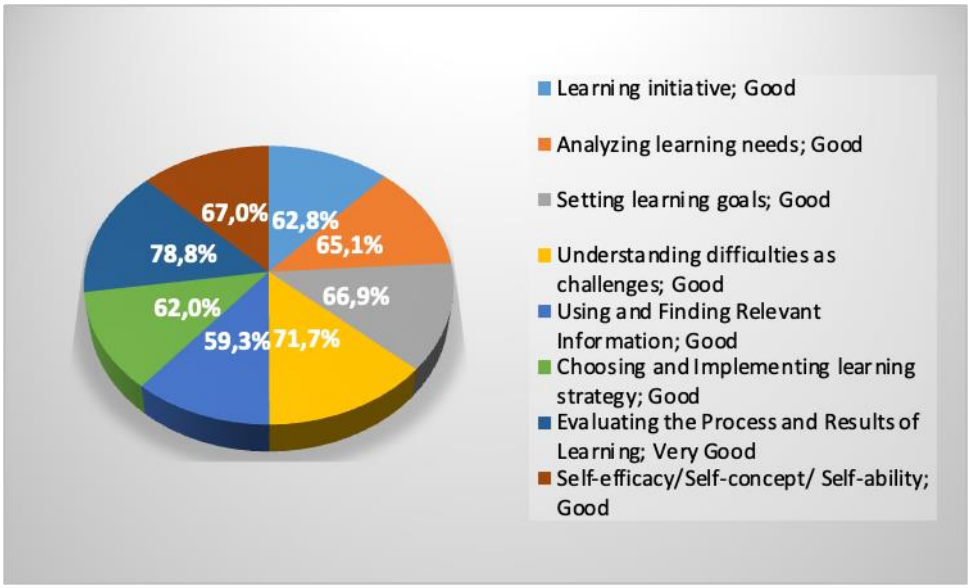

Figure 1. The Percentage of Students' Mathematics Learning Independence Attitude Scale

Figure 1 presents the analysis results of student learning independence questionnaire data obtained using the percentage formula in Microsoft Excel, and from each indicator, the calculated percentage is grouped based on the criteria in Table 2.

Figure 2 describes the results of students' answers on the mathematics learning independence scale on the quadratic function assisted by the GeoGebra.

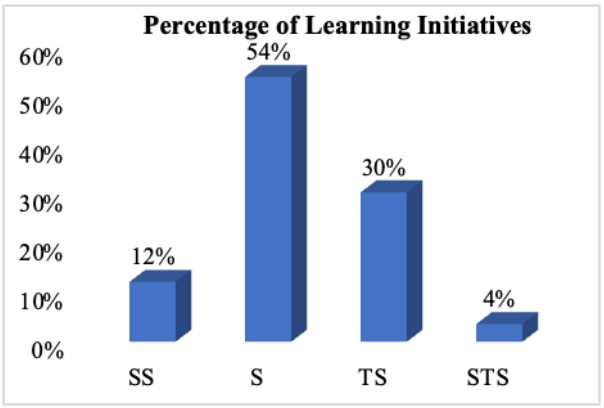

Figure 2. Percentage of Learning Initiatives

The descriptive analysis in Figure 2 shows that the learning initiative indicator contains student responses, where 12% of students strongly agreed when the teacher conveys material using the GeoGebra application, then 54% of other students agreed that there is a learning initiative when GeoGebra assists students' mathematics learning. While the other 30% disagreed because they needed teacher assistance when drawing the graph of the quadratic function using the GeoGebra application, and 4% strongly disagreed because they did not understand the material presented by the teacher. Regarding learning initiative, students' learning independence in mathematics can be categorized as good. Students must, however, continue to develop their learning independence on this indication and their initiative and sense of responsibility in the learning process to become accustomed to solving their difficulties without the assistance of others. This is in line with Amalia et al. (2018), who stated that students could take the initiative, handle any problems that arise and foster student confidence in doing various things without the help of others by implementing independent learning.

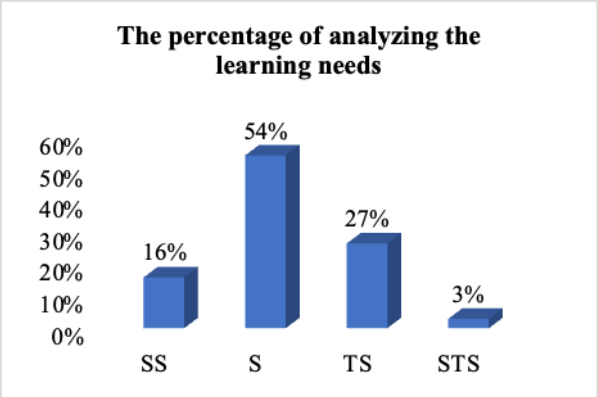

Figure 3. The percentage of analyzing the learning needs

Figure 3 shows that 16% of students strongly agreed that they diagnose learning needs on quadratic function graphs using Geogebra, and 54% agreed because diagnosing learning needs is necessary for mathematics learning. Another 27% disagreed because some students were unable to find out the weaknesses in themselves when learning, and 4% strongly disagreed because they had not been able to sort out what material should be relearned. The percentage on this indicator shows that diagnosing student learning needs in the GeoGebra during the learning process is categorized as good. This finding agrees with Ambiyar et al. (2020) that the indicators for diagnosing learning needs could be seen when students know

which math topic should be re-studied, what anxiety about their deficiencies in learning mathematics, and when determining the math topic to be re-studied.

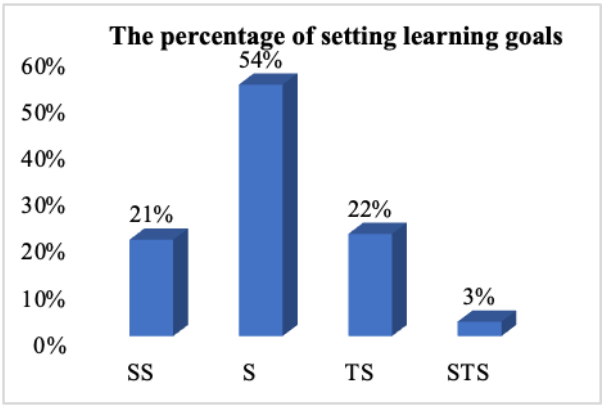

Figure 4. The percentage of setting learning goals

Based on the results of the data in Figure 4, 21% of students strongly agreed with setting learning goals/learning targets in mathematics learning assisted by GeoGebra, and 54% agreed on this matter. However, 22% of students disagreed with setting learning goals/learning targets because some students could not set their learning goals/targets during the learning process. This statement is reinforced by the opinions of students who say they strongly disagreed with making learning targets while learning math (3%). The indicator of setting student learning goals/targets in learning mathematics assisted by GeoGebra can be categorized as good. Accordingly, independent learning will positively impact students' intelligence and ability to understand complicated problems, define learning goals, choose the sources they want to use, and apply their learning strategies (Aisah, 2018).

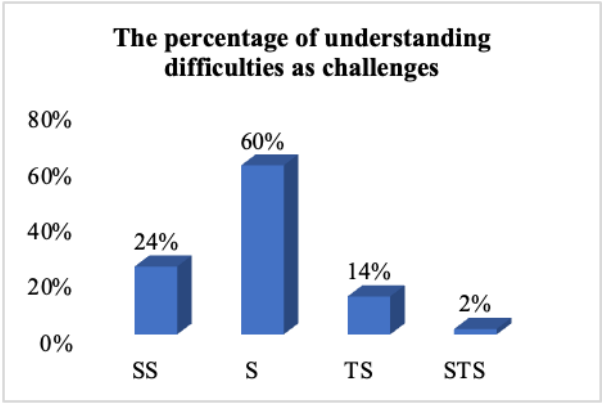

Figure 5. The percentage of understanding difficulties as challenges

The results of the descriptive analysis of the percentage of student responses in Figure 5 indicate that 24% of students strongly agreed, seeing that the difficulty in working on quadratic function graphs using GeoGebra is a challenge; this is also reinforced by the opinions of others students (60%) who agree. However, some also said they disagreed with the statement (14%). This is because many students think learning math is difficult, so most students are easily discouraged in the face of difficulties. Likewise, 2% strongly disagreed with the statement. From the percentage of indicators of seeing learning difficulties as a challenge, students' learning independence is classified as good.

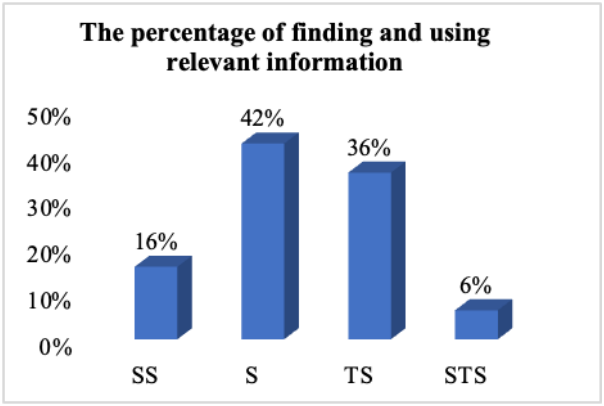

Figure 6. The percentage of finding and using relevant information

Figure 6 shows that 16% of students strongly agreed with utilizing and finding relevant sources in learning, and 42% agreed. Besides, some students disagreed (36%). This can happen because some students do not understand that it is very important to look for or utilize relevant sources before learning begins. Likewise, 6% strongly disagreed with the statement. From the percentage of indicators of utilizing and finding relevant sources, students' learning independence is classified as good. In line with this, Fajriyah et al. (2019) explained that all student efforts which can be carried out independently by seeking various learning information from learning sources other than teachers are independent learning. However, these percentages show no obvious difference between students who disagreed, which means that student learning independence must be improved.

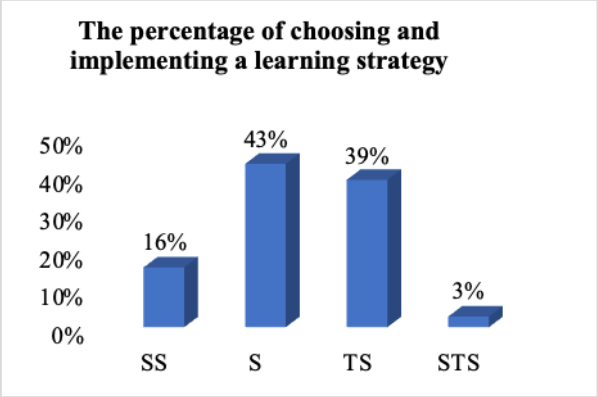

Figure 7. The percentage of choosing and implementing a learning strategy

Further analysis In Figure 7 shows that 16% of students strongly agree with the statement of choosing and applying learning strategies; this is also reinforced by the opinions of 43% who agreed. However, 39% of students disagreed because many students do not think it is necessary to choose a learning strategy that will be used before learning takes place. Likewise, 3% strongly disagreed with the statement. From the percentage of indicators choosing and applying learning strategies, it can be categorized as good. This is consistent with Aisah (2018), who found that independent learning will benefit students' intelligence and that they will be able to define learning goals, choose the sources they will use, and use methods of learning.

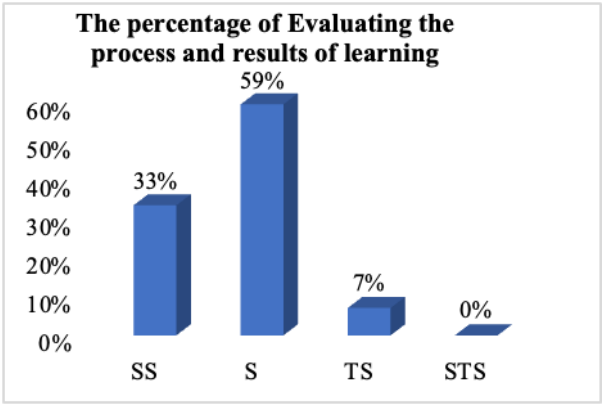

Figure 8. The percentage of Evaluating the process and results of learning

Furthermore, Figure 8 shows that 33% of students strongly agreed and 43% agreed to evaluate the learning of quadratic function graphs using Geogebra on the learning process and results because, in mathematics learning, it is necessary to evaluate. While the other 7% disagreed because they did not understand the material presented by the teacher. From this

indicator of evaluating the learning process and results, learning independence in learning mathematics can be categorized as very good.

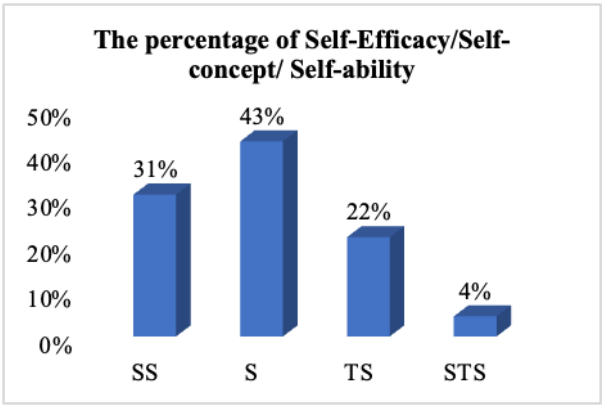

Figure 9. The percentage of Self-Efficacy/Self-concept/ Self-ability

Figure 9 shows that 31% of students strongly agreed they have self-efficacy/self-concept/self-ability in graphing quadratic functions using the GeoGebra Application, and 43% agreed. However, 22% disagreed with the statement because some students are not confident in their abilities, and 4% strongly disagreed. A student's independent learning gives them the self-confidence to solve difficulties independently (Rahayu & Aini, 2021). Based on the percentage of indicators of self-efficacy/self-concept/self-ability, it can be seen as good.

CONCLUSION

This study concludes that students learning independence is good. Details of these categories can be seen in Indicator 1: good learning initiatives (62.8%); Indicator 2: diagnosing the need for good learning (65.1%); Indicator 3: preparing good learning objectives (66.9%); Indicator 4: viewing difficulties as a challenge (71.7%); Indicator 5: utilizing and looking good relevant sources (59.3%); Indicator 6: choosing and implementing a good learning strategy (62,0%); Indicator 7: evaluating excellent learning processes and outcomes (78.8%) and Indicator 8 good self-efficacy/self-concept/self-ability (67.0%).

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