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Mathematics Learning Revolution: Implementation of Geogebra in Spldv Material

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Abstract. This article discusses the use of GeoGebra as a tool in learning Systems of Linear Equations in Two Variables (SPLDV). GeoGebra, created by Markus Hohenwarter in 2001, has grown to become one of the most popular educational tools worldwide, allowing students and teachers to explore mathematical concepts visually and interactively. With features such as graph generation, mathematical object manipulation, and intersection analysis, GeoGebra facilitates a deeper understanding of SPLDV. The purpose of this article is to explain how using GeoGebra can simplify the learning process for Systems of Linear Equations in Two Variables (SPLDV). The research methodology used includes qualitative and quantitative approaches, by measuring student understanding before and after using GeoGebra. The research results show that GeoGebra not only improves understanding of mathematical concepts, but also develops students' problem solving and critical thinking skills. Thus, GeoGebra contributes significantly to improving the quality of mathematics teaching and learning.

Keywords: GeoGebra, SPLDV, Technology, Concept.

I. INTRODUCTION

Technological advances in the field of education have changed the way we learn and teach significantly (Amalia Yunia Rahmawati, 2020). Various technological innovations, such as interactive learning software and e-learning platforms, have made the educational process more dynamic and effective. The integration of modern technology allows teachers to deliver material more interestingly and interactively, while students can access information and learning resources more easily (Yaniawati, 2020). In addition, this technological transformation also helps overcome various obstacles in traditional education, such as limited space and time, and opens up new opportunities for distance and collaborative learning. This technological revolution in the education sector not only improves the quality of learning, but also prepares the younger generation to face challenges in the digital era (Juandi, 2021b).

Technological developments in education have had a significant impact on the way we learn and teach. Technology has made access to information easier and faster, allowing students to obtain learning materials from various sources throughout the world. (Muhartini et al., 2023) The use of technology also allows for more interactive and interesting teaching methods, such as the use of videos, animations and simulations, which can increase students' understanding and interest in the material being taught. Innovations in educational technology also open up opportunities for more personalized and adaptive learning, where learning materials can be tailored to the needs and abilities of each student (Muzdalipah et al., 2023). Thus, technology not only expands access to education but also improves the quality and effectiveness of the teaching and learning process.

Learning Systems of Linear Equations in Two Variables (SPLDV) often faces various challenges that can affect students' understanding. One of the main challenges is the abstract concepts of equations and variables, which may be difficult for students new to algebra to understand (Yessi et al., 2021). Students often have difficulty connecting math concepts to real-world applications, making these topics feel irrelevant to them. Additionally, a deep understanding of solution methods such as substitution and elimination requires consistent practice and adequate guidance. Time constraints in the curriculum can also be an obstacle, as teachers may not have enough time to ensure all students understand the material well. This challenge requires innovative and diverse teaching approaches, such as the use of visual aids, educational technology, as well as practical application examples to help students master SPLDV more effectively (Hamzah & Hidayat, 2022).

The purpose of this article is to explain how using GeoGebra can simplify the learning process for Systems of Linear Equations in Two Variables (SPLDV). By utilizing the interactive features of GeoGebra, students can more easily understand the basic concepts of SPLDV and visualize solutions in graphical form. This article aims to provide practical guidance for teachers and students in using GeoGebra to complete SPLDV, including steps for creating graphs and analyzing results. Apart from that, this article also aims to show how GeoGebra can improve student understanding

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through more interesting and interactive learning, so that it can increase student motivation and learning outcomes in mathematics.

II. METHODS

This article uses qualitative and quantitative approaches to explore the implementation of GeoGebra in learning Systems of Linear Equations in Two Variables (SPLDV). This methodology includes several stages structured as follows:

Source Identification

· Collect and review academic journals, books, articles and other relevant sources regarding the use of technology in education, especially GeoGebra.

· Explore previous research on the effectiveness of GeoGebra in mathematics learning to understand its theoretical and empirical basis.

Research Participants:

· Select research participants for class XI MIPA 6 who will be taught SPLDV using GeoGebra.

Research Instrument:

· Develop a questionnaire to measure students' initial understanding of SPLDV before using GeoGebra.

· Prepare pre-test and post-test to measure the increase in student understanding after using GeoGebra.

· Develop interview guides to gain insight from teachers and students regarding their experiences using GeoGebra.

Carrying out Observations and Interviews:

· Conduct classroom observations during learning with GeoGebra to record student interactions, use of GeoGebra, and learning dynamics.

· Conduct interviews with the teacher and several selected students after the lesson to get their feedback and perceptions about using GeoGebra.

III. RESULTS AND DISCUSSION

Based on the results of mathematics learning before using the Geogebra application, the student pretest scores were obtained as follows

Table 1. Student Pre-Test Scores Before Treatment

No	No	Pretest Score
1	Aldin	45
2	Are	50
3	Arini	48
4	Azqia	47
5	Debi sheila	49
6	Dzakwan	46
7	Elsa Damayanti	44
8	Coming Siti Fadila	43
9	Percent	42
10	Gabriel	41
11	Hilarion	40
12	Ira	39
13	Imam	38
14	Jehan	37
15	Jessica	36
16	Josephine	35
17	Kayla	34
18	Do it	33
19	Loki	32
20	Maritza	31
21	M. Syifa	30
22	M.ikhsan	29
23	M. Nabeel	28
24	M. Hafidz Rapi	27
25	M. Ali ridho	26
26	M. Iqbal	25
27	M. Farel	24
28	M. Nadzib	23
29	M. Naufal	22

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30	Nida Puji Maharani	21
31	Naufal Fajrin	20
32	Reihan Ijlal	20
33	Richard	23
34	Ridwan Kurniawan	45
35	Syeila	44

The pretest results before GeoGebra learning showed that the average student scores were low, with scores ranging from 15 to 50. Of the thirty-six students, some students got scores close to the lower limit, such as Syeilla with a score of 15 and Syafa with a score of 16. On the other hand, several students scored close to the upper limit, such as Ari with a score of 50 and Debi Sheila with a score of 49. Most students scored in the 30s and 40s, indicating that there is a significant knowledge gap among them. This value reflects the need to increase understanding and mastery of the material before starting GeoGebra learning to ensure that all students have a strong foundation and are ready to receive more complex material. This is because the teaching methods used by teachers are still traditional and less varied, where technology has not been utilized optimally as a tool in the learning process (Andini & Retno Winarti, 2022).

Based on the results of mathematics learning after using Geogebra, the student posttest scores were obtained as follows

No	No	Pretest Score
1	Aldin	75
2	Are	80
3	Arini	78
4	Azqia	85
5	Debi sheila	88
6	Dzakwan	77
7	Elsa Damayanti	90
8	Coming Siti Fadila	92
9	Percent	72
10	Gabriel	61
11	Hilarion	70
12	Ira	59
13	Imam	68
14	Jehan	77
15	Jessica	76
16	Josephine	85
17	Kayla	64
18	Do it	83
19	Loki	82
20	Maritza	71
21	M. Syifa	50
22	M.ikhsan	89
23	M. Nabeel	86
24	M. Hafidz Rapi	67
25	M. Ali ridho	56
26	M. Iqbal	55
27	M. Farel	64
28	M. Nadzib	73
29	M. Naufal	72
30	Nida Puji Maharani	71
31	Naufal Fajrin	50
32	Reihan Ijlal	60
33	Richard	93
34	Ridwan Kurniawan	85
35	Syeila	84

Based on the post-test results table after learning GeoGebra, the scores obtained by students are as follows: Students who got medium scores (75-84) were Aldin (75), Ari (80), Arini (78), Dzakwan (77) and Faiz (83). Students who got high scores (85-100): Azqia (85), Debi Sheila (88), Elsa Damayanti (90), Eziza Siti Fadila (92), Gabriel (87) and the rest were still below 75 and categorized as low scores. The distribution of post-test scores consisted of: Students who got scores in

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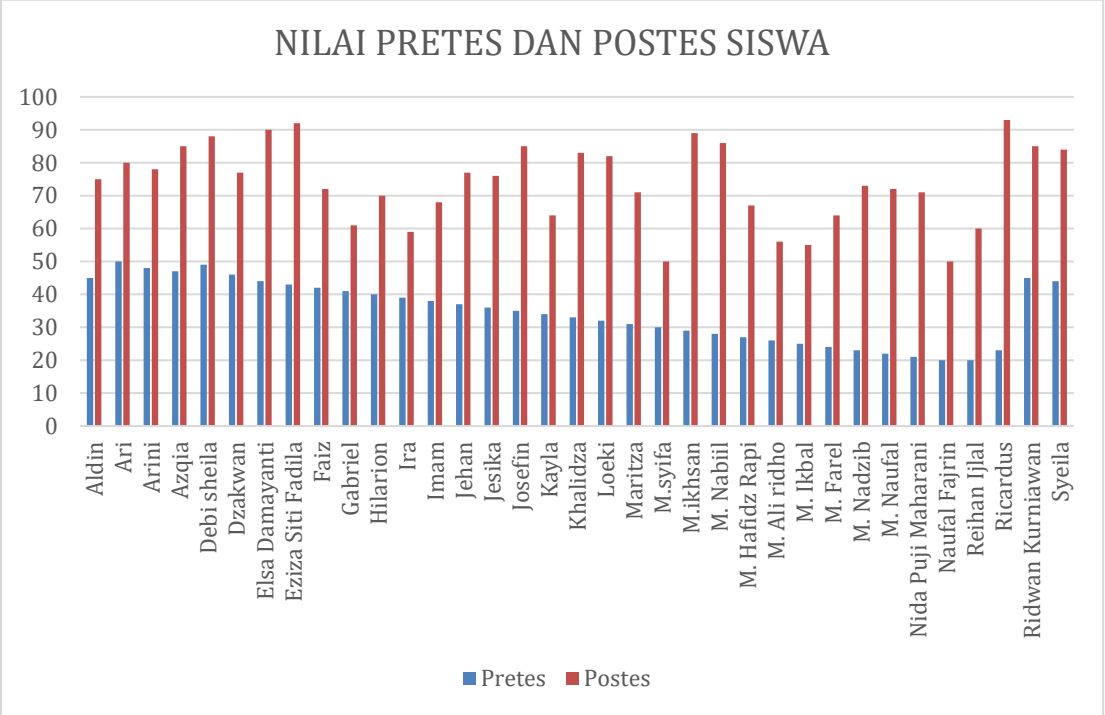
the low category were 42.85%, students who got scores in the medium and high categories were 28.57% each. The pretest and posttest scores when compared will be displayed in the following graph:



Graph 1. Comparison graph of student pretest and posttest scores

Based on Graph 1 above, we can compare the scores from students' pre-test results and post-test results, basically all students experienced an increase in their scores during the post-test (after learning treatment using Geogebra). This shows that learning using GeoGebra provides good results for all students, and achieves an increase in grades after learning using GeoGebra. This is in accordance with research results (Juandi, 2021a), that learning using GeoGebra has proven to be effective because this tool facilitates interactive and dynamic visualization of mathematical concepts. Furthermore, GeoGebra allows students to explore and manipulate mathematical objects in real time, thereby improving conceptual understanding and problem solving skills. Studies show that using GeoGebra in the learning process can increase student engagement, facilitate discovery-based learning, and improve overall academic outcomes.

CONCLUSIONS

Based on the results of observations of the use of Geogebra in learning at school, it can be concluded as follows:
1. Learning using GeoGebra has proven to be effective in increasing understanding of mathematical concepts.
2. GeoGebra facilitates interactive and dynamic visualizations that help students understand the material in more depth.
3. Using GeoGebra can increase student involvement in the learning process and develop problem solving skills.
4. Studies show improved academic results for students who use GeoGebra in mathematics learning.

Suggestions that can be given based on this article are:
1. Implementation of GeoGebra: Schools and educational institutions are expected to adopt GeoGebra as a tool in mathematics learning to increase learning effectiveness.
2. Teacher Training: Teachers need to receive adequate training to make optimal use of GeoGebra in teaching.
3. Curriculum Integration: GeoGebra should be integrated into the mathematics curriculum to support discovery and exploration-based learning.
4. Evaluation and Further Research: Further research needs to be conducted to continue to evaluate the effectiveness of GeoGebra and develop more innovative learning strategies.

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