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The effectiveness of Geogebra-assisted direct instruction learning in improving students' mathematical communication skill viewed from academic level

The effectiveness of Geogebra-assisted direct instruction learning in improving students' mathematical communication skill viewed from academic level

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Abstract. The aim of this study was to identify and analyze the effectiveness of utilizing Geogebra in improving students' mathematical communication skill viewed from academic level. This study is a mixed method research which combines both quantitative and qualitative methods with sequential explanatory strategy. The population was the second semester students of Mathematics Education and used purposive sampling technique. The result of this study showed that there was effectiveness of using Geogebra in improving students' mathematical communication skill viewed from their academic level. The students felt that their skill improved and developed through Geogebra-assisted Directed Instruction learning.

1. Introduction

In the era of Industrial Revolution 4.0, the implementation of technology, informatics and communication is inevitable in everything, including education. Utilizing educational technology may lead the students to grasp the learning materials independently, to choose work accuracy, to review lessons, and to identify the progress [1]. It was also in line with Husain [2] that using technology in learning is able to improve the effectiveness of the learning process, which is expected to increase the learning result and individual quality of each student in terms of technology with more precision and usefulness.

Based on the statements above, technology has an important part in developing education. It's also supporting lecture activities. One of the technological tools used in the classroom is notebooks. Notebooks are supported by software that is helpful in learning Mathematics, especially Algebra and Geometry. The software is known as Geogebra. It is dynamic, free, and applicable for the students.

One of the concepts of mathematics that can be constructed with Geogebra is *Plane Analytic Geometry*. Geogebra helps students visualize the lessons. Geogebra is a dynamic program with various facilities [3]. It can be used as a medium for learning mathematics to visualize mathematical concepts and tools to construct them. The utilizing Geogebra in Mathematics learning is able to help the students' conceptual and procedural knowledge [4].

Based on the research above, it is necessary for the lecturers to utilize Geogebra in learning to improve the students' communication skill. In the teaching and learning process, communication has an important role because it includes the students' skill to communicate concepts, solve problems, and find solutions.

In reality, the students' mathematical communication skill is still low. The findings of Zetriuslita [5] showed that there was no significant improvement in students' mathematical communication skill through Problem-Based Learning in Number Theory course. Students weren't ready to deal with how

they were required to study in groups or independently to communicate mathematical ideas, in addition to the low beginner level of mathematics.

2. Method

The method of this research used a mixed method approach [6] with sequential explanatory strategy [7]. The research design was quasi-experiment with *untreated control group design with pre-test and post-test* [8].

The population was the second semester students of Mathematics Education Study Program who took *Geometri Analitik Bidang* (Plane Analytic Geometry) course. Besides, the samples were chosen through *cluster random sampling* technique [9]. The samples were obtained from Class 2A with a total of 42 students as the experimental group, while Class 2B was chosen as the control group with 42 students. The independent variable was Geogebra-assisted Direct Instruction learning in the experimental class and conventional learning in the control class. Then, the instrument of qualitative data collection was a test. The test was conducted to obtain the scores of mathematical communication skill towards Geogebra-assisted Direct Instruction in experimental group and conventional learning in control group. The qualitative data were collected through an interview with the students regarding the learning methods. The data from the test result of communication skill were analyzed using quantitative descriptive statistics and inferential statistics. Then, the interview result was analyzed in qualitative narrative. The data were analyzed by comparing the scores of mathematical communication skill between the students who were given Geogebra-assisted Direct Instruction and convential learning. The magnitude of the increase before and after learning was calculated by the normalized gain formula [10] as follows:

$$\text{Normalized-gain } (g) = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score}$$

See the Normalized-gain score criteria in Table 1.

Table 1. Normalized-gain Score Criteria

$g > 0{,}7$	High
$0{,}3 < g \leq 0{,}7$	Medium
$g \leq 0{,}3$	Low

The researchers conducted normality and homogeneity tests from the data of experimetal class and control class, also performed **two mean similarity** tests using parametric statistics, namely Independent-Samples t-test and non-parametric statistical test known as Mann Whitney U test.

3. Result and Discussion

3.1 Descriptive Statistics Analysis of Mathematical Communication Skill

The mean score of students' mathematical communication skill in experimental and control groups at pretest, posttest, and N-Gain (g), see in Table 2.

Table 2. Mean Score of Students' Skill in Pretest, Posttest, and N-Gain (Experimental and Control Groups)

Group	$\bar{X}pretest$	$\bar{X}posttest$	g
Experiment	9,74	77,77	0,76
Control	10,10	42,52	0,37

Table 2 showed the improvement of students' mathematical communication skill from pre-test to post-test and N-Gain (g), where the average score in experimental class was higher after utilizing Geogebra-assisted Direct Instruction learning than conventional learning. In terms of Gain criteria,

experimental class is in High criteria while control class is Medium. In other words, the experimental class was better than control class.

3.2 Inferential Statistics Analysis.

3.2.1 Post-test Data of Experimental and Control Groups

The test result of students' mathematical communication skill before learning can be seen in Table 3.

Table 3. The statistical test result of pre-test data of mathematical communication skill in experimental and control groups

Group	*Sig*	*Result*	*Interpretation*
Experimental Control	0,83	H_0 accepted	There was no difference

In conclusion, there was no difference between the students in experimental and control groups in terms of mathematical communication skill.

3.2.2 Post-test Data of Experiment and Control Groups

The test result of students' mathematical communication skill before learning, as shown in Table 4.

Table 4. The statistical test result of pre-test data of mathematical communication skill in experimental and control groups

Group	*Sig*	*Result*	*Interpretation*
Experimental Control	0,00	H_0 rejected	There was a difference

In conclusion, students' achievement in experimental class was better than in control class in terms of mathematical communication skill.

3.2.3 Normalized-Gain of Experimental and Control Groups

The statistical test result of mathematical communication skill in experimental and control groups, as shown in Table 5.

Table 5. The statistical test result of mathematical communication skill in experimental and control groups

Group	*Sig*	*Result*	*Interpretation*
Experimental Control	0,00	H_0 rejected	There was a difference

In conclusion, the Normalized-Gain score of students in experimental class was better than control class in terms of mathematical communication skill.

3.3 Achievement of students' mathematical communication skill based on academic level

Based on the data analysis, it was found that the mathematical communication skill of students with High and Medium academic levels was from normal distribution and homogeneity of variances, so to see differences in the increase in mathematical communication skills of the two classes, Sig and low

groups were not normally distributed, the Mann Whitney test was employed, so the test results can be seen in Table 6 and Table 7.

Table 6. Achievement Result of Mathematical Communication for experimental and control groups for High and Medium academic levels

No	Class	Level	t_{hitung}	t_{tabel}	*Result*	*Interpretation*
1	Experiment Control	High	5,82	1,99	H_0 *rejected*	There was an increase
2	Experiment Control	Medium	6,75	1,99	H_0 *rejected*	There was an increase

Table 7. Achievement Result of Mathematical Communication for experimental and control groups for Low academic level

No	Class	Level	*Sig*	α	*Result*	*Interpretation*
1	Experiment Control	Low	0,00	0,05	H_0 *rejected*	There was an increase

3.4 Gain of Students' Mathematical Communication Skill based on Academic Level

Based on the data analysis, it was found that the mathematical communication skill of students with High and Medium academic levels were distributed normally and variances were homogenous, so to see differences in the increase in mathematical communication skills of the two classes Sig and low groups were not normally distributed, the Mann Whitney test was employed, so the test results can be seen in Table 8 and Table 9.

Table 8. Gain Result of Mathematical Communication Skill in Experimental and Control Groups for High and Medium levels

No	Class	Level	t_{hitung}	t_{tabel}	*Result*	*Interpretation*
1	Experiment Control	Low	5,85	1,99	H_0 *rejected*	There was an increase
2	Experiment Control	Medium	6,64	1,99	H_0 *rejected*	There was an increase

Tabel 9. Gain Result of Mathematical Communication Skill in Experimental and Control Groups for Low level

No	Class	Level	*Sig*	α	*Decision*	*Description*
1	Experiment Control	Low	0,00	0,05	H_0 *rejected*	There was an increase

Table 8 and Table 9 show that there was improving mathematical communication skill for each academic level.

3.5 Interview Analysis

Based on the interview, the students expressed their opinions regarding the learning process and the effect on their mathematical communication skill. Table 10 presents the interview result.

Table 10. Interview Result with Students about Learning in terms of Academic Level

Questions	Answers		
	High	Medium	Low
What do you think of Geogebra-assisted Direct Instruction learning in improving your mathematical communication skill?	Geogebra can increase communication, because it is easier to create graphs if it is described manually.	Geogebra can improve communication because the lecturer explains the steps so that the desired results are obtained.	Geogebra can improve communication skill because if you already understand, it's easy to re-explain it to friends
Does the learning method provide more value than the conventional one?	Geogebra provides more value than the usual method, because we can learn ellipses, parabola, hyperbola, and directional equations	Of course, it provides good pictures and definite results of the formula.	Yes, it does. Utilizing technology helps make graphics easier.
What advice can you give related to the learning process?	It needs more improvement, so that technology can be used in the right way.	It is better if learning with Geogebra is taught more in detail. Therefore, the problems	Learning with Geogebra needs to be optimized so that the results are maximized

Based on the data analysis, experimental and control groups relatively have the same mathematical communication skill before treatment. After being given different treatments, namely the experimental class with Geogebra-assisted Direct Instruction and control class with Direct Instruction without Geogebra, the results showed that the communication skill of the students in experimental class was better than the students in control class in the post-test. In terms of the Gain score difference, the students' mathematical communication skill in experimental class was higher than those in control class.

Furthermore, Geogebra-assisted Direct Instruction learning gave a significant influence in terms of academic level (High, Medium and Low). In other words, it is able to improve the students' mathematical communication skill as a whole. The result was supported by the interview with students as shown in table 9. Students from each academic level stated that the use of Geogebra in learning can help them improve mathematical communication skill. This was in line with [4] that utilizing Geogebra can improve the procedural and conceptual knowledge of high school students. The advantages of Geogebra conveyed by Hohenwarter and Fuchs [11] and Majerek [12] are visualizing images in learning material. Students' mathematical communication shows how they understand and describe mathematical problems, both in notation and graphics.

4. Conclusion

Geogebra-assisted Direct Instruction can improve students' mathematical communication regardless of their levels. It is recommended that this learning be applied better and developed for other materials.

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