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THE EFFECT OF THE USE OF ONLINE GEOGEBRA LEARNING MEDIA AND LEARNING STYLE CATEGORIES ON THE MATHEMATICAL COMMUNICATION SKILLS OF JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

This research aimed at testing, 1) whether there was a difference in mathematical communication skills of students in classes using Online GeoGebra and those not using Online GeoGebra; 2) whether there were differences in mathematical communication skills in terms of learning styles; 3) whether there was an interaction effect on students using Online GeoGebra and those not using Online GeoGebra and learning styles This research used a quasi-experimental design research method with a post-test only research design. The population of this research consisted of 8th-grade students with a total of 4 classes from of one of the Integrated Islamic Junior High Schools in Bekasi City. There were two groups for this research-the experimental group and the control group. The sample used consisted of two classes: one as The control class consisted 23 students and the other as the experimental class consisted 27 students. This research used two instruments: a questionnaire on learning styles and a test related to mathematical communication skills. Data analysis test using two-way ANOVA and Scheffe's multiple comparison test. The results of the research showed that, 1) there was a difference in mathematical communication abilities in classes using Online GeoGebra and those not using Online GeoGebra; 2) there were no differences in mathematical communication abilities in terms of learning styles; 3) there was an interaction between treatment and learning style on mathematical communication skills.

Keywords : Media, Learning Style, Communication Mathematical

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PRELIMINARY

Pursuant to Ministerial Regulation of National Education No. 22 of 2006, Mathematics is a subject studied by students starting from Elementary School to College (Depdiknas, 2006). It aims at making students able to think rationally, systematically, creatively and have the ability to work together (Harahap, 2017). Students are expected to be able to apply and practice mathematics in everyday life and in their efforts to learn various concepts coming from their experiences with the formation of reasoning, student attitudes, and challenges of implementing mathematics (Kusmaryono & Dwijanto, 2016).

Advances in science and technology has brought significant changes to human life, both in the fields of economics, society, religion and education (Wahid, 2018). The existence of technology is a phenomenon that cannot be separated from human life (Ngafifi, 2014). In order for education to continue participating in the development of science and technology, that's necessary to adjust the teaching factors in schools, namely the use of learning media (Wahid, 2018). The utilization of media during the learning process is able to encourage students to engage in more active, innovative, creative, and enjoyable learning processes. (Supriyono, 2018). Based on Samura (2015) students' experiences with with events in their environment, learning media can be created, for example, when studying geometry.

According to Made (2009), students with a computer-based learning process tend to understand abstract ideas better, which can improve learning outcomes. Abramovich (Arbain & Shukor, 2015:209) defines the GeoGebra software as freely accessible for learning geometry, algebra, and calculus at different levels. GeoGebra multirepresentative characteristics are: 1) algebraic representation; 2) graphical representation; and 3) numerical representation. The three characteristics are dynamically interconnected Theory enable students to learn abstract algebra and object geometry (Hohenwarter & Fuchs, 2005). Based on research of Telaumbanua (2020), GeoGebra software is easy for students to understand, makes learning more interesting, and facilitates problem-solving, and enables faster graph creation. Subsequently, research by Umiyatun et al., (2015) shows that learning with the assistance of GeoGebra can enhance students' understanding of mathematical concepts to determine the solution area of linear inequality system with a normalized gain score of 0.82 and a strong category in tenth-grade students of senior high school. Students treated with the Discovery learning model and Geogebra applet learning media have better problem solving abilities (Noverianto et al., 2024). Thus, Online Geogebra is highly beneficial as a medium for demonstration and visualization, a tool for construction, an aid in the discovery process, and a means for communication and representation.

Ministerial Regulation of Education and Culture No. 21 of 2016 (Permendikbud, 2016) emphasizes that one of the qualities that students should have is the ability to communicate mathematical ideas appropriately. The ability of students to communicate what they understand through dialogs occurring in the classroom, where there is an exchange of information regarding the mathematical materials studied by the students, can be interpreted as mathematical communication ability, for example, in the form of materials, formulas and problem-solving strategies (Afiani, 2017). The ability to communicate mathematics is a serious concern for students, where teachers are required to strive for

teaching using appropriate and innovative learning media also to involve students in teaching and learning activities both inside or outside the classroom to make mathematics learning more active Tarlina *et al.*, (2016). Communication is something that students should have and it can help students create permanent meaning and ideas, as well as facilitate the process of perfecting mathematical concept knowledge (Fahradina et al., 2014;Shodiqin et al., 2020). Carrying out communication during mathematics learning process helps students build mathematical thinking, since communication activities in mathematics learning process helps students improve and develop their mathematical thinking ability (Hastuti et al., 2021;Samo, 2017). In the research conducted by Purnamasari et al., (2021), a small number of students were unable to represent the problems they faced, and most students experienced difficulties in explaining the problem ideas both verbally and in writing but students were able to depict the problems in a picture or diagram.

Based on the research by Kusumah et al., (2020), communication skills improved if taught using GeoGebra compared to conventional learning. The results of the research carried out by Maryono et al., (2021) indicate that GeoGebra learning assisted by ELPSA improves students' mathematical communication skills in geometry material. The results of research conducted by Arnanda et al. (2021) also shows that students' mathematical communication skills increase due to the use of GeoGebra learning media. This is also in line with research conducted by Istikomah et al., (2021), by using GeoGebra the mathematical communication skills of students in the experimental class increased and were better than the mathematical communication skills of students in the control class.

In a research by Simbolon, (2020) it was stated that the use of Geogebra software in classroom learning was able to improve students' mathematical abilities and students who use GeoGebra software on geometry material more often achieve the Minimum Mastery Criteria. Subsequently, the research conducted by Nopiyani et al., (2018) states that students who learn realistic mathematics with the assistance of GeoGebra have superior mathematical communication skills compared to the mathematical communication skills of students who learn realistic mathematics without the assistance of GeoGebra. Therefore, Online GeoGebra can be utilized as a mathematical learning medium to demonstrate or visualize mathematical concepts and as a tool to construct mathematical concepts, thereby, enhancing students' mathematical communication skills. The results of the research by Andini et al., (2019) shows that students who learn using the GeoGebra-assisted PBL approach experienced better improvements in their mathematical communication skills than the students using conventional learning method.

Research conducted by Sari (2017) on learning styles is one of the factors that may influence mathematical communication skills. Learning style is a method that students consistently use in receiving stimulus or information, thinking and solving problems (Nasution, 2000). In the teaching and learning process, learning styles play an important role in education (Cahyani, 2017). Teachers must know students' learning styles to create models, approaches, strategies and learning methods (Widayanti, 2013).

Mathematical communication ability is positively influenced by learning styles (Subawo et al., 2021). Considering the findings of research by Hamdani et al., (2019), the achievement of eleventh-grade students in the mathematical communication ability test is affected by learning styles. Differences in learning styles are related to students' conceptual understanding abilities. (Khoirunnisa & Soro, 2021). Moreover, in a research carried out by Rohmanawati et al., (2021) communication skills are influenced by different learning styles-Students learning by using visual and auditory learning styles have better performance than those learning by applying kinesthetic learning style. The distinction of this research from the previous ones is that it uses Online Geogebra as the learning medium, viewed from the perspective of learning styles. With these conveniences, the Online GeoGebra program and the VAK (Visual, Auditory, Kinesthetic) learning styles bridge the thinking process of students to help them gain understanding in learning.

The results of observations on eighth-grade students at one of the Integrated Islamic Junior High Schools in Bekasi City state that when offline mathematics learning is not applied with learning media, the number of students achieving scores above the Minimum Mastery Criteria is less than 50%. Based on the background of the problem, the researcher feels that it is necessary to carry out research on the effect of using Online GeoGebra learning media and learning style categories on the mathematical communication skills of eighth-grade junior high school students.

METHODS

This research used a quasi-experimental research method with a post-test only design. Quasi-experimental design is a type of experiment that includes a control group but has limitations in monitoring all variables that affect the experimental process (Sugiyono, 2010). The population of this research consisted of 8^{th}-grade students with a total of 4 classes from of one of the Integrated Islamic Junior High Schools in Bekasi City. There were two groups for this research-the experimental group and the control group. In this research, the Cluster Random Sampling method was used as a sampling technique. The sample used

consisted of two classes: one as the control class consisted 23 students and the other as the experimental class consisted 27 students.

This research used two instruments: a questionnaire on learning styles and a test related to mathematical communication skills. The instrument used to collect data on mathematical communication skills was a test instrument (Link Instrument test: https://docs.google.com/document/d/18Xr66qjvU9h7ap3Oe6zmbd_d8mCkKWJm/edit?usp=sharing&ouid=109773203940236611036&rtpof=true&sd=true). The instrument used to measure the mathematical communication skills was an essay test consisting of seven (7) questions. The indicators of mathematical communication skills used in this research were: 1) Drawing, students' ability to represent mathematical ideas in the form of graphs, pictures, or diagrams; 2) Written Text, the ability to communicate mathematical ideas using correct and easy-to-understand mathematical language; 3) Mathematical Expression, ability to create mathematical models (Hikmawati et al., 2019).

The statements in this questionnaire were adapted from research Safitri & Miatun, (2021) containing 36 items consisting of 12 auditory questions, 12 visual questions, and 12 kinesthetic questions with four possible responses, namely: completely disagree, disagree, agree, and completely agree (Link Instrument: https://docs.google.com/document/d/1eNblKRD0gXJbHl9Gyfo5NXmi3Eb79gXM/edit?usp=sharing&ouid=109773203940236611036&rtpof=true&sd=true). To support the implementation of the treatment, a research design tailored to the study's objectives was used, allowing for analysis. The description of this research design is as follows:

Table 1. Research Design

Implementation/Learning media	**Learning Styles**		
	Visual	**Auditory**	**Kinesthetic**
Online GeoGebra	a_{11}	a_{12}	a_{13}
Without Online GeoGebra	a_{21}	a_{22}	a_{23}

Table 1 presents the research design containing data from the mathematical communication skills test scores of the treatment groups, categorized by learning style. Table 1, a_{11} shows data on students' mathematical communication skills with a visual learning style who were given learning treatment using Online GeoGebra. Subsequently, a_{12} in Table 1 presents the research design showing data on the matematical communication skills of students with auditory learning styles who received instruction using GeoGebra Online, and so forth. In the experimental class, the treatment involved learning using the Online Geogebra educational media, whereas in the control class, the treatment involved learning without using Online Geogebra. Before receiving the treatment, a balance test was conducted

to ensure equivalence between the experimental and control classes. Then, the prerequisite tests were carried out, namely: 1) normality test with Lilifors test; 2) homogeneity test with Bartlett method. Next, a hypothesis test was carried out using two-way ANOVA of unequal cells. This research tested 3 hypotheses, namely: a) H_0: There was a difference in mathematical communication skills in classes that use Online GeoGebra and those that do not use Online GeoGebra; b) H_0: there was difference in mathematical communication abilities based on learning style categories; and c) H_0: there was an interaction between those who use Online GeoGebra and those who did not use Online GeoGebra and learning styles A significance level of 5% is used for all statistical tests. Further ANOVA testing is used if H_0 was rejected during the hypothesis testing. The purpose was to track the average differences of each factor classification, the classifications between interaction pairs and each pair of cells. Multiple comparison technique used the Scheffe method.

RESULT AND DISCUSSION

RESULT

This research was conducted in the eighth grade classes of an integrated Islamic junior high school in Bekasi City, with a balance test carried out at the beginning of the study before classes A and B received the treatment. This test aims at determining whether the initial abilities of the experimental class and control class were balanced or not. Data were obtained from the Mid-Term Assessment of Odd Semester to measure the initial abilities of the samples. Table 2 is the data on the initial condition values of the samples' abilities. Table 2 shows the initial ability data of two sample groups.

Table 2. Data of Students' Initial Condition

Grades	n	Minimum	Maximum	Average	Standard Deviation
Experiment	27	40	100	76.67	13.66
Control	23	51	97	74.63	13.91

In Table 2, the average score of the experimental class was 76.67 with a standard deviation of 13.66, and the average score of the control class was 74.63 with a standard deviation of 13.91. Next, a balance test was conducted using the t-test to see the initial ability of students. However, previously, the data had to be normally distributed and made homogeneous. The normality test was used to find out whether the samples taken in the research were normally distributed or not. The normality test was carried out using the Liliefors method. The following are the results of the initial ability normality test presented in table 3.

Table 3. Initial Ability Normality Test Results

Grades	$L_{counting}$	L_{table}	Resolution	Consequence
Experiment	0.104	0.167	H_o accepted	Normal
Control	0.102	0.180	H_o accepted	Normal

From table 3, for the experimental and control classes, the result obtained was $L_{counting} < L_{table}$. So, at a significance level of 5%, H_0 of both classes was accepted and it could be be concluded that both sample groups were obtained from normally distributed populations. Subsequently, a homogeneity test was carried out, this test was used to find out whether the research population has the same variance or not. Bartlett's method was used to test the homogeneity of variance. The homogeneity test of the two sample classes was obtained, namely the value X^2_{table} = 0,007 with critical areas $\{X^2 | X^2 > 3{,}841)$. Value $X^2_{table} \notin$ DK, so H_o accepted, meaning that both data groups had the same variance.

Next, a data balance test was carried out using the t-test. The Hypothesis testing was H_0: students in experimental class and control class have the same initial ability. From the test result $tc_{ritical} < t_{table}$ with a value of 0,52 < 1,68. Therefore, Ho was accepted, indicating that students in the experimental and control classes had the same initial abilities.

Before being given treatment, both classes were given a learning style questionnaire. The questionnaires filled out by students were classified according to their learning styles, namely visual, auditory, and kinesthetic. Based on the data collected, data on the distribution of students who are included in the auditory, visual and kinesthetic learning style categories for the experimental class and control class can be seen in Table 4.

Table 4. Distribution of Students by Learning Style Category and Use of Online Geogebra Learning Media

Learning Media	Learning Styles			Total
	Visual	Auditory	Kinesthetic	
Online GeoGebra	2	8	17	27
Without Online GeoGebra	3	8	12	23
Total	5	16	29	50

The table above shows the distribution of students by learning style categories and use of Online GeoGebra learning media. In the test group, specifically the group utilizing online GeoGebra instructional resources, there were 7% students with a visual learning style, 30% students with an auditory learning style, and 63% students with a kinesthetic learning style. The data obtained indicate that there are more students with kinestetic learning style. Then, in the control class, namely the class not using Online GeoGebra learning media, there were 13% students with visual learning style, 35% students with auditory learning style, and the rest, namely 52% students with kinesthetic learning style.

Next, a hypothesis test was conducted with post-test data using the results of students' mathematical communication ability test scores after being given treatment. The hypothesis testing used two-way ANOVA with different cells, with normality and homogeneity tests first. The calculation of the normality test for the post-test of mathematical communication skills based on treatment and type of learning style can be seen in Table 5.

Table 5. Summary of Normality Test Results

Grades	$L_{counting}$	L_{table}	Test Decision
Experiment	0.141	0.167	H_0 Accepted
Control	0.150	0.180	H_0 Accepted
Visual	0.209	0.337	H_0 Accepted
Auditory	0.148	0.213	H_0 Accepted
Kinesthetic	0.155	0.161	H_0 Accepted

Based on table 5, it is seen in the experimental class $L_{counting}$ = 0.141, and in the control class $L_{counting}$ = 0.150, next, in each learning style, namely visual $L_{counting}$ = 0.209, auditory $L_{counting}$ = 0.148 and kinesthetic $L_{counting}$ = 0.155, it can be seen that $L_{counting}$ is less than $L_{table.}$ So, it can be concluded that each class is a sample originating from a normally distributed population. Next, a homogeneity test was conducted on each data group, namely the experimental class and control class (A1, and A2) and the learning style group (B_1, B_2, B_3). Table 6 displays the findings from the communication skills test's homogeneity test.

Table 6. Summary of Homogeneity Test

Group	X^2_{count}	X^2_{table}	Decision	Conclusion
(A1, A2)	0.146	3.841	H_0 accepted	Homogeneous
(B1, B2, B3)	0.206	3.841	H_0 accepted	Homogen

Based on Table 6 above, it is obtained from each group that the $\mathbf{X^2_{count} < X^2_{table}}$, so it can be concluded that the data in each group has a homogeneous population variance. So, the analysis prerequisite test met.

The Two-way ANOVA test was used to see the effect of treatment on mathematical communication skills and its interaction with learning style categories. Table 7 displays the ANOVA test summary results.

Table 7. Summary of ANOVA Test Results

Source	JK	dk	RK	Fhitung	Ftabel	Conclusion
A	2157.86	1	2157.86	12.29	4.06	Rejected
B	338.20	2	169.10	0.96	3.21	Accepted
A*B	87038.52	2	43519.26	247.79	3.21	Rejected
ERROR	7727.81	44	175.63			
Total	97262.39	49				

Based on the calculation of the ANOVA test results above, it could be concluded that 1) H_{0A} rejected, because $Fa > F_{table}$ with a value of $12.29 > 4.016$ so that Fa was in the DK region. There were differences in the effects between rows on the dependent variable, meaning that there were differences in mathematical communication skills in class using Online GeoGebra and those not using Online GeoGebra. 2) H_{0B} was accepted because $Fb > F_{table}$ with a value $0.96 > 3.21$ that consequently, Fb was outside the DK. There was no difference in the effect between columns on the dependent variable, meaning that there was no difference in mathematical communication skills based on learning style categories. 3) H_{0AB} was rejected because $Fab < F_{table}$ with a value $247.79 < 3.21$ so that Fb was outside the DK., meaning there was an interaction effect between treatment and learning style on mathematical communication skills.

In further testing after ANOVA in Table 7, multiple comparison tests were conducted using the Scheffe method. Table 8 displays the average results of mathematical communication abilities based on learning style and treatment categories.

Table 8. Summary of Marginal Mean

Media	Learning Styles			Marginal Average
	Visual	Auditory	Kinesthetic	
Online GeoGebra	40	42.63	38.88	40.07
Non-Online GeoGebra	18	30.75	21.33	24.17
Marginal Average	26.8	36.69	31.62	

Based on Table 8, the marginal average of mathematical communication skill based on the use of Online GeoGebra learning media was greater than the marginal average mathematical communication skill without Online GeoGebra learning media, that therefore, it could be concluded that the average mathematical communication skill of students using Online GeoGebra learning media are better than the mathematical communication skill of students learning without Online GeoGebra. Then the marginal average of mathematical communication skill based on learning style category obtained by students with auditory learning style was higher than the marginal average of mathematical communication skill of students with other learning styles.

Based on the results in Table 7, it is found that there is a difference in effects between the rows of classes using Online GeoGebra and those not using Online GeoGebra. Table 9 below are the results of the comparative hypothesis test between the mathematical communication skills of students receiving learning treatment using Online GeoGebra learning media and without Online GeoGebra learning media.

Table 9. Comparison of Treatments

Comparison	$F_{counting}$	F_{table}	Decision
Experimental vs. Control	17.88	4.06	H_0 Rejected

The hypothesis test comparing the experimental and control groups H_0 was rejected, indicating that there is a difference in mathematical communication skills between students using Online GeoGebra and those not using Online GeoGebra. From table 8, the marginal mean of the mathematical communication skill of the experimental class is higher than the marginal mean of the control class, because the marginal mean of the experimental group is 40.07 and the marginal mean of the control group is 24.17. It was found that the experimental class using Online GeoGebra learning media had better mathematical communication skills compared to the control class not using Online GeoGebra learning media.

Based on the calculation of the ANOVA test results in table 7, it showed that the A*B interaction H_0 was rejected, so further comparative testing between cells was continued. Table 10 displays the results of additional tests that were conducted to compare cells.

Table 10. Summary of Inter-Cell Comparison

Comparison	$F_{counting}$	F_{table}	Decision
m_{11} vs m_{12}	0.06	12.14	H_0 Accepted
m_{11} vs m_{13}	0.01	12,14	H_0 Accepted
m_{12} vs m_{13}	0,43	12.14	H_0 Accepted
m_{21} vs m_{22}	2.02	12.14	H_0 Accepted
m_{21} vs m_{23}	0.15	12.14	H_0 Accepted
m_{22} vs m_{23}	2.42	12.14	H_0 Accepted
m_{11} vs m_{21}	3.31	12.14	H_0 Accepted
m_{12} vs m_{22}	3.21	12.14	H_0 Accepted
m_{13} vs m_{23}	12.33	12.14	H_0 Rejected

According to the aforementioned Scheffe test findings, it could be concluded that students who were given treatment using Online GeoGebra who had visual and auditory learning styles ($m_{11} = m_{12}$) , did not have any differences. Furthermore, students who were treated using Online GeoGebra who had visual and kinesthetic learning styles ($m_{11} = m_{13}$) also did not have mathematical communication skills. Subsequently, in another comparison ($m_{12} = m_{13}$; $m_{21} = m_{22}$; $m_{21} = m_{23}$; $m_{22} = m_{23}$; $m_{11} = m_{21}$; $m_{12} = m_{22}$) also had no difference. They having a kinesthetic learning style who were given treatment using Online GeoGebra and those who were given treatment using Online GeoGebra ($m_{13} = m_{23}$) were different in mathematical communication skills.

DISCUSSION

Students in the kinesthetic learning style category received the highest overall scores in both the experimental and control groups, according to the research results previously discussed. This is in line with research conducted by Putri et. al., (2020) with 124 students as samples, in which the number of students with kinesthetic learning styles is 42%, the number of students with visual learning styles is 13%, the number of students with auditory learning styles is 35%, the number of students with a combination of visual and auditory styles is 3%, the number of students with a combination of visual and kinesthetic styles is 5%, and the number of students with a combination of auditory and kinesthetic styles is 2%.

Subsequently, this research showed that there was a difference in mathematical communication abilities in classes using Online GeoGebra and those not using Online GeoGebra. The mathematical communication skills of students using Online GeoGebra learning media were better than the mathematical communication skills of students without Online GeoGebra learning media. This is consistent with studies carried out by Kusumah et al., (2020) which concluded that students' mathematical and communication skills will improve if they are taught by using Online GeoGebra compared to those taught by using conventional learning method. In a research by Simbolon, (2020) it is stated that the use of GeoGebra software in classroom learning is able to improve students' mathematical abilities and students who use GeoGebra software for learning geometry materials achieve the Minimum Mastery Criteria more often. This is in line with research conducted by Alabdulaziz et al., (2021) that the experimental group using GeoGebra is superior compared to the control group. Then, in previous research conducted by Nopiyani et. al., (2018) it is stated that students who learn realistic mathematics with the help of Online GeoGebra have superior mathematical communication skills than students who learn realistic mathematics without the help of Online GeoGebra. In addition, in classroom teaching activities, the use of Online GeoGebra learning media can help teachers explain the materials so that students can be involved in a more meaningful learning process (Ekawati, 2016). Online GeoGebra learning media is a tool to help teachers explain the concept of mathematical graphs that as a consequence, students can solve the mathematical problems relevant to graphs well (Kania, 2018).

Furthermore, based on the research conducted, there were no differences in mathematical communication skills based on learning style categories. This is in line with research conducted by Marlian (2019) that learning styles do not have a significant effect on communication skills, but the results of qualitative analysis show that each category of

student learning styles has different communication ability results at each level of communication skills.

In addition, based on the results of research, there is also an interaction effect between treatment and learning style on mathematical communication skills. In previous research, no results were found that matched this research, however there were contradictory findings in a study conducted by Saputra et al., (2023) stating that there was no interaction between the treatment given and the learning styles of students regarding their mathematical reasoning ability.

Based on the follow-up comparison test between cells, the results showed that students treated with Online GeoGebra who had visual and auditory learning styles did not have differences in their mathematical communication skills. Furthermore, students who were treated using Online GeoGebra who had visual and kinesthetic learning styles also did not have differences in mathematical communication skills. Then, students who were treated using Online GeoGebra who had auditory and kinesthetic learning styles did not have differences in mathematical communication skills. Specific studies addressing the effect of different learning styles on mathematical communication skills have not been found. However, in previous research conducted by Prasetiawan et al., (2024), it was found that each learning style met different indicators of mathematical communication skills. Consequently, differences in students' learning styles were shown to affect their mathematical communication abilities, with previous research yielding different results from the current study. In previous studies, there has been no research that exactly matches the current study, but there has been related research on the relationship between the use of GeoGebra and students' learning styles by Huda & Khikmiyah (2019) providing results showing that there was an effect of using GeoGebra software on kinesthetic learning styles, but no effect on visual learning styles.

Furthermore, the results of the further comparative test between cells showed that students who were given treatment without using Online GeoGebra who had visual and auditory learning styles did not have differences in mathematical communication skills. Then, students who were given treatment without using Online GeoGebra who had visual and kinesthetic learning styles did not have differences in mathematical communication abilities. Furthermore, students who were given treatment without using Online GeoGebra who had auditory and kinesthetic learning styles did not have differences in mathematical communication abilities. Previously, there was no research indicating that there was no difference between the results of learning with online GeoGebra and learning without online

GeoGebra in terms of mathematical communication skills across different learning styles. However, there was a research by Pratiwi (2019) that there was no interaction between the Project Based Learning (PjBL) learning model and learning styles on students' mathematical communication skills. The results of the previous research were different from results of this research, since this research used Online GeoGebra learning media, while the previous research used Project Based Learning model. Then, in further comparative test between cells, the results showed that students with an auditory learning style who were given treatment using Online GeoGebra and those not given treatment using GeoGebra had no different in matematical communication skills. Furthermore, students with visual learning style who were given treatment using Online GeoGebra and those not given treatment using Online GeoGebra had no different in mathematical communication skills.

Subsequently, students with kinesthetic learning style who were given treatment using Online GeoGebra and those not given treatment using Online GeoGebra had different mathematical communication skills. According to Suhaifi et al., (2022), the kinesthetic learning style when applied in learning process using the Online GeoGebra application has a higher average value compared to conventional learning. This occurs because in the learning process using the Online GeoGebra application, students with kinesthetic learning style are able to adapt.

The learning process of the experimental class using Online GeoGebra learning media goes well and there are students actively asking questions when the teacher explains the materials or gives exercises relevant to linear equation materials. However, it is undeniable that there were still some students who chatted while the teacher was explaining the materials. In the experimental and control classes, the mathematical communication skills tests were carried out after the learning materials were completely given.

CONCLUSION

This research aimed at testing, 1) whether there was a difference in mathematical communication skills of students in classes using Online GeoGebra and those not using Online GeoGebra; 2) whether there were differences in mathematical communication skills in terms of learning styles; 3) whether there was an interaction effect on students using Online GeoGebra and those not using Online GeoGebra and learning styles. This research used a quasi-experimental design research method with a post-test only research design.. The population of this research consisted of seventh-grade students of one of the Integrated Islamic Junior High Schools in Bekasi City. Based on the results of the research, some results

were obtained, namely 1) there was a difference in mathematical communication abilities in classes using Online GeoGebra and those not using Online GeoGebra. Students in classes using Online GeoGebra learning media had better mathematical communication skills than those in classes not using Online GeoGebra. 2) there were no differences in mathematical communication skills in terms of learning styles; 3) there was an interaction effect on students receiving treatment and having learning styles on mathematical communication skills. The use of Online GeoGebra in learning process can be implemented in order to generate better mathematical communication skills of the students. It is recommended that further research focus more on mathematical communication skills based on learning style categories.

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