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Asian Journal of Advanced Multidisciplinary Researches

The Use of Geogebra and Cooperative Learning in Teaching Geometry

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ABSTRACT

This study investigates the effect of the use of GeoGebra and Cooperative learning (Think-pair and Share) on the students' performance of the Grade 7 students of Dawa-Dawa National High School S.Y. 2019-2020 in learning geometry. This research study utilized a quasi-experimental for nonequivalent group pretest-posttest design for which it compared the students' performance in terms of the MPS for two trial runs. Both the experimental group 1 (with 30 students) and the second experimental group 2 (with 30 students) were taught with the same lessons in geometry. Besides, the experimental group 2 was taught using the cooperative learning strategy (Think-Pair and Share) while the experimental group 1 was taught with the use of GeoGebra as a learning strategy. During the posttest result of the first and second trial run, the level of students' performance in the experimental group 1 consistently revealed to be moving towards mastery with an MPS of 75% and 73% respectively, while the experimental group 2 falls behind with an MPS of 56% in the two trial runs. Using One-way Analysis of Covariance (ANCOVA), the study revealed that there is a significant difference between the students' performance in the two experimental groups in both the first trial run and the second trial run. The results support the claim that students in the experimental group 1 performed better than in the experimental group 2 and that the use of Geogebra as a learning strategy improved students' performance in geometry.

Keywords ***:*** geogebra, geometry, students' performance, cooperative learning

1. INTRODUCTION

MATHEMATICS is the science that deals with logic and shape, quantity, and arrangement. It is considered an indispensable tool in solving problems in the past, present and will still be in the future with the onset of modern technology it is the only and proper imperative that Mathematics should have an extra and appropriate attention. As such, the subject has developed into the central piece of the curriculum of every educational institution. Often, applied projects raise questions that shape the foundation of an argument or theory and must gather shreds of evidence for the results. Other times the approach develops, and later applications are formed or discovered for the method. Hence, encouraging students to think for themselves, to conjecture, to analyze, to argue, to critique, to prove or disprove, and to know when an argument is valid or invalid is the center of Mathematics education (Chick, Baker, Pham, & Cheng, 2006a).

Today's learners are what we call the 21st-century learners. They are the center of the educational paradigm today. It means that the curriculum gives importance to the students' learning based on their existing knowledge or experiences. Mathematics is complex and has many mutually inclusive branches; because of its complexity, teachers used different strategies and materials in teaching mathematics in school. One of these strategies is the Cooperative learning strategy (Liang, 2002); this strategy shifted the learners from passive into active and made the teacher into a facilitator rather than a lecturer. With this, teachers guide the learners to work collaboratively and make sure that each of them acquires significant and effective learning experiences. Learners will be able to help one another in discussing and evaluating information (Acikgoz, 2003).

One of the usual cooperative learning used in the classroom is the Think-Pair and Share strategy. The use of Think-Pair and Share in teaching-learning has a lot of advantages. Students are encouraged to learn because they work on a pair, working on a couple makes students more interested in the topics (Marzano and Pickering, 2005). This cooperative learning strategy does not only focus on themselves. It teaches the students to think first and then share their thoughts and ideas with their classmates. They are not just sharing, but also, they are gaining knowledge from the other pairs who will also share their answers (Robertson, 2006).

The invention and utilization of mathematical software are beneficial in classroom settings because students can focus on the application than in calculation. A set of programs in the computer that aids in solving an equation or executing Mathematical computation is called Mathematical software (Mcgraw – Hill Dictionary Scientific and Technical Terms).

At the beginning of computers, the software helped to calculate but cannot manipulate. Today, Mathematical software is excellent on both calculation and manipulation (McGraw – Hill encyclopedia for Engineering).

Geogebra is a software that helps in the field of Mathematics. It is an integration of algebra, geometry, calculus, and other branches of the said subject. Geogebra is on hand as an application on different gadgets like tablets, iPods, and android as well as on Macus, Linux, and windows with its web application based on HTML's technology (Li, 2007). It is essential in the sense that it can support students more effectively by promoting their individual interests and skills. Every student is a unique individual (Ari and Deniz, 2008). Thus, they have different special abilities and difficulties. For those students who are weak, specific activities that will suit their skills and interests for them to overcome each of their problems learning. Thus, this strategy seems to have a minimal effect on the development of the students' performance.

The knowledge to use mathematical software is what the DDNHS teachers need, especially mathematics teachers. In teaching geometry, they commonly used cooperative learning strategy with the help of conventional tools (protractors, compasses, rulers, and geometrical objects), which is not enough for the students to be able to imagine, find relationships, construct, and manipulate geometric figures (Achera, Belecina, &Garvida, 2015).

Because of all the difficulties mentioned, the researcher finds ways and means in helping both teachers and students in achieving and creating meaningful learning in Mathematics, especially in Geometry. With the availability of technologies in DDNHS, the researcher was motivated to investigate on the effect of the use of Geogebra and Cooperative Learning on the students' performance in Geometry and have determined its impact on the performance of the grade VII students of Dawa-Dawa National High School in the school year 2019-2020. In the end, the researcher has positive expectations regarding the results of this study and to come up with a teaching guide that will aid both teachers and students in teaching-learning geometry.

Specifically, this study aimed to address the following questions:

1. What is the level of students' performance in geometry in the experimental group 1 and experimental group 2 in the pretest and posttest during the two trial runs?
2. Is there any significant difference in the students' performance in Geometry between the experimental group 1 (the use of Geogebra as a learning strategy) and the experimental group 2 (the use of cooperative learning strategy-TPS) in the posttest results of two trial runs?
3. What teaching guide can be made to improve the students' performance in Geometry?

Hypothesis

The conduct of this study is to prove the given Hypothesis.

1. There is no significant difference between the students' performance in Geometry of the experimental group 1 (the use of Geogebra as a learning strategy) and the experimental group 2 (the use of Cooperative learning strategy) in the posttest results of two trial runs.

2. METHODOLOGY

A Quasi-experimental for nonequivalent group pretest-posttest design was utilized to attain the objectives of this study and ensure the accuracy in the analysis and interpretation of the data gathered. A quasi-experimental design is mostly used when it is not feasible for the researcher to use random assignment, or it involves choosing groups, upon which a variable is tested, without any random pre-selection processes (White &Sabarwal, 2014). This design is used to pretest and posttest, which was conducted to both experimental groups to determine the differences of the groups within the given tests. In this study, the two groups were given the same set of lessons in which experimental group 1 was taught with the use of GeoGebra, while experimental group 2 used Cooperative Learning (TPS). Both groups were given the same pretests for each trial run, and after each investigation period, both groups were also given the same posttests to determine the significant differences in the learners' performance among and between the two groups.

This study was conducted in Dawa-Dawa National High School in the district Alicia, Zamboanga Sibugay. The school is situated in Dawa-Dawa, Alicia, Zamboanga Sibugay. It is located in the western part of the municipality of Alicia and 30 kilometers away from the Poblacion. The Dawa-Dawa National High School started as Dawa-Dawa Annex of Alicia National High School way back in 1992 with (5) volunteer teachers including the school head Mrs. Erlinda D. Bello under the effort of the late barangay captain Bonifacio Cascara and his cooperative barangay councilors. The first building started with four

(4) temporary classrooms made of bamboo and nipa. They had 30 students at that time, of which 8 were first year students, and 12 were second-year high school students. The operation of the said school gradually developed until it reached the increased number of enrollees, teachers, and infrastructures. Presently, the school has 50 sets of computers given by the Deped. It caters 814 students, including a senior high school with 39 teachers.

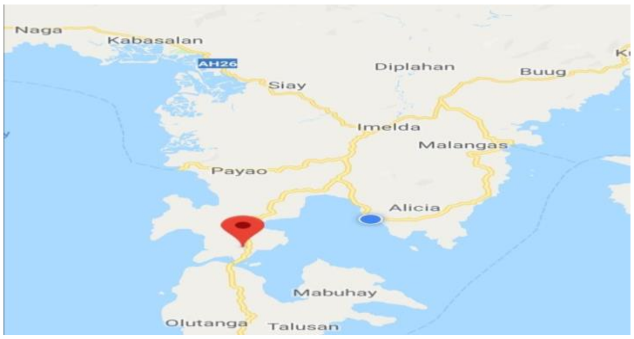

Fig. 1. Vicinity Map of Dawa-Dawa National High School

This study used homogenous purposive sampling, where the researcher purposely selected the students of the two sections of Grade 7 of Dawa-Dawa National High School to be included as research participants. This type of sampling focuses on participants sharing similar qualities or characteristics of the topic being researched (Etikan, Musa &Alkassim, 2016). The rationale of selecting the said participants from these two sections is that they share similar characteristics in terms of their performance in the subject or their homogeneity for the subject being taught.

3. RESULTS AND DISCUSSION

The following tables present the results of the data analyzed in the study and the interpretation of results to illustrate the effects of the use of Geogebra on students' achievement of the Grade 7 students of Dawa-Dawa National High School S.Y. 2019-2020. The results are organized and presented based on the order of specific problems in chapter one. Also, the research findings in this chapter are presented using tables, descriptive, and inferential statistics.

Table 1. *Levels of students' performance in geometry.*

	Test	Using Geogebra (Experimental Group 1)		Cooperative Learning Strategy (Experimental Group 2)	
		MPS	Descriptive Equivalent	MPS	Descriptive Equivalent
1st Trial Run	Pretest	36%	Average	38%	Average
	Posttest	75%	Moving Towards Mastery	56%	Average
	MPS Increase	**39%**		**18%**	
2nd Trial Run	Pretest	27%	Low	31%	Low
	Posttest	73%	Moving Towards Mastery	56%	Average
	MPS Increase	**46%**		**25%**	

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Mastery; 66 – 85% = Moving Towards Mastery; 35 – 65% = Average; 15 – 34% = Low; 5 – 14% = Very Low; 0 – 4% = Absolutely No Mastery

In the first trial run the use of Geogebra as a learning strategy generated an MPS of 36.00% in the pretest whose descriptive equivalent is *average,* and the level of students' performance increased by an MPS of 39.00% in the posttest with an MPS result of 75.00% which is descriptively interpreted as *moving towards mastery*. While as in the second trial run, the said method generated an MPS of 27.00% in the pretest whose descriptive equivalent is *low,* and the level of students' achievement also increased by an MPS of 46.00 % in the posttest with an MPS result of 73.00% which is descriptively interpreted as *moving towards mastery*.

On the other hand, the experimental group 2 (*the use of Cooperative Learning-TPS as a learning strategy*) generated an MPS of 38.00% in the pretest whose descriptive equivalent is *average,* and the level of students' achievement increased by an MPS of 18.00% in the posttest with an MPS result of 56.00% which is descriptively interpreted as *average*. While as in the second trial run, the said method for the experimental group 2 generated an MPS of 31.00% in the pretest whose descriptive equivalent is *low,* and the level of students' performance also increased by an MPS of 25.00% in the posttest with an MPS result of 56.00% which is descriptively interpreted as *average*.

The result shows that there was an improvement in the mean percentage score on both the experimental groups from the pretest to the posttest. Also, it is noticeable that the students gained learning from both strategies. Still, the participants from the experimental group 1 appear to have a better achievement since the group was able to gain an average increase in the MPS of 42.50% compared to the experimental group 2 whose average increase in the MPS was 21.50% only. It points out that the use of Geogebra as a learning strategy was able to get a higher performance level than the mere Cooperative Learning (Think-Pair and Share) as a learning strategy.

Furthermore, among the studies in support of the findings are those by Majerek (2014); Dogan and Icel (2011); and Zengin, et al. (2012), who were able to have similar results while investigating two groups of students to determine the effectiveness of using Geogebra in learning mathematical concepts. In the studies mentioned above, both the performance of the experimental group 1 and experimental group 2 improved. However, the group who were treated with Geogebra performed better.

Table 2

One-way ancova to test the difference in students' performance using the Geogebra (experimental group 1) and cooperative learning strategy (experimental group 2):1st trial run.

Source of Variation	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
Corrected Model	750.718a	2	375.359	19.007	.000
Intercept	730.762	1	730.762	37.003	.000
Covariates	414.651	1	414.651	20.996	.000
Main Effects	401.938	1	401.938	20.353	.000*
Error	1125.682	57	19.749		
Total	18014.000	60			
Corrected Total	1876.400	59			

Table 3

One-way ancova to test the difference in students' performance using the Geogebra (experimental group 1) and cooperative learning strategy (experimental group 2): 2nd trial run.

Source of Variation	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
Corrected Model	357.650a	2	178.825	12.713	.000
Intercept	639.598	1	639.598	45.472	.000
Covariates	101.384	1	101.384	7.208	.009
Main Effects	323.506	1	323.506	23.000	.000*
Error	801.750	57	14.066		
Total	16712.000	60			
Corrected Total	1159.400	59			

*a. R Squared = .308 (Adjusted R Squared = .284) *With Significant Difference*

Second Trial Run. As shown in Table 4, the main effects *(f-ratio=23.000* and *p-value<0.05)* indicate that the hypothesis is accepted. Furthermore, this implies that there is also a significant difference between the students' performance in the posttest results of the two experimental groups in the second trial run while controlling for the pretest results. The adjusted R squared shows that 28.40% of the variation of students' performance is accounted for by the variations in the use of Geogebra and Cooperative learning (Think-pair and Share) Strategies.

The result in both trial runs signifies that there is a significant statistical difference between the students' performance of the experimental group 1 and experimental group 2 by which it implies that the learning of the group treated with the use of Geogebra was significantly higher than the group who used Cooperative Learning (think-pair and Share) in teaching geometry. The aforementioned results corroborate with other conducted studies where the improvement of the students' ability and learning are significantly better in Geogebra assisted instruction than its counter methods (Juandi & Priatna, 2018; Khasanah, Usodo, &Subanti, 2018). Besides, the findings of the present study confirm with the result of the study conducted by Tarmizi, Ayub, AbuBakar & Yunus (2010) where the use of Geogebra enhanced students' ability in visualizing Mathematical concepts especially in geometry better and showed that Geogebra affects students' learning and performance positively.

In the same manner, the findings of this study concur to the work of Bhagat and Chang (2015) in examining the impact of using GeoGebra on students' achievement in learning geometry, the result indicated that Geogebra is a useful tool in the teaching-learning process by which the result of this study confirmed.

Descriptives

	Group			Statistic	Std. Error
Pretest	Control	Mean		8.6667	.42773
		95% Confidence Interval for Mean	Lower Bound	7.7919	
			Upper Bound	9.5415	
		5% Trimmed Mean		8.6574	
		Median		8.5000	
		Variance		5.489	
		Std. Deviation		2.34276	
		Minimum		4.00	
		Maximum		13.00	
		Range		9.00	
		Interquartile Range		3.63	
		Skewness		.184	.427
		Kurtosis		-.616	.833
	Experimental	Mean		7.8167	.39427
		95% Confidence Interval for Mean	Lower Bound	7.0103	
			Upper Bound	8.6230	
		5% Trimmed Mean		7.6389	
		Median		7.7500	
		Variance		4.664	
		Std. Deviation		2.15952	
		Minimum		5.00	
		Maximum		15.50	
		Range		10.50	
		Interquartile Range		3.13	
		Skewness		1.375	.427
		Kurtosis		4.274	.833
Posttest	Control	Mean		14.0333	.72116
		95% Confidence Interval for Mean	Lower Bound	12.5584	
			Upper Bound	15.5083	
		5% Trimmed Mean		13.7963	
		Median		13.5000	
		Variance		15.602	
		Std. Deviation		3.94997	
		Minimum		9.00	
		Maximum		24.00	
		Range		15.00	
		Interquartile Range		5.63	
		Skewness		.818	.427
		Kurtosis		.125	.833
	Experimental	Mean		18.4667	.61023
		95% Confidence Interval for Mean	Lower Bound	17.2186	
			Upper Bound	19.7147	
		5% Trimmed Mean		18.5556	
		Median		18.0000	
		Variance		11.171	
		Std. Deviation		3.34234	
		Minimum		9.00	
		Maximum		24.50	
		Range		15.50	
		Interquartile Range		4.63	
		Skewness		-.331	.427
		Kurtosis		.947	.833

From the result of the data analysis, it has been proved that data from both the pretest and posttest were skewed and kurtotic, but it did not significantly differ from normality.

For the Shapiro-Wilk test, control values in the pretest and experimental values in the posttest were above the significant level of 0.05 which means that there was a significant difference.

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pretest	Control	.095	30	.200*	.970	30	.547
	Experimental	.125	30	.200*	.878	30	.002
Posttest	Control	.114	30	.200*	.923	30	.032
	Experimental	.089	30	.200*	.961	30	.327

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Test of Homogeneity: Significantly different

Test of Homogeneity of Variances

VAR00001

Levene Statistic	df1	df2	Sig.
1.749	1	58	.191

ANOVA

VAR00001

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	962.001	1	962.001	182.677	.000
Within Groups	305.435	58	5.266		
Total	1267.436	59			

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of VAR00001 is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

To prove that there is a significant difference between variables, I performed a Kruskall-Wallis Test which means that the variances were distributed equally across categories. Result: Reject the null hypothesis. (There is a significant difference)

Moreover, the results of this study support the claim of Dogan and Icel (2011) in their research about The Role of Dynamic Geometry Software in the Process of Learning: Geogebra examples about triangles. The study elaborated that the utilization of the Geogebra leads to having a positive effect on students' learning and achievement on the problem-solving skills and attitudes of the learners towards mathematics. Accordingly, these findings are due to the actuality that the use of Geogebra in the presentation of problems aid students in identifying and solving mathematical problems, and it also attracts students' interest, for it provides an immediate response process to students.

In general, the views expressed in the studies, as mentioned above, are in accord with the results of this investigation.

4. CONCLUSION

In this study, it was proven that the use of Geogebra as a learning strategy significantly improved students' performance in Mathematics, specifically in learning geometry. Students were able to experience a strategy of learning which had a positive effect in enabling them to understand the concepts better. Furthermore, the said application provided students with a better opportunity to explore and visualize the concepts of geometry. Overall, Geogebra is a useful technological tool in assisting students in the mathematics classroom to achieve the princiles of constructivist learning.

5. RECOMMENDATIONS

Based on the findings, the following recommendations are forwarded:

1. Teachers should be encouraged to use Geogebra in teaching mathematics, specifically in geometry. Meticulous planning and execution are needed when Geogebra is integrated into the lessons to provide students better opportunities and learning outcomes.
2. School administrators should provide the necessary training and seminars to all math teachers on how to use Geogebra as a learning strategy to improve students' performance and understanding.
3. This study further recommends conducting future research that will explore the most effective approaches teachers should utilize in the effective use of Geogebra. To also explore various professional development models, including workshops, online courses, and mentorship programs, to identify the most impactful methods for enhancing teachers' pedagogical skills related to Geogebra integration.

Acknowledgments

The author expresses his deepest gratitude to all the people who helped her upon attaining the success of her research study. The researcher wants to thank her thesis adviser and instructor for their valuable guidance and assistance; the panelists for the brilliant ideas and meaningful recommendation; and the Lord Almighty for the strength and courage required to sustain the desire in making this paper into completion.

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