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Comparison of Student Achievement in Teaching Analytic Geometry of Planes and Space Using GeoGebra and PowerPoint Media at STKIP Abdi Wacana in Semester VI of the Academic Year 2021/2022 in Wamena

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Abstract

The research examines the comparison of student learning achievement on the topic of analytic geometry of planes and spaces, which is taught using two different learning media, namely GeoGebra and PowerPoint media. This experimental research used two different experimental classes, each consisting of 14 and 15 students. The research design used is a counterbalance design because even though students' initial knowledge is homogeneous, there are still many other variables that affect the process and learning outcomes, which cannot be controlled and are not homogeneous. The research data used were pre-test and post-test scores for each treatment, which were then processed to obtain normalized gain data. Data processing was carried out using SPSS software and was preceded by an analysis of homogeneity tests and normality tests.

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Based on the Wilcoxon Signed Test, it is clear that the two learning media are able to improve student learning outcomes. The paired samples test is used to compare the learning outcomes of the two learning models. The results showed that learning using GeoGebra media gave higher learning outcomes compared to using PowerPoint media. The average normalized gain difference between the two media is 0.34.

Keywords: Geometry; GeoGebra; PowerPoint; Achievement.

1. Introduction

The learning process in the classroom is said to be successful if the students succeed in mastering the graduate competencies of the subjects that have been set. In order to enhance the achievement of graduate competencies, teachers design learning processes using learning media, learning models, and learning strategies that are appropriate to the teaching materials being taught. The goal is that students can easily understand the teaching materials being taught and master the targeted graduate competencies.

There are two factors that influence the process of achieving these graduate competencies, namely the internal factor and the external factor, Slameto [1]. Internal factors refer to factors that come from within students, such as motivation, interest, and others. While external factors relate to factors that come from outside the student's self, such as the learning atmosphere in the classroom. External factors designed by the teacher in classroom learning can generate internal factors so that students can master graduate competencies. Therefore, teachers try to design learning that is interesting, fun, effective, and innovative.

There are several things that teachers can do to increase students' absorption in mastering the competence of graduate subjects, especially in mathematics. Some of them are developing learning models, developing learning media, designing appropriate learning methods, and others. In recent years, various strategies for teaching mathematics in schools that integrate contextual facts and relate to the culture of society have been developed. Several studies relate to ethnomathematics, such as Ubayanti, Lumbantobing, and Manurung [2], D'Ambrosio [3], Dumatubun, Kho, and Napitupulu [4], Kho and Siep [5] and Ruamba and his colleagues [6]. They looked into community cultural works that are related to mathematical principles and could be used in school math curricula. The goal is for students to get familiar with these mathematical topics rapidly, to be engaged in mathematics, and to achieve the prescribed graduate skills soon.

Currently, many researchers are focusing on developing mathematics learning media related to computers and information technology. Lumbantobing [7] conducted learning training using Google Classroom for mathematics teachers. Lumbantobing [8, 9] investigated the efficiency of mathematics learning media utilizing GeoGebra software on the topic of trigonometry and function derivatives. Furthermore, Hidayat [10] investigated the use of GeoGebra as a medium for learning geometry. The findings revealed that there are substantial disparities in the mathematical reasoning abilities of students who are taught using GeoGebra media and those who are not. This is acceptable since using GeoGebra media in the teaching and learning process may excite students' visual senses. In addition, GeoGebra media can stimulate students' interest and motivation towards the material being taught, so that students are able to absorb the learning material better. This finding is

in line with the opinion of Hamalik [11], who revealed that the use of learning media can provide stimulation to students in the learning process so as to foster interest and motivation to learn.

Apart from GeoGebra, there are several learning media that teachers often use, such as Microsoft PowerPoint. Microsoft PowerPoint has many features that teachers can use to be creative in designing learning to be interesting, interactive, and fun. Some of the facilities provided in this application are templates, custom shows, office art, graphic file formats, delivering presentations, animations, and others. Hamzah [12] studied the impact of using PowerPoint to teach mathematics on students' motivation, activity, and learning outcomes in mathematics. The results of his research showed that the application of PowerPoint learning media to the circle topic was effective. Wulandari [13] studied the differences in student learning outcomes between PowerPoint and Prezi learning media. Her study's findings demonstrated that Prezi media produces better learning outcomes than PowerPoint media. The use of PowerPoint as a learning medium has also been studied by Fitriyani, Puteri, and Ilmi [14] and Yuliansah [15]. Their study's findings suggested that PowerPoint presentations might improve learning outcomes and motivation.

To improve graduate competency achievement in schools, educators compare more effective learning designs, such as comparing the effectiveness of various learning media. Several researchers have conducted research on the effectiveness of classroom learning designs. Suhaifi, Rufi'i, and Karyono [16] have researched the effectiveness of using GeoGebra media in teaching various subject topics. The results of the study showed that learning outcomes using GeoGebra media are more effective at improving learning outcomes compared to conventional learning. Sinaga [17] has examined the comparison of learning mathematics with the classical method and GeoGebra media. The use of GeoGebra provides several advantages, such as fast and precise graphing of functions, clearer visualization in understanding mathematical concepts, and making it easier for teachers and students to investigate the properties of mathematical concepts.

In previous studies, researchers generally compared the learning outcomes of students who were taught using instructional media and those who did not use instructional media. This study will investigate the comparison of student learning outcomes taught using GeoGebra learning media and PowerPoint learning media.

2. Research Methods

2.1. Research Methods

This study employs a counterbalance design in two experimental courses as a quasi-experiment.

2.2. Sample

Two experimental courses from semester VI made up the sample for this investigation. There are 14 students in one class and 15 students in the other.

2.3. Research Design

The researchers adopted and modified the design carried out by Lumbantobing [8, 9]. Before carrying out a

counterbalance design, the researchers tested the homogeneity of the initial ability levels of the two experimental classes. There are many variables affecting student learning outcomes that cannot be homogeneous; therefore, a counterbalance design is used as follows:

Two distinct types of geometry learning treatments were performed in this study. The first treatment, let's say treatment T_1, was built with media GeoGebra software, whereas the second treatment, let's say treatment T_2, was made with media PowerPoint. The two experimental groups received both types of treatment in various orders.

Analytic geometry of planes and space has four compulsory subtopics in semester VI. Thus, two treatments (T_1) and two treatments (T_2) are given to each experimental class. To manage the order effects of the treatments, the researchers used a counterbalance design, Shuttleworth [27].

Pre-test and post-test were administered at the end of each treatment period in order to measure student learning improvement after implementing specific interventions. A counterbalance design can control the order of treatment effects and treatment effects. This was done since the experimental treatment was applied many times on various days. The counterbalance design that was used is shown in Figure 1.

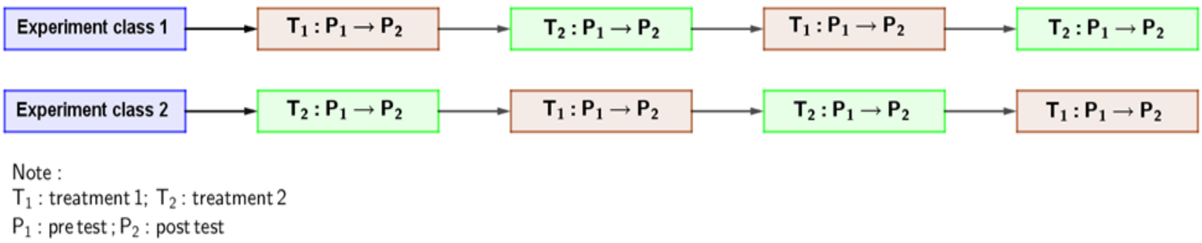

Figure 1: Counterbalance design.

2.4. Achievement Test

According to the STKIP Abdi Wacana Wamena curriculum, learning outcomes tests are developed based on the proficiency of graduates of the analytic geometry of plane and space course. The test consists of eight items, with questions drawn from several textbooks. To evaluate the topics' linked mathematical proficiency, the achievement test was developed. The exam was created by researchers and validated by three mathematics lecturers.

3. Analysis of Data

The treatments T_1 and T_2 were used to evaluate 29 samples in this study. The pre-test and post-test averages of both experimental classes were compared. To find out if the two experimental courses were homogeneous in terms of the student's initial abilities, a test of homogeneity of variances was conducted on the average pre-test scores. The following formula is used to generate normalized gain score data, Hake[18]:

$$\mathbf{Ng} = \frac{\mathbf{P_2 - P_1}}{\mathbf{maximum\ score - P_1}} \quad \ldots\ldots(1)$$

where P_1 represents the mean pre-test scores, P_2 represents the mean post-test scores, and Ng is the normalized gain score.

The SPSS application was used for the analysis. The significance threshold with two tails was set at 0.05. The Shapiro-Wilk test was used since fewer than 50 samples were used to determine if the data were normally distributed. To ascertain if there was a significant difference in the data collected, the paired samples t-test and Wilcoxon signed-rank tests were performed for normally distributed and non-normally distributed data, respectively, Rajagopalan [19] and Stang [20].

4. Results and Discussion

4.1. Decription of Data

Normalized gain data using formula (1) is used to process data on the development of learning outcomes. Table 1 below lists the research data in the description.

Table 1: Data Description.

Statistics	Treatments	
	Teaching with GeoGebra media	Teaching with PowerPoint media
Means	0.67	0.34
Std. Deviation	0.15	0.19
Minimum	0.42	0.02
Maximum	1.00	0.66

Table 1 demonstrates that there is a larger concentration of data on the advancement of learning outcomes using GeoGebra media than on the improvement of student achievement using PowerPoint media.

4.2. Homogeneity

The initial ability of students in both experimental classes is homogeneous.

This is obtained from the following data, which illustrates the outcomes of the pre-test average homogeneity test utilizing the test of variance homogeneity.

Table 2: Test of Variance Homogeneity.

		Levene statistics	df1	df2	Sig.
Averaged pre-test	Based on means	0.120	1	56	0.731
	Based on median	0.000	1	56	0.984

Table 2 shows that the two experimental groups have homogeneous initial abilities ($p > 0.05$).

These data indicate that there is no significant difference in students' initial abilities between the two experimental classes.

4.3. Normality

The Shapiro-Wilk test is applied to confirm the normality of the data as shown in Table 3.

Table 3: Test of Normality.

Treatments	Shapiro-Wilk		
	Statistics	df	Sig.
Teaching with GeoGebra media	0936	29	0.080
Teaching with PowerPoint media	0.964	29	0.403

According to Table 3, data on the development of student learning objectives taught utilizing both learning media ware normally distributed ($p > 0.05$).

4.4. Descriptive Statistics of Learning Outcomes Using PowerPoint Media

Table 4 displays the outcomes of learners who were taught using PowerPoint media.

Table 4: Descriptive Statistics of Student Learning Outcomes Using PowerPoint Media.

	N	Means	SD	Minimum	Maximum
Pre-test	29	32.04	8.47	15.00	53.00
Post-test	29	53.91	16.67	17.50	84.00

According to Table 4, the score improvement in student learning outcomes is 21.87. Table 5 displays the Wilcoxon Signed Test findings to determine the significance of the difference between post-test and pre-test scores using PowerPoint media.

Table 5: Wilcoxon Signed Test Comparing Learning Outcomes Between Pre-Test and Post-Test.

Learning outcomes	Z	Asymp. Sig (2-tailed)
Pre-test using PowerPoint media	-0.704	0.000
Post-test using PowerPoint media		

Based on Table 5, there was a considerable difference in the post-test and pre-test results of students who were taught utilizing PowerPoint media ($Z = -0.704$, $p < 0.05$). These findings indicate that the use of PowerPoint media has a significant impact on the learning of analytic geometry of planes and space.

4.5. Descriptive Statistics of Learning Outcomes with GeoGebra Media

The learning outcomes of students who were taught using GeoGebra media are presented in Table 6 below

Table 6: Student Learning Outcomes with GeoGebra Media.

	N	Means	SD	Minimum	Maximum
Pre-test	29	33.57	9.41	25.00	59.00
Post-test	29	77.37	11.13	56.25	100.00

According to Table 6, the score improvement in student learning outcomes is 43.80. Table 7 displays the Wilcoxon Signed Test findings to determine the significance of the difference between post-test and pre-test scores using GeoGebra media.

Table 7: Wilcoxon Signed Test Comparing Learning Outcomes Between the Pre-Test and Post-Test.

Learning outcomes	Z	Asymp. Sig (2-tailed)
Pre-test using GeoGebra media	-4,704	0.000
Post-test using GeoGebra media		

Based on table 7 above, it may be said that there is a considerable difference between the test results of students who are taught using GeoGebra media ($Z = -4.704$, $p < 0.05$). These findings indicated that the use of GeoGebra media has a significant impact on the learning of analytic geometry of planes and space. Additionally, the normalized gain score data were calculated to observe the variations in the development of student learning outcomes, Lumbantobing [8, 9]. Table 8 displays the normalized gain data descriptions for each treatment.

Table 8: Distribution of Normalized Gains.

Treatments	Day 1	Day 2	Day 3	Day 4
	G → P	P → G	G → P	P → G
Teaching with GeoGebra media	0.63	0.68	0.65	0.73
Teaching with PowerPoint media	0.33	0.35	0.39	0.28

G → P denotes that the treatment sequence is from GeoGebra media to PowerPoint media.

P → G denotes that the treatment sequence is from PowerPoint media to GeoGebra media.

As shown in Table 8, when students use learning tools that incorporate GeoGebra media, their learning is always more advanced.

4.6. Comparing Normalized Gain Between Treatments

The paired samples test was used to compare student achievement.

Table 9: Paired Samples Test.

Pairs	Means	SD	t	df	Sig. (2-tailed)
GeoGebra - PowerPoint	0.34	0.14	12.97	28	0.000

According to Table 9, there is a significant difference ($p < 0.05$) between the normalized gain of the learning achievement progress data utilizing GeoGebra media and PowerPoint media. The difference is 0.34, with a standard deviation of 0.14. The findings of this study show that by utilizing GeoGebra media, student learning outcomes are progressing more quickly than when using PowerPoint media. Table 10 shows these findings.

Table 10: Paired Sample Statistics.

Pairs	Means	N	SD
Teaching with GeoGebra media	0.67	29	0.15
Teaching with PowerPoint media	0.33	29	0.19

5. Discussion

This study examined the comparison of student achievement in the teaching of analytic geometry of planes and space using GeoGebra and PowerPoint media. The results showed that the use of GeoGebra media provided progress in student learning outcomes that exceeded learning progress using PowerPoint media. The results of this investigation are consistent with Lumbantobing [8, 9] and Zengen, Furkan, and Kutluca's research [21] who discovered that studying using GeoGebra media was preferable to learning without it.

According to normalized gain statistics in each treatment, GeoGebra media leads the learning outcomes that are taught to students. Teaching with GeoGebra media is more effective at illustrating mathematical concepts than PowerPoint media. These findings are reinforced by Hohenwarter and Preiner [22] and Hohenwarter and Jones [23], who claimed that studying with the GeoGebra media can improve students' understanding of the concepts, characteristics, and graphical functions of mathematics.

By using GeoGebra media, students can freely explore the properties and characteristics of geometric objects. Animation of geometric objects using GeoGebra media is one of the advantages of mathematics learning media that is not owned by other learning media, including PowerPoint media. In general, students' difficulties in learning the analytic geometry of planes and spaces are difficulties in visualizing geometric concepts and objects.

These difficulties can be overcome by using GeoGebra media so that students more easily understand the concept of geometry as well as teachers more easily teach the concepts and subject matter of analytic geometry of planes and space. This is in line with what was revealed by Kamber and Takaci [24], Tatar [25], and Adamek, Penkalski and Valentine [26].

6. Limitation

This study contains a number of limitations. For starters, this study was not cost-effective since each student required computer equipment. Second, both teachers and students need to have fundamental computer knowledge. Finally, the topic of analytical geometry of planes and space was not fully covered in this work. Therefore, further research is required.

7. Conclusion

In this study, the effectiveness of utilizing GeoGebra and PowerPoint media to teach analytical geometry of planes and space was compared. According to the analysis of pre-test scores, there was no discernible disparity in the initial abilities of the students between those two class experiments. Both educational approaches are capable of enhancing students' academic performance.

Furthermore, it was shown through the analysis of normalized gain data that there were notable differences in the students' academic achievement between the two learning media. It was concluded that learning using GeoGebra media resulted in higher students' learning outcomes.

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