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Analysis of the Spatial Thinking Ability of XI Social Students Through Map Media on the Material of Indonesia as the World's Maritime Axis at SMA Santo Mikhael Pangururan

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Abstract

The study analyzes students' spatial thinking abilities using map media on the topic of Indonesia as the World's Maritime Axis in class XI IPS at SMA Santo Mikhael Pangururan. A comparative descriptive method with a quantitative quasi-experimental design was applied. The sample consisted of 36 students in both the control (XI Social 3) and experimental (XI Social 1) classes, selected through purposive sampling. Data were collected using a test based on Jo and Bednarz's four spatial thinking components, consisting of 10 essay questions. Validity and reliability tests confirmed that 10 questions were valid. Pretest results in the control class showed scores for Non-Spatial (24.11), Primitive Spatial (20.38), Simple Spatial (6.44), and Complex Spatial (0.27). Posttest results increased slightly except for Complex Spatial, which remained the same. The experimental class showed more significant improvement, with pretest scores of Non-Spatial (17.5), Primitive Spatial (13.75), Simple Spatial (7.97), and Complex Spatial (0.97). After the intervention, all components increased, but Complex Spatial remained low. The N Gain test results showed a moderate improvement in the experimental class (0.59) compared to a low improvement in the control class (0.15). Statistical tests confirmed a significant difference (Sig. 2-tailed = 0.000 < 0.05), indicating that map media effectively enhanced students' spatial thinking abilities. The four spatial thinking components—non-spatial, primitive spatial, simple spatial, and complex spatial—help students connect visual and symbolic information, recognize locations, understand spatial relationships, and analyze geographical changes. The findings highlight the benefits of map media in improving spatial thinking, particularly in learning about Indonesia as the World's Maritime Axis.

Keywords: Indonesia as the Maritime Axis, Maps, Spatial Thinking *Ability*

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1. Introduction

Since humans fundamentally cannot survive alone and rely on natural resources and social connections for survival and growth, they are inherently dependent on both society and nature. According to Xie et al. (2021), the analysis and change of geographical space directly impact an individual's ability to survive. The Earth's surface, where all geographical events can occur, is the geographical space in question. To understand various geographical phenomena, all spatial-based information, including size, shape, distance, patterns, and relationships between different things, must be managed and processed by us (Newcombe & Shipley, 2015).

Therefore, the capacity for geographic thinking is the essential ability implied in several talents to understand the phenomena that occur and solve the emerging geographical challenges. Spatial thinking involves more than just geographical knowledge; it also includes the ability to observe and analyze to understand geosphere events, distribution, patterns, and spatial interactions among different things (Amaluddin et al., 2019), enabling us to address various issues occurring on Earth (Aliman et al., 2020).As a result, students need to have and develop spatial thinking skills (Anwar, 2016). To meet the challenges of the 21st century, which demand human expertise in various fields, including academics, spatial thinking is crucial. This includes the ability to recognize the surrounding environment and the regional environment of the nation and state (Aliman et al., 2018).

Spatial thinking is a unique characteristic of the field of Geography (Ahyuni, 2016). According to Golledge and Stimson (1997) in Aliman et al.'s research (2020), spatial thinking is the ability to process and develop spatial information through input, analysis, and output processes. The ability to understand, analyze, and think visually is known as Spatial Thinking Ability, according to Marlyono and Urfan (2020). A person who has this ability can transform a mental image into two or three dimensions. As a collection of cognitive skills, spatial thinking ability consists of three main elements: the concept of space, instruments that describe space, and spatial reasoning processes. Learning locations is just one aspect of spatial thinking; other skills include distribution, patterns, and spatial relationships between various things, as well as the ability to observe and analyze geospheric events (Amaluddin et al., 2019), to address various problems that arise on this planet (Aliman et al., 2020). Therefore, the ability to think spatially is very important and essential (Webster, 2015) and should be fostered and developed by students (Anwar, 2016).

The material on Indonesia as the World Maritime Axis refers to concepts and policies emphasizing Indonesia as the center or axis in the global maritime geopolitical and economic context. In this context, spatial thinking is essential because this concept involves various aspects related to the location and utilization of Indonesia's geographical space as an archipelagic nation. In this material, students' spatial thinking ability will be analyzed through a daily exam.

The research findings by Rahayu, Murjainah, & Idris (2019) regarding "The Effect of Google Earth Utilization on Students' Spatial Thinking Ability" show that students in the experimental group, who used Google Earth during the learning process, had spatial thinking abilities that were different from students in the control group who did not use Google Earth. Moreover, the geography learning outcomes of the experimental group were superior to those of the control group. These findings highlight the importance of spatial information for student learning, especially in improving their learning outcomes.

Based on observations during geography lessons at SMA Santo Mikhael Pangururan, students' spatial thinking ability has not developed optimally. This is evidenced when the teacher gave a daily exam on the topic "Indonesia as the World Maritime Axis." The students' exam results were quite low, with the average score being 50, while the Minimum Completeness Criteria (MCC) for geography was 70, so the students' exam results were far below the MCC. The students' understanding of natural phenomena, especially the material on Indonesia as the World Maritime Axis, was also quite low. When 36 students were given a map to review, the results showed that only six of them could describe the information on the map effectively, while the other 30 students were still hesitant and passive in expressing the spatial information and concepts on the map. This indicates the students' low spatial reasoning ability.

Based on this, there is a difference: the study conducted by Rahayu, Murjainah, & Idris (2019) shows that the utilization of Google Earth in geography learning significantly contributes to the improvement of students' spatial thinking skills. However, observations at SMA Santo Mikhael Pangururan indicate that students' spatial thinking skills are still relatively low, as evidenced by exam scores below the minimum competency standard (KKM) and students' difficulties in analyzing and interpreting spatial information on maps. This gap suggests that the implementation of spatial-based learning technology, such as Google Earth or map media, has not been optimal in the school, highlighting the need for innovative strategies to enhance students' spatial understanding. In connection with the situation described, the researcher is interested in conducting a study on the "Analysis of the Spatial Thinking Ability of XI Social Students at SMA Santo Mikhael Pangururan."

2. Method

This research was conducted at SMA Santo Mikhael Pangururan, Samosir Regency, North Sumatera Province. The reason for choosing the location of SMA Santo Mikhael Pangururan is because it has a diverse student population, supportive learning facilities, and subjects that emphasize spatial thinking skills. Additionally, the school provides the necessary data to analyze variations in spatial thinking abilities and offers potential for applying the research results to improve teaching methods that can enhance spatial thinking skills. The sample in this study consists of class XI Social 1 as the experimental group with 36 students, and class XI Social 3 as the control group with 36 students. Therefore, the total sample size is 72 students. The reason for selecting these samples is based on the consideration of having the same number of students and the same class hours. The map of the research area is as follows:

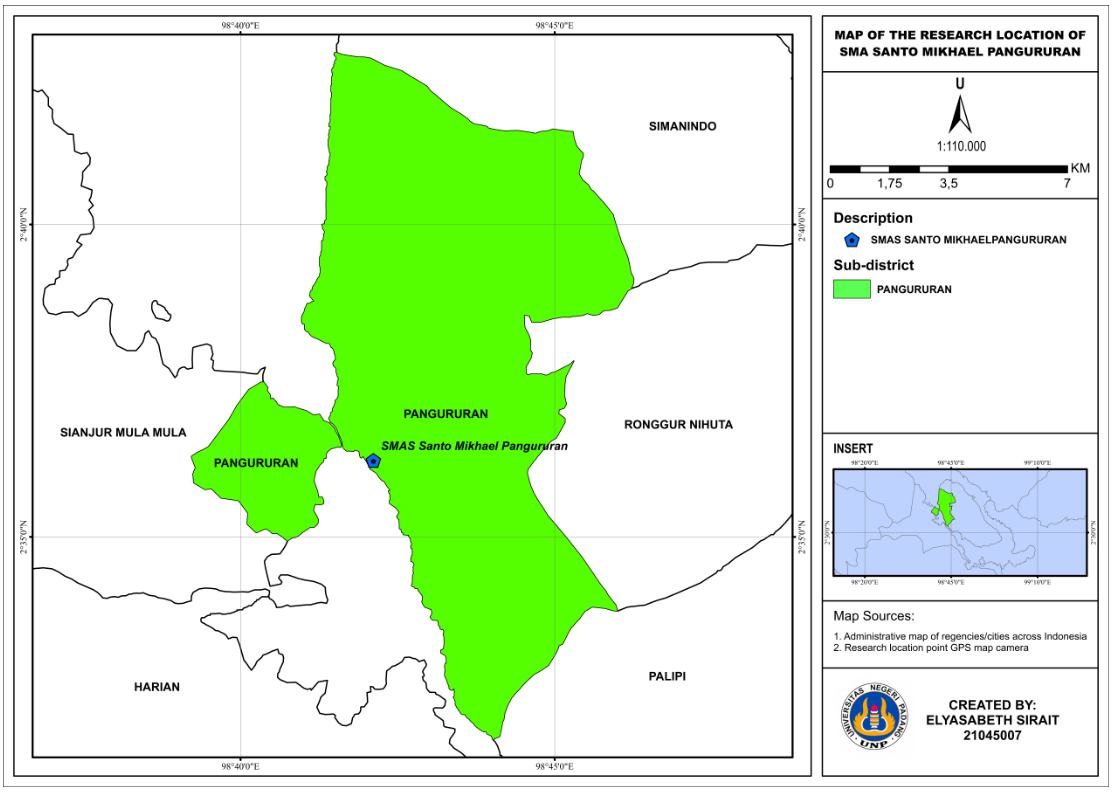

Figure 1. Map of Research Locations

This research is quantitative in nature, and the research methodology used is a comparative descriptive quantitative research method. The aim of the quantitative technique is to determine whether there is a significant difference between the experimental class and the control class (Santoso, I., & Madiistriyatno, 2021). According to Sugiyono (2019), the experimental research method is a research method conducted through experimentation, which is a quantitative method used to determine the effect of an independent variable (treatment) on a dependent variable (outcome) under controlled conditions.

The instrument used in this study is an essay-type test designed to measure students' spatial thinking ability in learning geography through daily exams in the classroom. The components of spatial thinking ability are used in the development of the test instrument by Jo and Bednarz (2009). The distribution of question items in the research instrument was structured based on the spatial thinking indicators by Jo and Bednarz and has been tested for validity and reliability to ensure measurement accuracy and consistency. The validity test using the Pearson correlation method showed that most items had rhitung > rtabel (0.334), indicating their validity. Furthermore, the reliability test using Cronbach's Alpha yielded a value of 0.621, signifying an acceptable level of reliability. Thus, the instrument meets the validity and reliability standards, making it suitable for accurately and consistently measuring spatial thinking ability.

The analysis of the research instrument includes content validity testing conducted by experts, content validation using Microsoft Excel 2010 and SPSS version 29, and reliability testing. During the pretest and posttest, the tested instrument will be administered. The data is then evaluated to assess the students' ability levels using normality test, homogeneity test, N-Gain test, t-test, and components of spatial thinking ability.

3. Result and Discussion

A. Result of the Normality Test

To verify normality, the Asymp is assessed using the one-sample Kolmogorov-Smirnov test. There are two tails in the significance value (sig). If the significance value is greater than 0.05, the data is considered to be normally distributed; if it is less than 0.05, the opposite occurs.

Table 1. Normality Test

Class	Kolmogrov smirnov			Shapiro-Wilk		
	Statistic	Degrees of Freedom	Significance	Statistic	Degrees of Freedo	Significance
Pretest-Experimental	096	36	.200	.979	36	.709
Postest-Experimental	157	36	.024	.856	36	<,001
Pretest-Control	113	36	.200	.947	36	.086
Postets-Control	138	36	.080	930	36	.025

A significance value greater than 0.05 found in the Tests of Normality table indicates that the data being examined is normally distributed.

B. Homogenity Test

After the pretest and posttest results from both sample classes showed a normal distribution, a homogeneity test was conducted. The purpose of this test is to determine whether the two data sets are homogeneous. To assess the homogeneity of the variables, the homogeneity test was conducted using SPSS 29 software. According to the homogeneity criteria, the data is considered homogeneous if the probability (Sig) is greater than 0.05 and not homogeneous if Sig is less than 0.05.

Table 2. Homogenity Test

Test of Homogenity of Variance					
		Levene Statistic	Degrees of Freedom 1	Degrees of Freedom 2	Significance
Hasil Belajar	Based on Mean	1.697	1	70	.199
	Based on Median	1.723	1	70	.194
	Based on Median and with ajusted df	1.723	1	69.501	.194

	Based on timmed Mean	1.786	1	70	186

The results of the homogeneity test calculations for the sample and experimental class for the pretest and posttest meet the criteria, according to the Test of Homogeneity of Variance table, which shows that the Significance (Sig.) is greater than 0.05 with a mean value of 0.199. Data is considered homogeneous if the Levene's Significance (Sig.) value is greater than 0.05. Thus, the variances of the posttest data for the control class and the experimental class are the same

C. Level of Students' Spatial Thinking Ability

1. Pretest Results of the Control Class and the Experimental Class

Table 3. Average Pretest Scores of Spatial Thinking Ability of Students on Each Component for Essay Questions

Number	Component	Average Value per Component			
		Control	**Criteria**	**Experimental**	**Criteria**
1	*Non Spatial*	24,11	Low	17,5	Low
2	*Primitive Spatial*	20,38	Low	13,75	Low
3	*Simple Spatial*	6,44	Low	7,97	Low
4	*Complex Spatial*	0,27	Low	0,97	Low

From the table above, it can be seen that the average score for each element of spatial thinking ability in the essay questions by students in the control class was highest in the non-spatial component, which was 24.11 with a low category, and lowest in the complex spatial component, which was 0.27, also in the low spatial thinking category. In the experimental class, the average spatial thinking ability of students was highest in the non-spatial component, which was 17.5 with a low category, and in the complex spatial component, it was 0.97, also within the low category.

2. Postets Results of the Control Class and the Experimental Class

The data on students' spatial thinking ability based on components in the posttest results of the control class and the experimental class can be seen in the following Table 4:

Table 4. Average Posttest Essay Scores of Students on Each Component

Number	Component	Average Value per Component			
		Control	**Criteria**	**Experimental**	**Criteria**
1	*Non Spatial*	27,69	Low	56,75	Moderate

2	*Primitive Spatial*	21,88	Low	50,70	Moderate
3	*Simple Spatial*	10,33	Low	34,054	Moderate
4	*Complex Spatial*	0,27	Low	3,80	Low

Based on the table above, it can be seen that the average posttest essay scores for spatial thinking ability components obtained by students in the control class were highest in the non-spatial component, which was 27.69 with a low category, and 0.27 in the complex spatial component, which also falls into the low category. In contrast, the average scores of students in the experimental class for the posttest spatial thinking ability component were highest in the non-spatial component, which was 56.75 with a medium category, and 3.80 in the complex spatial component, which falls into the low category.

D. Differences Between the Control Class and the Experimental Class

1. Pretest Results of the Control Class and the Experimental Class

Data on students' spatial thinking ability based on components in the posttest results of the control class and the experimental class.

Table 5. Recap of Pretest Scores for Spatial Thinking Ability in the Class

Number	Statistic	Control Group	Experimental Group
1	Sample size	36	36
2	Minimum Value	20	10
3	Maximum Value	78	69
4	Means	50,97	39,78
5	Varians	291,11	230,63
6	Standar Deviation	17,06	15,18

From the table above, it can be seen that the experimental class and the control class have the same number of samples, which is 36. This resulted in a higher average pretest spatial thinking ability score for the control group compared to the experimental group of students. The average pretest score obtained by students in the control class was 50.97 with a variance of 291.11, where the lowest score was 20 and the highest score was 78. Meanwhile, the average pretest score obtained by students in the experimental class was 39.78, with the lowest score being 10 and the highest score being 69. Variance is the average of the squared deviations of each data point from the mean, and the standard deviation is the square root of the variance, which shows the standard deviation of data from the mean. The variance in the control class is higher, at 291.113, with a standard deviation of 17.062, compared to the variance in the experimental class, which is 230.635, with a standard deviation of 15.187.

2. Postest Results of the Control Class and the Experimental Class

After the implementation of the learning process with a conventional learning approach in the sample class and a learning approach using maps in the experimental class, an end test, namely the posttest, was conducted. Based on the results of the descriptive analysis of the posttest scores for students' spatial thinking ability, processed using SPSS version 30, the data on spatial thinking ability scores of students in the control and experimental classes are presented in the following Table 6.

Table 6. Recap of Posttest Scores for Spatial Thinking Ability in the Control and Experimental Classes

Number	Statistic	Control Group	Experimental Group
1	Sample size	36	36
2	Minimum Value	30	30
3	Maximum Value	80	90
4	Means	60,19	76,44
5	Varians	181,91	235,81
6	Standar Deviation	13,48	15,35

Based on the table above, it can be seen that with the same sample size of 36 in both the control class and the experimental class, the average score in the experimental class is higher than the average score in the control class for the posttest of spatial thinking ability. The average posttest score obtained by students in the control class was 60.19 with a variance of 235.81, where the lowest score was 30 and the highest score was 80. Meanwhile, the average posttest score obtained by students in the experimental class was 76.44, with the lowest score being 30 and the highest score being 90. The variance in the experimental class is higher, at 235.818, with a standard deviation of 15.366, compared to the variance in the control class, which is 181.911, with a standard deviation of 13.487. This is because the use of map media tends to be more focused, more engaging, and more effective in producing more consistent results, thus spreading the data.

E. Test N-Gain

The N-gain test is used in this study to assess the extent to which the spatial thinking ability of students in the experimental class, which uses map media, and in the control class, which uses conventional learning, has improved. The following table provides a summary of the descriptive analysis of the N-gain test for the control group:

Table 7. Average N-gain Results for the Control and Experimental Group

Number	Class	Average N-Gain	Description
1	Control	0,15	Low
2	Experimental	0,59	Moderate

The category of students' spatial thinking ability that is low is indicated by the average N-gain increase score of 0.15 in the control class, as shown in the previous table. Meanwhile, the average N-gain increase score in the experimental group is 0.59, indicating a moderate category. Based on the explanation above, it can be concluded that the improvement in students' spatial thinking ability using the map media approach is higher compared to the spatial thinking ability of students using the conventional learning model.

F. T-test Result

The t-test was conducted to examine the differences between the control class and the experimental class regarding students' spatial thinking ability in geography learning for grade XI IPS at SMA Santo Mikhael Pangururan. If the results of this t-test meet the t-test requirements, the results will be accepted. If the p-value is less than 0.05, H1 is accepted; if it is greater than 0.05, H1 is rejected. The table below shows the results of the t-test for the posttest data of the control and experimental classes.

Table 8. Recap of the t-test Results for the Posttest in the Control and Experimental Group

Test	F-statistic	Significance	T – statistic	Degrees of Freedom	Mean Difference	Significance.(2-tailed
Levene’s Tes (Equal Variances Assumed)	1.679	1.99	4.770	70	16.250	<0.001
Levene’s Tes (Equal Variances Not Assumed)	-	-	4.770	68.853	16.250	<0.001

Based on the table above, the t-test results show that H1 is accepted and H0 is rejected, meaning the Sig (2-tailed) value of 0.000 < 0.05. It can be concluded that there is a significant difference between the control class and the experimental class regarding students' spatial thinking ability in geography learning for grade XI IPS at SMA Santo Mikhael Pangururan.

G. Discussion

Based on the data analysis, it can be concluded that the map media approach has a significant impact on students' spatial thinking abilities in geography learning for grade XI IPS at SMA Santo Mikhael Pangururan. This is evidenced by the noticeable difference in the spatial thinking abilities of students in the experimental class using the map media compared to the control class using the conventional learning model.

There is a significant difference in the scores for each component of spatial thinking ability in the essay questions between the control and experimental classes. In the pretest, the control class showed the following scores: Non Spatial 24.11, Primitive Spatial 20.38, Simple Spatial 6.44, and Complex Spatial 0.27, all of which are categorized as low. In the pretest for the experimental class, Non Spatial scored 34.05 (moderate), while Primitive Spatial 17.5, Simple Spatial 13.75, and Complex Spatial 0.97 were all categorized as low. In the posttest, the control class had the following scores: Non Spatial 27.69 (low), Primitive Spatial 21.88 (low), Simple Spatial 10.33 (low), and Complex Spatial 0.27 (low). Meanwhile, the experimental class's posttest scores were: Non Spatial 56.75, Primitive Spatial 50.70, Simple Spatial 34.05, and Complex Spatial 3.80. These results indicate that, although there was improvement, spatial thinking ability in the complex spatial questions still needs to be further developed.

The difference in the average scores between the control and experimental classes shows that, in the pretest, the control class had a higher average score (51.22) compared to the experimental class (40.19), with the control class in the moderate category and the experimental class in the low category. However, in the posttest, the experimental class showed significant improvement with an average score of 76.52, which is higher than the control class's average score of 60.19. The experimental class is in the high category, while the control class remains in the moderate category. This indicates that although the control class had better spatial thinking abilities in the pretest, the experimental class demonstrated much faster progress in the posttest, with a higher final spatial thinking ability.

The high spatial thinking ability in the experimental class is attributed to the active involvement of students in activities that support their understanding and processing of spatial information, such as location, shape, position, and the relationships between objects in space. Jo and Bednarz (2009) stated that the use of map media helps students understand the four levels of spatial thinking: non-spatial, spatial primitives, simple-spatial, and complex-spatial. With this approach, students can more easily understand geographical concepts visually, which is more effective than conventional learning that is lecture-based and focuses on memorization.

As stated by Sternberg (2003), spatial thinking is part of analytical intelligence, involving the ability to think systematically and solve problems based on an understanding of space and relationships between objects. Map-based learning supports this skill by providing students with opportunities to directly engage with the material. On the other hand, conventional learning, which tends to be monotonous, can reduce student engagement and hinder the development of critical thinking skills (Firmansyah, 2017). Therefore, the map media approach has proven to be more effective in improving students' spatial thinking abilities.

4. Conclusion

Based on the four components of spatial thinking ability, the research findings indicate an increase in post-test scores in both classes after the intervention. However, the improvement was more significant in the experimental class compared to the control class. Specifically, in the Complex Spatial component, although there was an increase, the score remained relatively low and requires further attention in learning development.

Additionally, there was a significant difference in students' spatial thinking ability between the experimental class, which used a map-based approach, and the control class, which employed a conventional learning model. The average score of the experimental class was higher, and statistical test results showed a significant difference with a Sig (2-tailed) value of $0.000 < 0.05$. The N-Gain test also indicated that the improvement in spatial thinking ability was higher in the experimental class compared to the control class.

The implications of these findings suggest that a map-based approach is effective in enhancing students' spatial thinking ability, particularly in the Non-Spatial, Primitive Spatial, and Simple Spatial components. However, the Complex Spatial component still needs further development. Therefore, future research is recommended to explore more specific strategies for improving Complex Spatial ability and to consider other factors that may influence the effectiveness of the map-based approach.

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