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THE USE OF MAP MEDIA: A STUDY OF SPATIAL THINKING SKILLS

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Abstract

The Use Of Map Media: A Study Of Spatial Thinking Skills. *This study aims to analyze the effectiveness of using map media in improving students' spatial thinking skills in biosphere phase E (class X) material at SMAN 1 North Kampar. Spatial thinking is very important in science education to understand spatial relationships in ecosystems, but biosphere learning faces complex challenges related to the interaction of organisms and their environment. Therefore, the use of map media, both digital and printed, is integrated in ecosystem analysis and prediction of environmental change to improve students' understanding. This study used a quantitative approach with a quasi-experimental method and Non-Equivalent Group Design. The research sample consisted of 30 students of class X3 as the experimental group and 30 students of class X1 as the control group. The intervention was conducted for two weeks in the odd semester. Data analysis using Independent Sample T-Test showed a significance value (sig = 0.001 <0.05), which means there is a significant difference between the two groups. N-Gain results showed that the experimental class had high effectiveness in spatial thinking (76.68%), while the control class was less effective (55.58%). These results show that map media can be used as an effective learning tool to improve students' spatial thinking skills. Teachers can utilize interactive or digital maps in ecology learning to clarify the concept of space and improve students' understanding of the biosphere.*

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INTRODUCTION

Spatial thinking plays an important role in everyday life, one of which is helping individuals to carry out activities more efficiently. For example, when someone wants to travel somewhere, they will determine the fastest route to reach their destination. This decision-making process reflects spatial thinking skills. According to Aliman (2016:63), spatial thinking is a person's ability to understand and analyze certain spatial conditions. This skill also includes the cognitive ability to transform and connect various information related to spatial aspects.

Spatial thinking skills refer to the utilization of elements in space to structure problems, formulate answers, and express solutions. This is in line with Carleton's opinion (in Astawa et al., 2019: 182), which states that spatial thinking skills are the ability to understand the meaning of size, shape, orientation, direction, location, trajectory of an object, process, or phenomenon, as well as the relative position of several objects in space.

Indonesian's Today" and data summarized by the Ministry of Education and Culture (in Sartika, et al., 2020), only 5% of Indonesian students have analytical thinking skills, while the majority of other students only have skills up to the knowledge level(Fitriani, Zubaidah and Hidayati, 2022);(Kwangmuang *et al.*, 2021);(Hadi *et al.*, 2018). Problems in education are often related to the lack of emphasis on analytical skills. The problem of achieving educational goals is not entirely dependent on the written curriculum, but also on the knowledge of teachers who implement it in schools (Ahyuni, Mudjiran and Festiye 2023). In many schools, students are more often trained to memorize facts than to develop higher-order thinking skills. Especially in learning geography in high school, educators need to introduce a more holistic approach, relate geography concepts to everyday phenomena, and encourage learners to think more analytically. Therefore, geography has an important role in various aspects of life (Avci, İbret and Recepoğlu, 2017). One of its roles is that geography learning is characterized by spatial thinking. Thus, basic materials such as biosphere students' spatial thinking ability can be improved through the use of map media in learning. Ramirez, C. A. M. (2021).

Spatial thinking is a crucial cognitive skill across multiple disciplines, including science education. In the field of science, spatial thinking aids students in understanding relationships between structure and function in biology, the distribution of chemical elements in the Earth's crust, and the movement patterns of celestial bodies in astronomy. However, this skill is often underdeveloped in traditional learning environments that prioritize rote memorization over analytical exploration and visual conceptualization. Previous research has demonstrated that visual media, such as maps and interactive models, significantly enhance comprehension of abstract scientific concepts (Bednarz et al., 2012; Gersmehl, 2007). Despite these findings, there remains a gap in studies that specifically measure the effectiveness of map media in enhancing spatial thinking skills within science education. Therefore, this study aims to analyze the extent to which map media improves students' spatial thinking skills in learning about the biosphere and how this approach can be adapted for broader scientific education contexts.

By incorporating spatial representations into science learning, students can develop a deeper understanding of ecological interactions, geochemical processes, and planetary dynamics. This study contributes to existing literature by providing empirical evidence on how spatial media can be leveraged to facilitate science education. Ultimately, the findings from this research will offer insights into innovative teaching strategies that align with 21st-century educational objectives, fostering critical thinking and problem-solving skills among students. Learning media is one of the important components that can increase the effectiveness of material delivery (Wiratmojo in Falahudin, 2014). The use of media in learning can increase interest, motivation, and provide stimulation to students. Currently, teenagers tend to use electronic media more often than print media or books (Yusupa & Aeni, 2018).

The results of preliminary observations on Geography subjects in class X phase E SMAN 1 North Kampar Regency Kampar Riau in the implementation of biosphere learning is only done by using the book/lecture technique. Previous research shows that spatial thinking is a crucial cognitive skill in understanding scientific concepts, especially in geography and ecology (National Research Council, 2006). Cognitive and educational theories confirm that visual representations, such as maps, can help improve spatial understanding by presenting relationships between objects more concretely and systematically (Newcombe & Shipley, 2015). In the context of biosphere learning, students often have difficulty in understanding the patterns and relationships between ecosystem elements due to their abstract and complex nature. Map media has been empirically proven to improve spatial thinking skills by helping students identify environmental patterns, understand spatial relationships, and make geographic data-based predictions (Uttal et al., 2013). While teacher observations can be used to strengthen the argument, for example by noting the challenges students face in understanding biosphere concepts, this research must remain grounded in scientific theories and studies to ensure its academic validity. Thus, this study has a strong justification in the context of science education and students' cognitive development.

So that learning is not monotonous, it can be done by utilizing one of the geography learning media, namely by using maps. Where maps not only function as media but can also improve students' spatial thinking skills. Spatial thinking in geography education is often associated with map reading skills, Kastens, (2001), in Hidayah, R. (2024).

Maps are a representation of spatial thinking and learning them can improve spatial thinking skills (Geospatial Information Agency, 2015). Since the publication of the report "Learning to Think Spatially" by the National Academy of Sciences (Committee on Support for Thinking Spatially, 2006), the urgency of spatial thinking in solving various problems has received increasing attention. The report highlighted the importance of spatial thinking learning strategies in schools as well as the role of spatial technology in developing this skill. As a result, spatial thinking has become an interesting topic of study for many researchers.

The link between Geographic Information Science (GIScience) and spatial thinking has attracted the attention of geographers such as Goodchild, Golledge, Gersmehl & Gersmehl, Lee, Bernadz, and others. These experts believe that learning geography has a crucial role to play in improving students' spatial thinking skills, thus encouraging more research in this area. These spatial skills include the ability to read maps, such as determining direction, measuring distance, understanding geographical characteristics, and recognizing certain patterns, Carswell (1971) in Hidayah, R. (2024). Spatial thinking involves various cognitive processes that can support exploration, discovery, visualizing relationships, imagining transformations between scales, seeing things from other angles, looking at images of places and others Ahyuni (2016). Spatial representations, such as maps, are very useful in framing geographic questions, which include collecting, organizing, and analyzing geographic information, as well as explaining and communicating geographic patterns and processes.

These skills are essential for the development of 21st century competencies (Bednarz et al., 2012). Gersmehl (2007) defines spatial thinking as the ability used by a geographer to analyze spatial relationships on the earth's surface. Therefore, spatial thinking ability is very important to be developed in students, especially in geography subjects. Less innovative learning models can be an obstacle in achieving optimal educational goals.

Although previous studies (Apriana, 2021; Fomba, Talla, & Ningaye, 2023; Müller, Mildenberger, & Steingruber, 2023) have discussed factors that influence learning effectiveness, such as teaching quality, assessment, incentives, and time, there is still a gap in understanding how map media can improve spatial thinking skills in biosphere learning.

This study aims to examine the effectiveness of map media in improving students' spatial thinking skills compared to conventional methods, as well as its impact on understanding spatial relationships in biosphere materials. Although the experimental class received special treatment, this was done to scientifically test the effectiveness of learning strategies to improve the overall quality of education. In addition, evaluation plays an important role in assessing student progress and increasing learning motivation. Thus, this study provides empirical evidence of the benefits of map media in the development of spatial thinking skills, filling the research gap that focuses more on general learning effectiveness.

Based on the hypothesis that there is a difference in students' spatial thinking ability between the experimental and control classes, the author is motivated to conduct research with the title "The Effectiveness of Using Map Media on Phase E Biosphere Material on Students' Spatial Thinking Ability." This study aims to analyze the effectiveness of using map media in improving students' spatial thinking skills in Geography subjects at SMAN 1 North Kampar, Kampar Regency, Riau. The results of this study are expected to make a positive contribution in the development of innovative and effective learning methods and provide new insights for educators in improving the quality of learning in the classroom.

METHODS

The research method used is quantitative with the type of Quasi Experiment research. This research design applies Non-Equivalent Group Design, which compares experimental groups and control groups without random assignment. The quasi-experimental method was chosen as it allows for the measurement of treatment effects in a realistic educational setting, even when random assignment of subjects is not feasible (Shadish, Cook, & Campbell, 2002). This design provides a valid means to evaluate the effectiveness of map-based learning interventions in real classroom environments where controlled randomization is often impractical.

Table 1. Research Design

Class	Pre test	Treatment	Post test
Experiment	O1	X	O2
Control	O1	-	O2

Description:

X: Treatment using map media

-: Treatment not using map media

O1: pre-test and post-test of the experimental class

O2: pre-test and post-test of the control class

The research instruments, including the spatial thinking test and learning materials, were tested for validity by geography education and assessment experts. Evaluation was conducted based on relevance, clarity, construct validity, and classroom usability. Expert feedback was used to revise the instruments before implementation. Reliability Test (Cronbach's Alpha) To ensure internal consistency, Cronbach's Alpha was calculated. Values between 0.70 - 0.90 indicate high reliability. After the Indenpenden sample test and N-Gain test with a total of 15 easy questions.

Research location at SMAN 1 North Kampar, North Kampar District, Kampar Regency, Riau Province. The study population was all students of class X SMAN 1 Kampar Utara Utara consisting of 3 classes with a total of 90 students. This study used random sampling, which is a sample selection technique based on certain criteria with equal opportunities for each class X to be selected, because there is no superior class (Sugiyono, 2017). The research sample consisted of class X1 as the control class and class X3 as the experimental class used to measure the effectiveness of map media in improving students' spatial thinking skills.

Table 2. Research Sample

No	Phase/Class	Number of Students	Description
1	Phase E Class X-1	30	Class Control
2	Phase E Class X-3	30	Class Experiment
Total		**60 Students**	

The intervention group (class X3) used map media as the main tool in biosphere learning. Digital maps and printed maps, which helped students in understanding spatial relationships. Map media maps and digital maps.

The control group (class X1) used conventional methods, namely lectures and discussions without map media. The teacher explained the material using textbooks and the blackboard, while students took notes and discussed the concept of biosphere without the help of visualisation. Comparison of Learning Time.Experimental Class: The learning took place over 2 weeks (4 meetings of 90 minutes) with media integration maps in each session.Control class: The learning also took place over 2 weeks (4 meetings of 90 minutes), but only using conventional methods. The main difference lies in the use of map media, which is expected to improve students' spatial thinking skills in understanding biosphere concepts compared to the usual lecture method. Both classes are taught by the same teacher.

In the experimental class, students were introduced to thematic maps related to biosphere studies. The learning process began with Spatial Data Analysis, where students identified patterns in ecosystem distribution and biodiversity using maps. Through this activity, students were encouraged to analyze variations in natural habitats and understand how environmental factors influence biodiversity. Following this, Collaborative Group Discussion was conducted to allow students to share their interpretations and connect environmental factors with ecosystem variations. These discussions fostered a deeper understanding of spatial patterns and their real-world implications, helping students develop scientific reasoning skills.

The final phase involved Problem-Based Learning (PBL), where students were presented with case studies that required them to apply spatial analysis techniques. By engaging with spatial representations, students assessed environmental changes caused by human activity, such as deforestation and urban expansion, and proposed potential mitigation strategies. This structured learning approach ensures that students actively engage with spatial data, enhancing their analytical skills and deepening their comprehension of scientific concepts. The integration of thematic maps, collaborative discussions, and problem-solving exercises creates a dynamic learning environment that promotes higher-order thinking skills and prepares students for complex scientific challenges.

The data collection techniques used in the study were tests and documentation. The spatial thinking ability test questions prepared by the researcher consisted of 15 essay-shaped questions (descriptions), with varying levels of difficulty, ranging from non-spatial, spatial primitive, simple spatial, to spatial complex as the most difficult level. The Independent Sample T-test was used to compare the learning outcomes between the class that used the map learning media, with the control class, and the experimental class. The Ngain score test was conducted by calculating the difference between the pre-test value and the post-test value. (Meltzer, 2002). By calculating the difference between post-test and post-test scores, or gain score, we can determine whether the use or application of a particular method is effective or not. The steps to analyse the normalised gain Meltzer 2002 are as follows:

a. Calculate the normalised gain score with the formula:

$$<g>=+TF/SI-Ti/TI$$

Description:
<g> = Normalised gain
Tf = Post test score
Ti = Pre test score
SI = Ideal score

b. Determining the average value of the normalised gain score
c. Determine the gain improvement criteria.

The categorisation of the N-gain score can be determined based on the N-gain value or the value of the N-Gain value in the form of percent (%).

Table 4. Category N Gain percent (%)

N-Gain	Criteria
g ≤ 0,3	Low
0,3 < g ≤ 1,00	Medium
0,70 g ≤ 1,00	High

RESULTS AND DISCUSSION

Results

1. Normality Test

The data normality test was carried out to determine whether the research data followed a normal distribution or not. The normality test was carried out with Kolmogorov-Smirnov because the sample was greater than 50.

Table 7. Normality Test

Class	Statistics	Df	Sig
Experiment	0,954	30	0,223
Control	0.951	30	0,177

Based on the Kolmogorov-Smirnov test, it is known that the sig value for the experimental class is 0.223 and the control class is 0.177. Because the sig value for both groups is greater than 0.05, it is concluded that the data on student learning outcomes for the control class and experimental class are normally distributed.

2. Homogeneity Test

The homogeneity test was carried out to determine whether the research data had similar variations or not.

Table 8. Homogeneity Test

Tests of Homogeneity of Variances					
		Levene Statistic	***df1***	***df2***	***Sig***
Student Learning Outcomes	Based on Mean	0.088	3	116	0,967
	Based on Median	0.161	3	116	0,922
	Based on Median and with adjusted df	0,161	3	111,614	0,922
	Based on trimmed mean	0,097	3	116	0,961

Based on the Test of Homogeneity of Variance Table, it is known that the Significance (Sig.) Based on Mean is 0.961> 0.05, so it can be concluded that the variance of the experimental class Post Test data and the control class Post Test is the same or homogeneous. Thus, one of the conditions (absolute) of the independent sample t-test.

3. Independent Sample T-Test.

The independent sample t-test is an effective analytical tool for comparing two groups of unpaired data.

Table 9. Independent Sampel T-Test

Data	T	df	Sig. (2 tailed	Differen ces	Std Difference. Error
Student Learning Outcomes	-36,07	59	<0.01	-43.837	8.919

Based on the data in the table above, the significance value (sig 2-tailed) is 0.01, which is smaller than 0.05 (sig 0.01 < 0.05), so H_0 is rejected and H_1 is accepted. This indicates a significant difference between the average learning outcomes of the control class and the experimental class. However, to understand the impact of this difference, further analysis of the effect size is needed. If the effect size is large, then the use of map media can be considered to have a strong influence in improving students' spatial thinking skills in the real world.

4. N-Gain Score

a. N-Gain of Learning Outcomes

The spatial thinking ability of experimental and control class students can be seen in Table 10.

Table 10. N-Gain of Students' Spatial Thinking Improvement

No	Class Experiment		Class Control	
1	Number of Students	30	Number of Students	30
2	Average	0,76	Average	0,55
3	Minimum	0, 46	Minimum	0, 20
4	Maxsimum	0,94	Maxsimum	0,83

Based on the N-Gain results, there is an increase in students' spatial thinking between the experimental class and the control class, namely the N-Gain score for the experimental class is 0.76, so the increase in the spatial thinking ability of experimental class students is in the high category. While for the control class, the N-Gain score of 0.55 increased students' spatial thinking ability for the control class, including the medium category.

Table 11. N-Gain Score Analysis of Effectiveness of Media Use

No	Class	Aspect	N-Gain %	Effectiveness
1	Experiment	Average	76,68	Effective
		Min	46	
		Max	94	
2	Control	Average	55,58	Less Effective
		Min	20	
		Mak	83	

Based on the results of the N-Gain calculation in Table 11. The experimental class (Map Media) achieved an average N-Gain of 76.68%, calculated from the total N-Gain scores of all students divided by the number of students, then multiplied by 100%. This falls into the effective category (N-Gain ≥ 70%), indicating that using map media significantly improved students' spatial thinking skills. The control class (using books) had an average N-Gain of 55.58%, also calculated in the same way. This score falls into the less effective category (30% ≤ N-Gain < 70%), suggesting that conventional book-based learning had a moderate impact on improving spatial thinking. This table presents the average N-Gain scores for the experimental and control classes, showing the effectiveness of map media in enhancing students' spatial thinking abilities. The experimental class demonstrated a significantly higher improvement compared to the control class, with an N-Gain categorized as "effective," while the control class's improvement remained in the "less effective" range.

b. N-Gain of Spatial Thinking

N-gain is used to see the increase in indicators of spatial thinking ability given by students in learning with media using maps.

Table 12. Average Score of Spatial Thinking Indicators

Indicator	Experiment		Control	
	Pre test	Post test	Pre test	Post test
NonSpatial	75%	100%	50%	65%
Spatial Primitiveness	34%	87,5%	25%	52,5%
Simple Spatial	10%	96%	12%	68%
Spatial Complex	17,5%	82,5%	17,5%	65%

So based on the results of the score calculation, it shows that the average score of each spatial thinking indicator of the experimental class has increased from the control class. Non-spatial indicators score experimental class 100%, control class 65%. Primitive spatial indicators score experimental class 87.5%, control class 52.5%. Simple spatial indicators score experimental class 96%, control class 68. Spatial complex indicators score experimental class 82.5%, control class 65%.

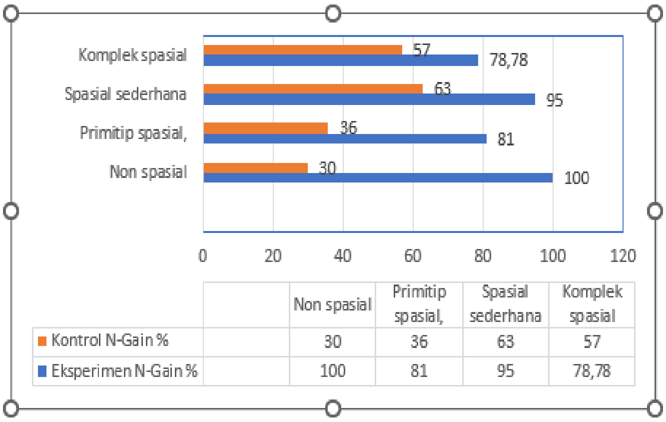

Figure 1. Average Spatial Thinking Indicator

Based on the graph above, it can be seen that in the experimental class, the highest percentage lies in non-spatial indicators with a percentage of 100%, which is included in the effective category, while in the control class, non-spatial indicators with a percentage of 30% are included in the ineffective category. Furthermore, in the experimental class, the lowest percentage lies in the spatial complex indicator with a percentage of 78%, which is included in the effective category, while in the control class, the spatial complex indicator with a percentage of 57% is included in the moderately effective category. The results of the statistical analysis indicate a significant improvement in the spatial thinking abilities of students in the experimental group compared to those in the control group. The independent sample t-test results (sig = 0.001 < 0.05) confirm that the use of map media in teaching significantly enhances students' spatial cognition. Additionally, the N-Gain score analysis categorizes the experimental group’s improvement as highly effective, with an average of 76.68% compared to the control group’s 55.58%.

DISCUSSION

The basic objective of this study is the effectiveness of using map media to improve students' spatial thinking. Researchers conducted an initial test or pretest to determine the status of students' initial abilities. Based on the data obtained and processed by researchers using the

SPSS version 30.0 program, it was revealed that the pretest data had significant differences between the experimental and control classes. The normality test using One-Sample Kolmogorov-Smirnov showed that the significance value for the experimental class was 0.223 and for the control class was 0.177. Because both values are greater than 0.05, it can be concluded that the data on student learning outcomes in the experimental and control classes are normally distributed and then the independent sample t-test is continued.

The independent sample t-test is an effective analytical tool for comparing two groups of unpaired data, where the significance value (sig 2-tailed) is 0.01. The value is smaller than 0.05 (sig $0.01 < 0.05$), so Ho is rejected and Ha is accepted, so it can be concluded that there is a significant difference between the average value of the learning outcomes of the control and experimental classes. The results showed that the spatial thinking ability of students in the experimental class, which used maps in learning, was higher than the control class that applied the conventional approach. This difference can be seen from the average score obtained by each class. It can be seen from the averages obtained by each class, these findings are also supported by previous research (Viona & Ahyuni 2024; Safitri, N. D. (2018) by using the same method. The experimental class reached an average of 76.68%, while the control class obtained 55.58%. The spatial thinking ability of students in the experimental class is included in the effective category, totaling 30 people, while the spatial thinking ability of the control class students is in the less effective category with 30 people. The results are supported by Saputro, R., (2020); Hidayah, R. (2024). One of the key benefits of utilizing map-based learning is its ability to enhance students' conceptual understanding by fostering pattern recognition and relational thinking. In scientific disciplines such as physics and chemistry, spatial visualization aids in grasping concepts like molecular structures, force vectors, and planetary motion. When students engage with thematic maps, they develop an ability to transfer spatial reasoning skills to other scientific contexts, reinforcing interdisciplinary learning. This cognitive transferability aligns with constructivist theories of learning, where students actively construct knowledge by relating new information to prior experiences (Piaget, 1952).

The control group showed an N-Gain score of 55.58%, although lower than the experimental group, it still showed an improvement in learning. This difference is due to the learning method used, the level of student engagement, or the difference in prior knowledge between the two groups. The effectiveness of the method, the level of motivation of conventional students, as well as how students process information without the help of map media, can provide a more comprehensive insight into whether conventional methods still have certain advantages in certain aspects of learning that may not be fully replaced by map media.

In terms of the average value of each question indicator in the experimental class, the highest percentage in the experimental class lies in non-spatial indicators with a percentage of 100% which is included in the effective category, while in the control class non-spatial indicators with a percentage of 30% which is included in the ineffective category. Furthermore, in the experimental class, the lowest percentage lies in the spatial complex indicator with a percentage of 78%, which is included in the effective category, while in the control class the spatial complex indicator with a percentage of 57% is included in the moderately effective category. The findings suggest that incorporating maps in teaching does not merely facilitate geography learning but also has broader implications in science education. Students' enhanced ability to analyze spatial relationships can be applied to various scientific domains, including ecology, geology, and environmental science. For instance, understanding biodiversity patterns through thematic maps provides an essential foundation for grasping concepts in conservation biology and ecosystem management. Beyond improving academic performance, the use of spatial media contributes to cognitive development by promoting active learning and engagement. Traditional text-based instruction often limits students' ability to visualize and analyze data comprehensively.

Integrating maps in science education encourages students to interpret real-world data, formulate relationships between variables and develop evidence-based conclusions. This approach is in line with Vygotsky's (1978) theory of social constructivism which emphasises that learning occurs through interaction and scaffolding. Interactive map-based learning allows students to work collaboratively, discuss findings and refine their understanding through exchanging ideas with peers. This contributes to deeper cognitive engagement than conventional methods. In addition, adding qualitative feedback from students on their experience of using the map media will provide additional insight into the level of engagement and ease of use of this method in learning.

This research is supported by Nurindah, Rayuna & Ode (2023); Junita, S. (2022), with results that reveal that the level of spatial thinking ability of students is at an effective level. This statement is based on the level of spatial thinking ability that is in the effective category. The results of this study are expected to provide an initial data description of the spatial thinking ability of phase E students in class X SMA N 1 North Kampar Riau Province because basically everyone's spatial thinking ability is different and can experience changes, either increasing or decreasing. Gumilar & Nandi (2018) stated that differences in individual abilities are caused by various factors, both academic and non-academic, such as the environment, socio-economic conditions, and genetic factors.

Teachers are expected to apply appropriate learning strategies and methods to develop and improve students' spatial thinking skills, especially in geography learning. Although the findings are relevant for teachers in Indonesia, the implications of this study are broader and can contribute to the development of science education in general. The application of map media in learning not only improves spatial understanding but also strengthens critical thinking, problem-solving and data analysis skills, which are important in various disciplines. Therefore, in the discussion it is necessary to emphasize the broader impact of using map media in education, before relating it specifically to the Indonesian context. This approach will highlight the research's contribution to global education theory and practice while providing insights for educators across different education systems. With spatial thinking skills honed through geography education, students will be better able to understand and solve various geographical problems in their environment. This study aligns with previous research findings (Gersmehl, 2007; Ramirez, 2021), which emphasize the importance of visual-spatial tools in promoting analytical thinking. The results reinforce that spatial thinking is not an isolated cognitive skill but an integral component of scientific literacy. Compared to traditional text-based learning, visual representation through maps enables students to engage with scientific concepts dynamically, fostering critical inquiry and problem-solving skills. Based on the test results that have been conducted, a t-test (Independent Sample T-Test) found a significant difference in the average spatial thinking ability of students in the experimental class who used maps in learning, with students in the control class who did not use maps.

The use of creative learning media and teaching materials will have a positive impact on increasing student knowledge, in line with the results of research conducted by Saputro, R. (2020), which also shows that the average spatial thinking ability of students who use map media is higher than students who use books. This strengthens the conclusion that map media is more effective in improving the spatial thinking ability of conventional learning students, so that the proper utilization of learning media can support the achievement of more optimal learning outcomes. The results of this study are in line with the findings of Haris, F., Mardin R., & Mahfudz, A. (2021); Hartonto, H.B. (2023); and Febrianto, Purwanto, & Irwan (2021) which show a significant difference in spatial thinking ability between students who use map media and those who learn with conventional methods. These studies stated that students who learned using maps showed a higher increase in spatial thinking compared to students who followed conventional learning. This result supports previous findings on the effectiveness of map media in improving the understanding of spatial concepts. However, to strengthen the discussion, it is necessary to conduct a more in-depth comparison with other studies in spatial learning, especially regarding the cognitive aspects and learning mechanisms that underlie the effectiveness of map media. Further analysis of factors such as learning design, student engagement, and technology integration in map media will also enrich insights into its impact in improving spatial thinking skills.

In Syahputra, E. (2013), the National Academy of Science said that many fields of science that require spatial thinking skills in the application of science include astronomy, geoscience, psychology, education, and geography. Spatial thinking affects students' understanding of science concepts, such as ecology, geosphere, or other natural phenomena. Waskito, S. N. (2022). So overall, map media can improve students' spatial thinking not only in geography but also in science. For example, showing how spatial thinking skills can support learning in physical science (e.g. understanding graphs or diagrams) or biology (e.g. in ecosystem mapping).

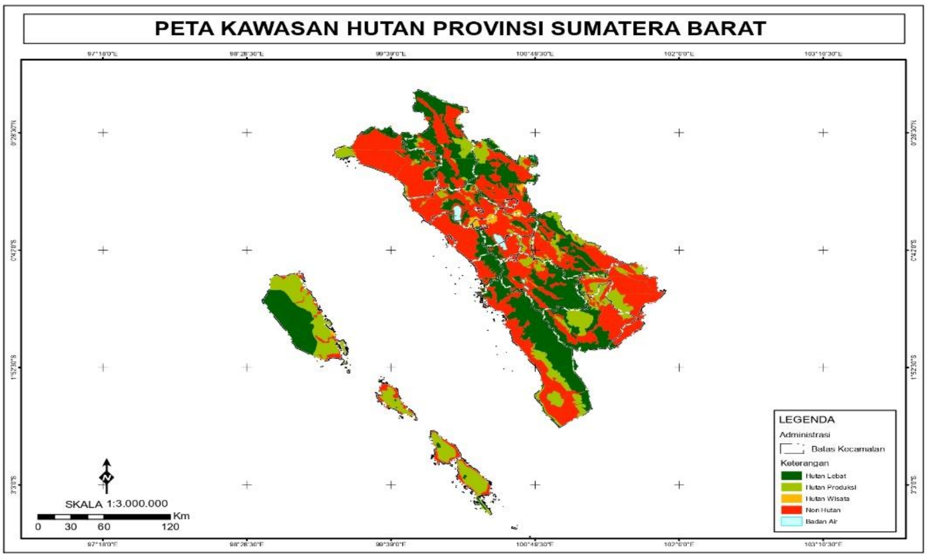

Figure 2. Map Media

Given the significant improvements observed in this study, it is recommended that educators integrate interactive map-based learning strategies into the science curriculum. Future research should explore how digital tools, such as Geographic Information Systems (GIS) and Augmented Reality (AR), can further enhance students' spatial cognition. Additionally, a longitudinal study tracking students' retention of spatial concepts over an extended period would provide deeper insights into the long-term impact of map-based learning. Overall, the study underscores the efficacy of using maps as an educational tool to improve students' spatial thinking abilities, with potential applications extending beyond geography to various fields of science education. While the results of this study highlight the effectiveness of map media in improving spatial thinking skills, there are some challenges that need to be considered. One limitation is the variability of students' prior knowledge in map reading, which may affect the effectiveness of the intervention. In addition, this study only measured short-term improvements in spatial thinking, without assessing whether these skills can be sustained in the long term. Therefore, a follow-up study that evaluates the retention of spatial thinking skills over a longer period of time would be beneficial, in order to understand the sustainable impact of using map media in learning. Additionally, access to high-quality digital mapping tools and teacher training in utilizing spatial technologies remain obstacles to widespread implementation. Future research could explore how different types of map media, such as interactive digital maps or virtual reality-based mapping, affect spatial learning in other subjects beyond geography. In addition, further research also needs to investigate solutions that can be widely implemented, such as the development of training programs for teachers to integrate digital mapping applications in science learning in the classroom.

CONCLUSION

1. This study successfully demonstrated that map media significantly improved students' spatial thinking skills, as hypothesized. With an average N-Gain of 76.68% for the experimental class compared to 55.58% for the control class, these results demonstrate the effectiveness of map media in improving spatial thinking skills.
   The results of this study confirm that maps can be used as an effective learning media in improving students' learning outcomes and spatial thinking skills. Therefore, educators are encouraged to integrate map media in geography learning to increase student engagement and reduce boredom compared to lecture or book-based methods.
   Although this study demonstrates the effectiveness of map media, some limitations must be acknowledged. Variations in students' prior map reading skills may affect the results. In addition, this study only measured short-term improvement without assessing long-term retention of spatial thinking skills. Therefore, future research could investigate the long-term effects of using map media in learning. Comparing map media with other technologies, such as interactive digital mapping or virtual reality. Develop teacher training to optimize the use of map media in learning. The research objectives have been achieved, and the results of this study are useful for future research.
2. Non-spatial indicators with a percentage of 100% are included in the effective category, while in the control class non-spatial indicators with a percentage of 30% are included in the ineffective category. Furthermore, in the experimental class, the lowest percentage lies in the spatial complex indicator with a percentage of 78%, which is included in the effective category, while in the control class, the spatial complex indicator with a percentage of 57%, which is included in the moderately effective category.
3. This shows that map media can be used as one of the learning media in the process of learning activities at school to improve learning outcomes, improve students' spatial thinking skills, and also be able to reduce student boredom if only using the book/lecture method. The findings suggest that educators should integrate interactive maps in geography learning to encourage students' analytical and spatial thinking skills.

SUGGESTION

This study provides preliminary evidence regarding the effectiveness of using map media in improving students' spatial thinking skills on biosphere material at SMAN 1 North Kampar. However, this study has several limitations, including a relatively small sample size and a focus on only one school. Therefore, further research is needed to confirm these findings and understand the factors that influence the effectiveness of map media in geography learning. Future research can be conducted by:

1. Investigate the effectiveness of map media on a wider sample, for example by involving at least 500 students from various schools in urban and rural areas to obtain more generalizable results.

2. Comparison with other learning methods, Comparing the effectiveness of map media with other technologies such as virtual reality (VR) or augmented reality (AR) in improving the understanding of spatial concepts.
3. Development of more innovative map media. Examine the use of technologies such as interactive GIS maps, 3D map models, or integration of real-time satellite imagery to enhance students' learning experience.
4. Qualitative analysis of students' and teachers' experiences Dig deeper into how students' initial map reading skills affect the effectiveness of map-based learning, and understand the challenges and opportunities teachers face in integrating map-based learning into the curriculum.

With further research that is more comprehensive, it is hoped that we can gain deeper insights into the role of map media in geography learning as well as optimal strategies for developing students' spatial thinking skills.

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