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The Effect of Gersmehl's Spatial Learning on Students' Disaster Spatial Literacy

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Abstract: Learning geography in Indonesia philosophically aims to develop spatial literacy. Students must improve spatial literacy to form reasoning skills and apply spatial concepts in real life. Applying Gersmehl's spatial learning can improve students' spatial literacy through syntax arranged based on spatial aspects. The use of google earth helps students to complete case studies of disaster mitigation materials without the need to go directly to the field. This quasi-experimental research refers to the posttest-only control group design by comparing the posttest of spatial literacy in the experimental and control classes. This study involved students of class XI IPS SMAN 1 Blitar City. The instrument is a five-point description test based on indicators of spatial literacy in disaster mitigation materials standardized with validity and reliability tests. The research data were analyzed using normality, homogeneity, and hypothesis tests. The data tested were in the form of posttest scores for spatial literacy in the experimental and control classes. The results of Gersmehl's spatial learning influence spatial literacy. The use of LKPD bridges the implementation of spatial learning syntax with Google Earth as a geospatial medium. The implementation of syntax in spatial learning is interrelated with spatial literacy indicators, thereby increasing students' spatial literacy based on experience and spatial recognition.

Keywords: *Disaster, gersmehl spatial learning, spatial literacy.*

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Introduction

The 2020 World Risk Report shows that Indonesia is ranked 40th with a World Risk Index of 10.39, including a high-risk level for disasters (Behlert et al., 2020). Therefore, Indonesia must build resilience and respond to disaster risks to minimize the resulting impacts. The importance of disaster education is studied in the Hyogo Framework 2005-2015 as one of the strategic steps in disaster mitigation. The Sendai Frame Work also emphasizes the importance of increasing public education and awareness of disaster risk in its efforts to reduce it (Oktari et al., 2018; Sakurai et al., 2018; Shiwaku & Shaw, 2016). The Indonesian government's efforts to follow up the disaster risk reduction framework included the integration of the disaster education curriculum into geography learning in schools (Kamil et al., 2019; Marlyono & Urfan, 2019; Ridha et al., 2021).

Learning geography in Indonesia philosophically emphasizes studying the spatial geosphere phenomenon (Yani, 2016) to develop spatial literacy that allows students to understand the environment, its influence on human activities, and how humans affect the environment (BSNP, 2020; Skarstein & Wolff, 2020). Integrating spatial literacy in disaster education is useful for developing knowledge of disaster preparedness based on a spatial perspective because the knowledge learned affects student responses pre-during and post-disaster (Ridha et al., 2021; Shoji et al., 2020). Spatial literacy is closely related to geography, but it is rarely defined explicitly but is discussed regarding spatial abilities and spatial thinking. (Jarvis, 2011; McAuliffe, 2013).

Spatial literacy is described by de Lange (2003, as cited in Moore-Russo et al., 2013) as an individual's perception and understanding of objects and spatial relationships. The definition that is often used as a reference proposed by Goodchild (2006, as cited in Bednarz & Kemp, 2011) is that spatial literacy is the ability of individuals to capture and communicate knowledge in the form of maps, understand and recognize the world as seen from above (images), recognize, and interpret patterns. The basis of spatial literacy is the ability to reason and apply spatial concepts (Grossner & Janelle,

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2014). This is reinforced by the National Research Council (2006), which states that spatial literacy is the core of spatial thinking and includes components of spatial habits of mind, spatial concepts and thinking skills, and critical spatial thinking (Minsung, 2011).

The experts' perception in the previous description shows that it is important for students to improve spatial literacy in the learning process. This is because spatial literacy can shape students' ability to reason and apply spatial concepts in real life (Grossner & Janelle, 2014). Also, with a solid foundation in spatial literacy, students will be better prepared to consider scientific questions and social aspects of the 21st century (Bednarz et al., 2013; Tsou & Yanow, 2010). However, the facts show that many students need help understanding how spatial concepts should be integrated into learning. This happens due to various factors, such as learning models and learning products that lack training and provide experience for students in applying spatial thinking processes (Maharani & Maryani, 2015).

One of the lessons that prioritize spatial aspects in each syntax is Gersmehl's spatial learning (Anthamatten, 2010; Gersmehl & Gersmehl, 2011). Gersmehl and Gersmehl developed this learning based on its relevance to the spatial thinking component so that it gave rise to a syntax that describe the location (Expressing Location), conditions at the location (Describing Condition in Location), and trace connections with other locations (Tracing Connection with Other). Location) (Gersmehl, 2014). At the stage of describing the location, it is necessary to use a representation tool to visualize the field of study—one of them using google earth.

Google Earth is a free web-based geospatial platform and download application that allows students to observe the conditions and changes in the study location through various scales (Hsu et al., 2017; Jarvis et al., 2017; Xiang & Liu, 2017). Google Earth includes altitude information on the entire surface so that the data obtained is more accurate about the study location points (De Paor et al., 2017; Osaci-Costache et al., 2015). The use of google earth can support Gersmehl's spatial learning so that students obtain a spatial-visual picture of the study location without making direct observations.

Research using Gersmehl spatial learning still needs to be widely found, especially in geography learning in Indonesia. This is evidenced by the limited number of journals that can be used as references for the influence of Gersmehl's learning. Research on the Gersmehl model was carried out by Winata (2018) with the title The Effect of the Gersmehl Spatial Learning Model on the Geography Skills of Class X Students of SMAN 01 Jogorampi Banyuwangi. In addition, research on spatial literacy was conducted by Minsung (2011) with the title Effects of a Gis Course on Three Components of Spatial Literacy. The novelty of this research is by testing the effect of Gersmehl's spatial learning with the help of google earth, which is applied to disaster material on spatial literacy adapted to the conditions (Maharani & Maryani, 2015) during the pandemic, and requires real-life-based learning in accordance with 21st century learning. This research focused on measuring the cognitive domain and ignoring the psychomotor domain, given the limitations in the learning process. In practice, the research method was carried out by preparing online and offline learning to adjust policies that apply in schools by considering the sustainability of further research. Researchers hope that through this research, they can contribute to the selection of spatial learning in geography subjects in a class by making adjustments based on the surrounding environmental conditions.

Literature Review

Spatial Literacy

Spatial literacy is closely related to spatial thinking skills, as agreed by the National Research Council (2006) that spatial literacy is a condition that is achieved through the practice of thinking spatially (Grossner & Janelle, 2014; Jarvis, 2011). The individual's ability to capture and communicate knowledge through maps, understand and recognize the environment through the use of images, and be able to interpret patterns is the definition of spatial literacy based on Goodchild (2006, as cited in Bednarz & Kemp, 2011; Clagett, 2009). (Berse et al., 2011) Through spatial literacy, learning will form a unity between skills, application, and problem solving so that the learning process carried out is more meaningful (Maharani & Maryani, 2015). Spatial literacy is related to cognitive processes (Moore-Russo et al., 2013) that are learned and honed continuously, so that each individual has a different application in dealing with a situation (Minsung, 2011).

Spatial literacy in this study is obtained through a description test concerning indicators. Spatial literacy indicators include three components (Minsung, 2011), Namely (1) thinking habits that emphasize spatial perspectives/spatial habits of mind, with indicators covering spatially describing space and using spatial technology. Spatial Gersmehl's learning is implemented using spatial technology such as Google Earth in location identification. Its application emphasizes how students understand a location using manual and digital maps. (2) The concept and ability to think spatially / spatial concepts and thinking skills, with indicators covering spatial distribution and spatial thinking. Knowledge of spatial concepts is the key to spatial literacy, but if not accompanied by the ability to think spatially, spatial concepts cannot be applied in the right context. In this component, students conduct an analysis based on understanding the map of the previous indicators. The last is (3) the process of critical and in-depth thinking about spatial problems / critical spatial thinking, with critical spatial thinking indicators. Through this critical spatial thinking component, students process the data obtained by evaluating it to find solutions and solutions from the study of problems. Individuals who master spatial literacy can certainly have the skills to recognize the right application in solving a problem.

Gersmehl Spatial Learning Assisted by Google Earth

Gersmehl learning is a learning stage that trains students to think spatially to conduct a phenomenon study (Gersmehl, 2014). The review of Gersmehl's spatial learning is based on eight modes of spatial thinking (Gersmehl & Gersmehl, 2011; National Research Council, 2006), which were further simplified into three stages of Gersmehl's spatial learning. The syntax consists of 1) expressing location (expressing location) with the key question "where" as a fundamental question in geography, (2) describing conditions at the location (describing conditions in location) with the key question "what is it like there" and (3) tracing connections with other locations (tracing connections with other locations) with the key question "how is that place connected to other places". The three stages above are related to each other so there needs to be a gradual reasoning process in building knowledge. In addition, indicators of spatial literacy are related to Gersmehl's learning syntax, which leads to the process of reasoning from a spatial point of view.

Each learning model has its advantages and disadvantages. The advantages of Gersmehl spatial learning are: (1) Gersmehl learning focuses on spatial-based learning so that it is in line with the objectives of learning Indonesian geography (Yani, 2016), (2) very simple stages with three learning stages, (3) simple stages that are easy to understand and to be applied to all geography materials, (4) students are trained to obtain, sort, and evaluate spatial data, (5) students can learn to use representation tools to provide an overview of study locations, (6) simple stages allow learning activities to be carried out online and offline, (7) students can develop spatial literacy skills. The disadvantages of this learning model are (1) the learning process that requires spatial data requires students to be able to use media or tools that accommodate searches so that the available technology or facilities are considered in the use of this model.

In practice, the application of spatial models cannot be separated from the use of auxiliary media to provide a visual description of the study location. According to Gersmehl (2014), good geography learning should emphasize more than memorizing spatial facts but linking facts to space to build an understanding of the occurring phenomena. To support this research, Google Earth is used as a representation tool that helps students investigate. Using Google Earth is considered effective given the current condition of students not being able to make direct observations at the study site due to the pandemic. The use of google earth is integrated into the learning model and adapted to Gersmehl's spatial learning steps using a student activity sheet, which bridges the two. Google earth strengthens students' spatial abilities through the use of 3D visualization and connecting with prior knowledge (Blank et al., 2016; Hsu et al., 2017; Malarvizhi et al., 2016).

Linking Gersmehl's Spatial Learning Assisted by Google Earth with Disaster Spatial Literacy

In practice, the application of spatial models cannot be separated from the use of auxiliary media Gersmehl's spatial learning is structured based on geography lesson rules, namely thinking and reasoning based on spatial conditions or spatial perspective (Gersmehl, 2014). This research is synchronized with geography material in KD 3.7 regarding disaster mitigation. In line with self-control in disaster mitigation, the main step taken is to recognize the environmental conditions. It is important to improve students' spatial literacy by applying Gersmehl's spatial learning model adapted to the spatial literacy component. On the other hand, some disasters cannot be predicted at any time, so it requires effort to prepare students to deal with emergencies. Therefore, students need to understand their environmental conditions by using Google Earth. One of the components of spatial learning is the use of representation tools that can be implemented with the help of Google Earth to make it easier for students to get a spatial-visual picture of the condition of the study location by remote observation.

Methodology

Research Design

This study uses a quantitative approach to the type of quasi-experimental research. The implementation involved two classes, namely an experimental class using Gersmehl spatial learning assisted by Google Earth, which encouraged students to be more active through discussion activities. In addition, the experimental class worked on an activity guide sheet that integrated geospatial technology in the form of Google Earth to improve students' spatial literacy in analyzing phenomena at the study site. At the same time, the control class uses conventional learning methods or methods that are often applied in schools. In the control class, the activity guide sheets were not integrated using geospatial technology media. The data collection instrument was a descriptive test based on spatial literacy indicators, with a posttest-only control group design where the posttest results of the experimental and control classes were compared to determine the effectiveness of the treatment in the experimental class. In this study, the teacher acts as a facilitator and provides directions and observations to students about the effectiveness of Gersmehl's spatial learning.

The instrument must be valid and reliable to measure spatial literacy. The implementation of Gersmehl's spatial learning is integrated into student activity guide sheets arranged based on learning syntax. After Gersmehl's spatial learning treatment was applied to the experimental class, a spatial literacy posttest was carried out for the experimental and control classes using the same questions. Posttest values were then analyzed through normality tests and homogeneity tests to process whether the data was representative for use in hypothesis testing. After testing the hypothesis, if significant data differences are found between the experimental and control classes, Gersmehl's spatial learning model is suspected to affect spatial literacy.

Sample and Data Collection

There are no specifications regarding the experimental and control classes' characteristics. The selection of the experimental and control classes assumes that the two classes have the same geography material that has been studied. Furthermore, using the purposive sampling technique, non-probability sampling was used to determine the sample. Thus, obtained class XI IPS 1, with a total of 35 students, as an experimental class with details of students consisting of 16 boys and 19 girls, and class XI IPS 2, with a total of 34 students, as a control class with details of students consisting of 14 boys and 20 girls.

The data collection technique used was an essay test. This test indicator refers to Minsung's research (2011), which was later developed by the research team. The preparation of this test is adjusted to the conditions in the class and adjusted to the level of education studied. The test was applied after Gersmehl's spatial learning was carried out in the experimental class or as a posttest. The contents of this test are in the form of 5 questions; details of the questions are listed at the end of this paper. This research is focused on measuring the cognitive domain in the form of spatial literacy related to disaster material, bearing in mind that most of Indonesia's territory is a disaster-prone area. The research location, Blitar Raya, is vulnerable to the Kelud Volcano eruption. The essay test measured students' spatial literacy variables in the control and experimental classes.

Before the questions are used, it is necessary to test the validity and reliability of the items. The validity test showed that the R count results are greater than the R tables (0.05). The calculated R-value (Pearson correlation) shows that the five items are significantly valid as a measuring tool. Whereas in the reliability test, the results of Cronbach's alpha test were 0.596, which showed that the items were consistent for measuring students' spatial literacy within a certain time bracket so that the items could be relied upon as a measuring tool when conducting the posttest. The following were the indicators in this study's spatial literacy test.

Table 1. Spatial Literacy Test Question Indicators

No	Spatial Literacy Indicators	Sub Indicator
1	Spatial Habits of Mind	Describing space
		Use of spatial aids
2	Spatial Concept and Thinking Skill	Spatial concept - distribution
		Spatial thinking
3	Spatial Critical Thinking	Critical spatial thinking

Source: Minsung (2011)

Sub-indicator describing the space is reflected in question number 1. Sub-indicators of the use of spatial tools are reflected in questions number 2, 3, 4, and 5 as tools for conducting analysis. Sub-indicator spatial concept - spatial distribution and thinking is reflected in questions number 2 and 4. Sub-indicators of critical spatial thinking are reflected in questions number 3 and 5.

Analyzing of Data

Spatial literacy research instruments, before use, need to be tested for validity to find out whether the questions are valid and reliable to check the instrument's consistency as a measuring tool. If the questions are valid and reliable, the instrument can be used to measure the spatial literacy of the experimental and control classes. In the assessment of the spatial literacy test, assessment references are prepared, and scoring is based on the suitability of student answers with the references that have been prepared. The research team carried out this study's qualitative and quantitative analysis. Before testing the hypothesis on the results of the spatial literacy test, it is necessary to go through a prerequisite test in the form of a normality test and a homogeneity test. The normality test for spatial literacy results uses the Kolmogorov-Smirnov test with the help of SPSS 25.00 for windows. The normality test is required as a condition for conducting the t-test. Data on spatial literacy test scores are normally distributed if the value is significant or the probability is 0.05. If there is data that is not normally distributed or not representative, it will be deleted to get a normal distribution. If the data is normally distributed, the homogeneity test is continued using the Levene Test for Equality of Variances assisted by IBM SPSS Statistics 25. The data is declared homogeneous if the significance or probability value is 0.05. A hypothesis test was carried out after the data distribution was declared normal and homogeneous to ensure that Gersmehl's spatial learning, assisted by Google Earth, affected spatial literacy. The hypothesis is obtained through an independent t-test with SPSS 25.00 for windows. The t-test was conducted to compare whether the results of the experimental and control class spatial literacy tests had significant differences. If the significant value is 0.05, then Gersmehl's spatial learning affects students' spatial literacy. The hypotheses tested in this study include the following:

H_i : Gersmehl's Spatial Learning Affects Students' Spatial Literacy

H_0 : Gersmehl's Spatial Learning Has No Effect on Students' Spatial Literacy

Findings / Results

Spatial Literacy Data (Posttest)

The posttest in this study is the value obtained from the spatial literacy test after being given special treatment in the form of Gersmehl spatial learning in the experimental class and compared with the value of the control class spatial literacy test, which was not previously given a special treatment. The following table 2 is the distribution of the frequency and percentage of spatial literacy posttest scores.

Table 2. Distribution of Frequency and Percentage of Spatial Literacy Posttest Values

Interval Value	Qualification	Experimental Class		Control Class	
		f	%	f	%
80-100	Very good	11	32%	7	21%
60-79	Well	17	50%	8	24%
40-59	Enough	6	18%	13	38%
20-39	Not good	0	0%	6	18%
0-19	Very not good	0	0%	0	0%

Based on students' spatial literacy data, the experimental class has a higher spatial literacy value when compared to the control class. This is a benchmark for the influence of Gersmeh spatial learning assisted by Google Earth on disaster materials.

Hyphotesis Test

Hypothesis testing was proven through the parametric test, namely the independent sample t-test. The criteria used were equal variances assumed because the data used in the hypothesis test has the same variance based on the results of the homogeneity test. The data tested was the posttest value of spatial literacy. The following table 3 shows the results obtained from the t-test.

Table 3. Hypotheses Test Results

Posttest Literasi Spasial	Levene's test for equality of variances		T-test for equality of means				
	F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	0.987	0.324	3.097	67	0.003	11.830	3.821
Equal variances not assumed			3.091	65.498	0.003	11.830	3.821

Based on the criteria, the value of sig (2-tailed) is 0.003, indicating that sig's value is <0.05, so H_0 is rejected. Thus, the study's results prove that "Gersmehl's spatial learning affects students' spatial literacy". A value of 0.003 can be interpreted that learning in the new normal era with various limitations can run effectively and efficiently when accompanied by the selection of learning models and media that can be applied flexibly, considering that pandemic learning is carried out online and offline as well as improving students' spatial literacy. The mean difference in this study shows the mean difference in the experimental class (group 1), and the control class (group 2) in the test carried out as a result of 11.830. these results indicate that the experimental class has a higher score than the control class. Based on the results of Cohen's d calculations, a value of 0.49 is obtained or has a moderate effect. The effect given by the Gersmehl learning treatment did not have a significant impact.

Gersmehl's spatial learning with the help of google earth is poured in the form of a simple case study project in groups. It is compiled based on real-life experiences adapted to the rules of thinking and reasoning based on spatial conditions. So that students focus on something other than memorizing concepts but on how to apply them to case studies through spatial analysis. The use of google earth in this model aims to provide a visual-spatial picture to students regarding the condition of the study location by remote observation.

Discussion

Based on the hypothesis test, it shows that there is an influence of Gersmehl's spatial learning when assisted by Google Earth on the disaster spatial literacy of students at SMAN 1 Kota Blitar. Even though the implementation of learning has limitations, that is not an excuse for not being able to improve students' spatial literacy by adjusting the learning model and using learning aids.

The average posttest score between the experimental and control classes has differences due to the dissimilarity of treatment in the implementation of learning. In the experimental class, Gersmehl's spatial learning was implemented with the help of Google Earth, which encouraged students to be more active through discussion activities, work on worksheets integrated with geospatial technology in the form of Google Earth to increase students' spatial literacy in analyzing phenomena at study sites (Hsu et al., 2017; Jarvis et al. al., 2017; Xiang & Liu, 2017). Through spatial learning assisted by Google Earth, students were trained to reason and think based on spatial conditions or the spatial perspective of the study location, which can be seen through high-resolution image visualization that can display study locations both in 2D and 3D online on Google Earth.

The control class did not apply Gersmehl's learning, which was carried out using a learning model often applied in schools. In the control class, learning was dominated by the teacher in providing material. At the same time, assignments in the form of worksheets were not integrated with the use of geospatial technology media in the form of google earth. This resulted in a lack of training for students to study phenomena based on the real conditions of a location.

The relationship between the syntax of Gersmehl's spatial learning assisted by Google Earth and the indicators of spatial literacy will be described in the following explanation. Before carrying out Gersmehl's spatial learning, students were given an overview and directions regarding the activities to be carried out and what needs to be prepared. The implementation of Gersmehl's spatial learning, which consists of three syntaxes, was divided into two meetings to adjust to the time allocation in the form of one meeting of 2 hours of lessons with a duration of 30 minutes for each JP. Students are directed first to form groups with two student members and are given introductory material and a student activity sheet with disaster material adapted to Gersmehl's spatial syntax and to become a liaison with the use of google earth as a spatial visualization tool to make work easier if it needs to be completed outside the classroom due to time constraints.

The first syntax was to describe the location (expressing location). The key question in Gersmehl's spatial learning is "where", so students are directed to find the location of a phenomenon. At this stage, students gather with groups that were previously formed. Students were given the news about flood disaster events in the district and city of Blitar to determine which locations experienced these events during 2021. After students get information about locations affected by floods, students were directed to open google earth and search for these locations to know and mark the absolute location (coordinate) affected by the flood.

This syntax follows its advantages. Namely, students can learn to use geospatial tools such as Google Earth to provide a visual image as a representation in conducting study locations without the need to come to the location in person (Hsu et al., 2017; Jarvis et al., 2017; Xiang & Liu, 2017). Using google earth in spatial-based learning strengthens students' spatial abilities using visualization and connecting with the knowledge that has been learned. This first syntax was in line with the spatial literacy indicator using spatial aids in the form of Google Earth to determine the location of the study. This first syntax becomes fundamental in spatial learning by familiarizing students with thinking from a spatial perspective. The thing that is found in schools is that students are still unfamiliar with the features available on Google Earth, so there is a need for more detailed instructions regarding their use before taking the next steps.

The second syntax describes the condition of the location (describing conditions in location). In this syntax, the key question is "what is it like there" so students are directed to do a condition analysis using Google Earth imagery. Students are directed to observe the conditions of each location, which previously mentioned which locations were affected by flooding via Google Earth. Conditions that need to be observed by students include average height, settlement conditions (density level), land use other than settlements, most of the vegetation observed through imagery (rice fields, forests, plantations), the distance of settlements to rivers (can be measured using ruler tools in the application google earth). Google Earth imagery has a high resolution with a varied base map that can be observed in 2D and 3D (De Paor et al., 2017), thus providing a real picture of the study location, namely the flood-affected area in Blitar Raya by zooming in.

This second syntax is in line with spatial literacy indicators, namely describing locations based on a spatial perspective using spatial vocabulary. In the syntax for describing site conditions, students are trained to compile explanations regarding the flood conditions in several areas in Blitar Regency. Students have started to use spatial vocabulary to describe the location. The selection of spatially related vocabulary aims to determine the level of a student's ability to analyze a spatial problem.

The third syntax is tracing connections with other locations. In this syntax, the key question is "how is the relationship between these locations and other locations" so that students are directed to associate the conditions of one location of floods. In addition to making connections, students are directed to conclude which locations with the highest flood levels are located based on the data and observations that have been collected. Students are also directed to provide solutions to reduce the impact of flooding in Blitar Raya.

The third syntax is in line with the spatial literacy indicators in the form of thinking spatially and spatially critically. Knowledge of spatial concepts is a prerequisite for someone to have good spatial literacy in himself. However, if it is not accompanied by the ability to think critically spatially, students cannot apply spatial concepts in conducting case studies appropriately. In addition, with this third syntax, students are trained to solve problems with spatial skills by emphasizing critical and in-depth thinking processes in the case studies at hand.

Syntax two and three follow the advantages of spatial learning. Namely, students can learn to obtain, sort, and evaluate spatial data that can be used to analyze a problem and generate a solution based on the conditions of the location. Results that were found at school, the majority of groups did well in their analysis, but some groups copied and pasted assignments from other groups, and this could affect the formation of students' spatial mindset.

Through Gershmel's spatial learning, students are trained to fulfill spatial literacy indicators. This can be seen from the students' results in working on the LKPD, which provides an overview of how the Gersmehl spatial learning syntax works to help students carry out spatial investigations with the help of Google Earth images. Besides that, based on the results of the spatial literacy test after learning shows that there is a difference, namely the experimental class has a higher posttest score than the control with a moderate difference. The existence of time limitations in conducting research and the lack of researchers to conduct in-depth research affects the results of comparisons that do not show any significance between the experimental and control classes.

Conclusion

Based on the results of the study, it was found that Gersmehl's spatial learning influences students' spatial literacy by showing a comparison of posttest scores, where the experimental class was superior. These differences are influenced by using a student activity sheet in bridging the implementation of spatial learning syntax with Google Earth as a medium to provide an indirect description of the location of the Blitar Raya flood study. The implementation of syntax in learning is also interrelated with spatial literacy indicators. It is hoped that through the application of spatial learning, students can develop the ability to understand the environment, the influence of the environment on human activities, and human activities on the environment so that spatial literacy is formed based on experience and spatial recognition.

Recommendations

Future research is expected to conduct an in-depth analysis of the variables that affect students' spatial literacy using various research methods, including quantitative and qualitative classroom action research (CAR). Spatial learning research with disaster materials needs to be developed, considering that Indonesian people must always be aware of disaster conditions. The development of research instrument questions into other forms of questions and research that conducts comparative tests on several learning models is needed to improve spatial literacy.

Limitation

The study results are more varied when using a sample of students from several schools. One limitation of this study is that the need for a broad research sample resulted in limited research results for students from one test school. The data analysis of this study was based on student's answers to the description questions without intervention from the teacher. However, students will only know their learning outcomes if intervention is carried out. The form of description test questions that ask for broad answers can be developed into multiple-choice questions to produce consistent assessment guidelines. Students' answers were immediately corrected after the research activities were carried out in their respective schools. Thus, there may be inconsistencies in the assessment of students' answers at different times.

Authorship Contribution Statement

Purwanto: Design, conceptualization, deep analysis, writing and reviewing. Hidayah: Data acquisition, conceptualization, analysis and interpretation of data, writing, edition, and final approval, Translation. Wagistina: Conceptualization, design, analysis, writing.

References

Anthamatten, P. (2010). Spatial thinking concepts in early grade-level geography standards. *Journal of Geography*, *109*(5), 169–180. https://doi.org/10.1080/00221341.2010.498898

Badan Standar Nasional Pendidikan. (2020). Fokus pembelajaran SD/MI - SMP/MTs - SMA/MA [Learning focus SD/MI - SMP/MTs - SMA/MA] (1st ed.). Badan Standar Nasional Pendidikan.

Bednarz, S. W., Heffron, S., & Hyunh, N. T. (Eds.). (2013). *A road map for 21st century geography education: Geography education research*. Association of American Geographers https://bit.ly/3n2lZug

Bednarz, S. W., & Kemp, K. (2011). Understanding and nurturing spatial literacy. *Procedia - Social and Behavioral Sciences*, *21*, 18–23. https://doi.org/10.1016/j.sbspro.2011.07.004

Behlert, B., Diekjobst, R., Felgentreff, D. C., Manandhar, T., Mucke, P., Pries, P. D. L., Radtke, D. K., & Weller, D. (2020, September 15). *World Risk Report 2020-Focus: Forced displacement and migration*. Relief Web. https://bit.ly/42bQ7DE

Berse, K. B., Bendimerad, F., & Asami, Y. (2011). Beyond geo-spatial technologies: Promoting spatial thinking through local disaster risk management planning. *Procedia - Social and Behavioral Sciences*, *21*, 73–82. https://doi.org/10.1016/j.sbspro.2011.07.037

Blank, L. M., Almquist, H., Estrada, J., & Crews, J. (2016). Factors affecting student success with a google earth-based earth science curriculum. *Journal of Science Education and Technology*, *25*, 77–90. https://doi.org/10.1007/s10956-015-

9578-0

Clagett, K. E. (2009). *Virtual globes as a platform for developing spatial literacy* [Doctoral dissertation, NOVA Information Management School]. Repositório Universidade Nova. https://run.unl.pt/handle/10362/2317

De Paor, D. G., Dordevic, M. M., Karabinos, P., Burgin, S., Coba, F., & Whitmeyer, S. J. (2017). Exploring the reasons for the seasons using google earth, 3d models, and plots. *International Journal of Digital Earth*, *10*(6), 582–603. https://doi.org/10.1080/17538947.2016.1239770

Gersmehl, P. (2014). *Teaching geography* (3rd ed.). Guilford Publication www.guilford.com/p/gersmehl

Gersmehl, P. J., & Gersmehl, C. A. (2011). Spatial thinking: Where pedagogy meets neuroscience. *Problems of Education in the 21th Century*, *27*, 48–66. https://bit.ly/3nef80U

Grossner, K., & Janelle, D. G. (2014). Concept and principles for spatial literacy. In D. R. Montello, K. E. Grossner, & D. G. Janelle (Eds.), *Space in mind: Concept for spatial learning and education* (pp. 239-262). MIT Press. https://doi.org/10.7551/mitpress/9811.003.0013

Hsu, H. P., Tsai, B. W., & Chen, C. M. (2017). Teaching topographic map skills and geomorphology concepts with Google earth in a one-computer classroom. *Journal of Geography*, *117*(1), 29–39. https://doi.org/10.1080/00221341.2017.1346138

Jarvis, C. H. (2011). Spatial literacy and the postgraduate GIS curriculum. *Procedia - Social and Behavioral Sciences*, *21*, 294–299. https://doi.org/10.1016/j.sbspro.2011.07.022

Jarvis, C. H., Kraftl, P., & Dickie, J. (2017). (Re)connecting spatial literacy with children's geographies: GPS, google earth and children's everyday lives. *Geoforum*, *81*, 22–31. https://doi.org/10.1016/j.geoforum.2017.02.006

Kamil, P. A., Utaya, S., Sumarmi, & Utomo, D. H. (2019). Improving disaster knowledge within high school students through geographic literacy. *International Journal of Disaster Risk Reduction*, *43*, Article 101411. https://doi.org/10.1016/j.ijdrr.2019.101411

Maharani, W., & Maryani, E. (2015). Peningkatan spatial literacy peserta didik melalui pemanfaatan media peta [Increasing the spatial literacy of students through the use of map media]. *Jurnal Geografi Gea*, *15*, 46–54. https://doi.org/10.17509/gea.v15i1.4184

Malarvizhi, K., Kumar, S. V., & Porchelvan, P. (2016). Use of high-resolution Google earth satellite imagery in landuse map preparation for urban related applications. *Procedia Technology*, *24*, 1835–1842. https://doi.org/10.1016/j.protcy.2016.05.231

Marlyono, S. G., & Urfan, F. (2019). Optimalisasi kecerdasan spasial untuk meningkatkan kesiapsiagaan bencana [Optimization of spatial intelligence to improve disaster preparedness]. *Seminar Nasional Peningkatan Mutu Pendidikan*, *1*(1), 441–449. http://bit.ly/3JYOjac

McAuliffe, C. P. (2013). Geoliteracy through aerial photography: Collaborating with K-12 educators to teach the national geography standards. *Journal of Map and Geography Libraries*, *9*(3), 239–258. https://doi.org/10.1080/15420353.2013.817368

Minsung, K. (2011). *Effects of a gis course on three components of spatial literacy* [Doctoral dissertation, Texas A&M University]. OAKTrust. https://bit.ly/3yT7PP3

Moore-Russo, D., Viglietti, J. M., Chiu, M. M., & Bateman, S. M. (2013). Teachers' spatial literacy as visualization, reasoning, and communication. *Teaching and Teacher Education*, *29*(1), 97–109. https://doi.org/10.1016/j.tate.2012.08.012

National Research Council. (2006). *Learning to think spatially*. The National Academies Press. https://doi.org/10.17226/11019

Oktari, R. S., Shiwaku, K., Munadi, K., Syamsidik, & Shaw, R. (2018). Enhancing community resilience towards disaster: The contributing factors of school-community collaborative network in the tsunami affected area in Aceh. *International Journal of Disaster Risk Reduction*, *29*, 3–12. https://doi.org/10.1016/j.ijdrr.2017.07.009

Osaci-Costache, G., Ilovan, O. R., Meseșan, F., & Dulamă, M. E. (2015). Google earth helping virtual learning in the geographical university education system in romania. In Albeanu, Popovici, Jugureanu, Adăscăliței, & Istrate, *Proceedings of the 10th International Conference on Virtual Learning* (pp. 114-120). Bucharest University Press. https://bit.ly/3n6b8zB

Ridha, S., Utaya, S., Bachri, S., Handoyo, B., Kamil, P. A., & Abdi, A. W. (2021). Spatial thinking and decision-making abilities to learn about disaster preparedness. *IOP Conference Series: Earth and Environmental Science*, *630*, Article 012017. https://doi.org/10.1088/1755-1315/630/1/012017

Sakurai, A., Bisri, M. B. F., Oda, T., Oktari, R. S., Murayama, Y., Nizammudin, & Affan, M. (2018). Exploring minimum essentials for sustainable school disaster preparedness: A case of elementary schools in Banda Aceh City, Indonesia. *International Journal of Disaster Risk Reduction*, *29*, 73–83. https://doi.org/10.1016/j.ijdrr.2017.08.005

Shiwaku, K., & Shaw, R. (2016). *Introduction: Disaster risk reduction and education system*. In K. Shiwaku, A. Sakurai & R. Shaw (Eds.), *Disaster resilience of education systems. disaster risk reduction* (pp. 1-10). Springer. https://doi.org/10.1007/978-4-431-55982-5_1

Shoji, M., Takafuji, Y., & Harada, T. (2020). Formal education and disaster response of children: Evidence from coastal villages in Indonesia. *Natural Hazards*, *103*(2), 2183–2205. https://doi.org/10.1007/s11069-020-04077-7

Skarstein, F., & Wolff, L. A. (2020). An issue of scale: The challenge of time, Space and multitude in sustainability and geography education. *Education Sciences*, *10*(2), 28. https://doi.org/10.3390/educsci10020028

Tsou, M. H., & Yanow, K. (2010). Enhancing general education with geographic information science and spatial literacy. *URISA Journal*, *22*(2), 45–54. https://bit.ly/3n8VLWY

Winata, E. F. (2018). Pengaruh model pembelajaran spasial gersmehl terhadap keterampilan geografi siswa kelas x SMAN 1 Jogorampi Banyuwangi [The effect of the gersmehl spatial learning model on the geography skills of class x students of SMAN 01 Jogorampi Banyuwangi] [Unpublished master's thesis]. Universitas Negeri Malang

Xiang, X., & Liu, Y. (2017). Understanding 'change' through spatial thinking using google earth in secondary geography. *Journal of Computer Assisted Learning*, *33*(1), 65–78. https://doi.org/10.1111/jcal.12166

Yani, A. (2016). Standar proses pembelajaran geografi pada kurikulum 2013 [Geography learning process standards in the 2013 curriculum]. *Jurnal Geografi GEA*, *16*(1), 1-12. https://doi.org/10.17509/gea.v16i1.3463

Appendix

Thursday, February 13, 2014, at 22:50 WIB, Mount Kelud erupted, affecting almost the entire Java Island. Several cities/regencies in East Java and its surroundings were affected by the eruption of Mount Kelud, which disrupted community activities. To find out the extent of the impact, look at the digital map via the following link (https://magma.esdm.go.id/v1), which describes several volcanoes in Indonesia. Select the map of the Mount Kelud disaster-prone area (KRB) by enlarging the map of the East Java region and clicking the Mount Kelud symbol on the digital map.

After observing the Mount Kelud Disaster Prone Area (KRB), answer the questions below.

1. Mount Kelud in 2014 had explosive eruption characteristics by releasing pyroclastic flow material and pyroclastic fallout. Based on the map presented, what dangers are posed to each disaster-prone area (KRB)?
2. Based on the disaster-prone area (KRB) map, which locations have the highest level of vulnerability to the eruption of Mount Kelud?
3. Look at the data on the population of Blitar Regency and City in 2014 below!

Tabel / Table 3.1.3 Penduduk dan Rumahtangga menurut Kelurahan / *Population and Household by Village* 2014

Kelurahan *Village*	Penduduk / *Population* Laki-laki *Male*	Perempuan *Female*	Total *Totally*	KK *Household*
(1)	(2)	(3)	(4)	(3)
010. Sukorejo	*24 881*	*24 545*	*49 426*	*14 683*
1. Tlumpu	1 838	1 811	3 649	1 096
2. Karangsari	2 650	2 596	5 246	1 586
3. Turi	1 536	1 558	3 094	932
4. Blitar	2 214	2 286	4 500	1 336
5. Sukorejo	7 107	7 006	14 113	4 264
6. Pakunden	5 200	5 081	10 281	2 991
7. Tanjungsari	4 336	4 207	8 543	2 478
020. Kepanjenkidul	*20 867*	*21 169*	*42 036*	*12 437*
1. Kepanjenkidul	3 871	4 116	7 987	2 477
2. Kepanjenlor	2 867	2 908	5 775	1 718
3. Kauman	3 114	3 206	6 320	1 782
4. Bendo	2 763	2 770	5 533	1 660
5. Tanggung	2 705	2 595	5 300	1 579
6. Sentul	3 815	3 862	7 677	2 199
7. Ngadirejo	1 732	1 712	3 444	1 022
030. Sananwetan	*26 701*	*26 948*	*53 649*	*15 814*
1. Rembang	1 454	1 531	2 985	930
2. Klampok	2 215	2 199	4 414	1 364
3. Plosokerep	2 304	2 327	4 631	1 380
4. Karangtengah	3 608	3 561	7 169	2 065
5. Sananwetan	6 713	6 860	13 573	3 994
6. Bendogerit	5 108	5 209	10 317	3 003
7. Gedog	5 299	5 261	10 560	3 078
Kota Blitar/*Blitar City*	72 449	72 662	145 111	42 934

Sumber/*Source* : Dinas Kependudukan dan Catatan Sipil/ *Office of Population and Civil Registration of Blitar City*

Tabel : / Table 3.1.9 Penduduk menurut Jenis Kelamin, Sex Rasio, dan Jenis Kelamin, 2014 / *Population by Sex, Sex Ratio, , 2014*

Kecamatan *Districts*	Penduduk/ *Population* (Jiwa) Laki-laki *Male*	Perempuan *Female*	Jumlah *Total*	Sex rasio *Sex ratio* (%)
[1]	[2]	[3]	[4]	[5]
010. Bakung	12 463	13 000	25 463	95,87
020. Wonotirto	17 856	17 696	35 552	100,90
030. Panggungrejo	20 558	20 657	41 215	99,52
040. Wates	14 083	14 058	28 141	100,18
050. Binangun	21 375	21 358	42 733	100,08
060. Sutojayan	23 550	24 120	47 670	97,64
070. Kademangan	32 454	32 506	64 960	99,84
080. Kanigoro	38 357	37 751	76 108	101,61
090. Talun	30 086	30 341	60 427	99,16
100. Selopuro	20 180	19 579	39 759	103,07
110. Kesamben	23 902	24 542	48 444	97,39
120. Selorejo	17 250	17 674	34 924	97,60
130. Doko	18 849	18 898	37 747	99,74
140. Wlingi	25 156	25 012	50 168	100,58
150. Gandusari	33 542	32 974	66 516	101,72
160. Garum	32 439	31 898	64 337	101,70
170. Nglegok	34 881	34 504	69 385	101,09
180. Sanankulon	27 623	27 619	55 242	100,01
190. Ponggok	50 768	49 535	100 303	102,49
200. Srengat	32 102	32 339	64 441	99,27
210. Wonodadi	23 331	23 413	46 744	99,65
220. Udanawu	20 498	20 016	40 514	102,41
Kabupaten Blitar *Blitar Regency*				
Tahun /*Year* 2014	571 303	569 490	1 140 793	100,32
2013	568 596	568 105	1 136 701	100.09
2012	565 689	564 734	1 130 423	100,14
2011	562 779	561 996	1 124 775	100,17
2010	559 522	559 397	1 118 919	100,09

Sumber : Proyeksi SP - BPS Kabupaten Blitar
Source : SP Projection - BPS Blitar Regency

The composition of the population in terms of number, gender, and age group living in a disaster-prone area affects the level of vulnerability of a location to disaster threats. Judging from the population, do all regions have the same level of vulnerability? Analyze the area that has the highest disaster vulnerability by linking the population with the disaster-prone area (KRB) map!

4. If you are in Blitar City and there is an eruption of Mount Kelud, as illustrated on the map. Which area will you choose as the evacuation site? Give an argument for choosing a location for an escape!

5. Because of living in an area prone to volcanic eruptions, what adaptive actions need to be applied in preparing oneself?