THE EFFECT OF PROBLEM BASED LEARNING MODEL BASED ON GEOGRAPHIC LITERATURE ON SPATIAL INTELLIGENCE OF HIGH SCHOOL STUDENTS

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ABSTRACT

The purpose of this study was to determine the effect of the Problem Based Learning model based on geographic literacy on spatial intelligence. This study includes a quasi-experimental design with a nonequivalent pretest-posttest control group design. The research subjects are students of SMAN 1 Way Jepara, X Social which will be selected for the experimental class, control class, and instrument test class. The research instrument consisted of spatial intelligence test questions in the form of a description/essay consisting of 8 questions. Data collection techniques were carried out through observation, tests, and documentation. Analysis of research data was carried out through descriptive statistical methods and parametric inferential statistics with hypothesis testing using the Independent Samples T-test (assisted by SPSS 23 for Windows). The results of this study is the Problem Based Learning model based on geographic literacy has an effect on spatial intelligence in the hydrosphere material of high school students.

Tujuan penelitian ini adalah mengetahui pengaruh model pembelajaran Problem Based Learning berbasis literasi geografi terhadap kecerdasan spasial. Penelitian ini termasuk eksperimen semu (quasi experiment) dengan desain nonequivalent pretest-posttest control group design. Subyek penelitian adalah siswa SMAN 1 Way Jepara, yakni X IPS yang akan dipilih kelas eksperimen, kelas kontrol, dan kelas uji coba instrumen. Instrumen penelitian terdiri dari soal tes kecerdasan spasial dengan bentuk uraian/essay terdiri 8 butir soal. Teknik pengumpulan data dilaksanakan melalui observasi, tes, dan dokumentasi. Analisis data penelitian dilaksanakan melalui metode statistik deskriptif dan statistik inferensial parametrik dengan uji hipotesis menggunakan Independent Samples T-test (berbantuan SPSS 23 for Windows). Hasil dari penelitian ini yaitu model pembelajaran Problem Based Learning berbasis literasi geografi berpengaruh terhadap kecerdasan spasial pada materi hidrosfer siswa SMA;

Introduction

Spatial intelligence is the ability to understand, recognize and describe a form of spatial dimension. Armstrong (2002) says that spatial intelligence includes the ability to think in drawing, changing and re-creating various aspects of the world. In line with this opinion, Gardner (2003) suggests that humans have several intelligences, one of which is spatial intelligence (space) which is defined as the visual ability to recognize and describe the shape of one's thoughts. Therefore, spatial intelligence becomes very important in one's life, so it needs to be developed and trained in the learning process (Anthamatten, 2010; Klemmer & B Neill, 2020; Lim, 2005).

Humans basically have had various kinds of intelligence since birth, including spatial intelligences. However, this intelligence needs to be directed and developed according to needs through various activities in education and learning. Geography as a subject at the high school level requires various kinds of intelligence to understand each material substance (Hegarty, 2010; Komninos, 2011; Sarno, 2012). According to the Seminar and Workshop of the Indonesian Geography Association (IGI) in Semarang in 1988, Geography is a science that studies various similarities and differences in geosphere phenomena which are examined from an environmental and regional point of view in a spatial context (Suharyono & Amien, 2013).

Based on this understanding, Geography in studying or analyzing a problem is guided by three approaches. These approaches are spatial, environmental and territorial. Therefore, if in geography learning can be developed spatial intelligence, it will support the use of these three approaches. This is because spatial intelligence is related to the spatial approach. So, if spatial intelligences are possessed and trained in each individual student, then students will have a high sensitivity to environmental conditions and environmental problems will be easier to overcome (Crampton, Roberts, & Poorthuis, 2014; Spielman, 2014).

The results of initial observations through interviews conducted with several Geography educators at State Senior High Schools in East Lampung Regency and Bandar Lampung City, explained that the spatial intelligence possessed by students, especially in terms of analyzing a problem and their sensitivity to geographic problems was still lacking. not optimal. Students still find it difficult to identify problems using a geographical approach, especially a spatial approach, even though the geography approach is the key in identifying a geographic problem. This explains that spatial intelligence possessed by students need to be guided and directed in the learning process. Therefore, spatial intelligence as abilities and sensitivity in analyzing problems need to be improved to support good learning outcomes and achievements (Amaluddin *et al.*, 2019; Yani, Mulyadi, & Ruhimat, 2018).

Based on observations, problems regarding spatial intelligence that are not optimal in learning can be minimized by selecting and using appropriate learning models/strategies. The learning model that can help students improve their spatial intelligence is the Problem Based Learning model. According to Tan in Rusman (2013), Problem Based Learning is defined as a model that uses various types of intelligence to face various challenges and complex updates in everyday life. The meaning of using various kinds of intelligence is that in studying a problem, especially the problem of geography, it does not only require one intelligence, but requires other intelligences such as spatial intelligence (Janowicz, Gao, McKenzie, Hu, & Bhaduri, 2020; Singleton & Arribas-Bel, 2019 ; Yan, Janowicz, Mai, & Zhu, 2019).

Problem Based Learning has characteristics. These characteristics, namely giving a problem to students, from these problems are then researched and analyzed, then developed based on learning objectives (Golightly & Muniz, nd; Pawson et al., 2006; Read, 2010; Spronken-smith & Spronken-smith, 2007). This learning model requires various kinds of intelligence to solve problems, especially geographic problems related to space and the environment (Golightly & Raath, 2015). As for each student, must have a dominant and different intelligence or ability level. Therefore, by using the Problem Based Learning model, students are directed and guided so that their spatial intelligence can

be optimal. It is reviewed that to study Geography related to spatial problems, this intelligence is very much needed.

Problem Based Learning was chosen because it leads to contextual learning. That is, the learning involves real problems. According to several studies, including Chen, Sun, Sears, & Dai (2019); Khalaf, Academy, Bt, Zin, & Academy (2018); Lai, Chen, & Lee (2019); and Peacock (2018), a model that is able to involve learning materials with the real world is Problem Based Learning. Culclasure & Terry (2019) also said that this model uses contextual and ill-structured problems, namely if the data obtained are incomplete, an investigation is needed to solve and determine solutions. Therefore, involving students to be able to form an active and imaginative mindset in exploring information or knowledge.

Geography subjects, many present concepts so that examples or illustrations are needed to clarify and understand them. Illustrations that can be taken from the life or environment of a society strongly support the implementation of the Problem Based Learning model. Besides being easy to find, students are also able to understand and digest the knowledge or information that has been obtained. Carvalho (2013) said that the selection of problem-based learning models in geography learning is important. This is seen from its relation to real-life experience, real and authentic problem solving, the presentation of teaching materials/learning resources must be relevant to real situations, emphasizing the importance of problem solving and thinking (Dolmans, Michaelsen, Van Merriënboer, & Van Der Vleuten, 2015; Gallagher & Gallagher, 2013; Warnock & Mohammadi-Aragh, 2016).

Based on this, this research was carried out by combining the Problem Based Learning model with geographic literacy. Geographic literacy is a person's ability in the form of awareness to think critically and be sensitive to environmental conditions (Blyznyuk, 2019; Kerski, 2015; Turner & Leydon, 2012). Appel (2019) says that geographic literacy is defined as the ability to apply basic geography skills and use them to develop an understanding of the real world as a place where all living things live. Based on this statement, it is clear that geographical literacy is very important because it involves the abilities and skills of students in understanding geographical phenomena.

Geographic literacy basically requires various understandings, especially with the concept of geography. Conover & Miller (2014); Lukinbeal (2014), suggests that geographic literacy involves understanding at least five basic concepts, namely theme, location, place, relationship, movement and regions. This understanding is needed in order to identify space. The American Geographical Society asserts that the interaction in the physical characteristics and activities of human economic activities gives each space and place a special meaning. This meaning is useful as an attraction to explore space and place in providing a way for geography to understand the earth (Asiyanbola, 2019; Branch, 2014; Mhishi, Pedzisai, & Mandoga, 2013).

Geographical problems related to everyday life require a lot of solutions using a geographic approach. However, most of the solutions provided today override this approach, so that it cannot solve the problem optimally. Based on this, a person's ability to solve a problem when viewed based on geographic literacy can be said to be still low (Emmiyati, Rasyid, Asfah Rahman, Arsyad, & Dirawan, 2014). A person's ability to solve geographic problems should be based on geographic literacy and geographic approach. Hintermann, Bergmeister, & Kessel (2020) Humans have four important reasons for the need to master geographic literacy, namely reasons for existential reactions, ethical reasons, intellectual reasons and practical reactions. This reason is the basis that to solve the problem, the existence of geographic literacy is very necessary.

Based on the explanation above, researchers are interested in conducting research by combining geographic literacy and Problem Based Learning models in high school geography subjects and seeing their effect on the spatial intelligence of high school students.

Method

Based on the background and problem formulation, this research is quantitative research. This type of research is quasi-experimental research. The research design used was non-equivalent pretest-posttest control group design, because it linked two groups of subjects (experimental and control). The experimental group was treated with Problem Based Learning based on geographic literacy, while the control group used a conventional learning model. The research subjects are students of SMAN 1 Way Jepara, X Social which will be selected for the experimental class, control class, and instrument test class. The research instrument consisted of spatial intelligence test questions in the form of a description/essay consisting of 8 questions.

Data collection techniques were carried out through observation, tests, and documentation. Data analysis was performed using descriptive statistics and parametric inferential statistics. Descriptive statistical analysis is used to describe the data in the form of a graph in the form of an average value (mean). Parametric inferential statistical analysis was used to test the hypothesis by processing data from the results of the pretest and posttest. Hypothesis testing is using the t-test (Independent Samples t-test) using the SPSS 23 for windows program, the hypothesis in this study is as follows:

H_1: Problem Based Learning model based on geographic literacy has an effect on spatial intelligence

H_0: Problem Based Learning model based on geographic literacy has no effect on spatial intelligence

The criteria used for decision making t-test with a significance level of 0.05 (2-tailed) are: a) if the significance probability value < (0.05) and the average value of the experimental class is higher than the control class, then H_0 rejected; and b) if the significance probability value > (0.05) then H_0 is accepted.

Results and Discussion

3.1. Spatial Intelligence Pretest Results

The spatial intelligence pretest is a score obtained from the results of the spatial intelligence test in the experimental class before being given treatment and the control class. The purpose of giving the test to the experimental and control classes is to obtain information on the initial abilities of the two classes. The following is the spatial intelligence pretest data from the experimental class and the control class.

Table 1. Frequency Distribution of the Pretest of Spatial Intelligence in the Experimental Class

Interval	Frequency	Percentage (%)	
78 – 84	1	3	
71 – 77	1	3	
64 – 70	17	50	
57 – 63	8	24	Mean = 63
50 – 56	6	18	
43 – 49	0	0	
36 – 42	1	3	
Total	**34**	**100**	

Source: Primary Data, 2020

Based on table 1, it is known that the frequency distribution of the experimental class's spatial intelligence pretest is mostly in the range of 64-70 with a percentage of 50% of a total of 34 students. The highest score is in the range of 78 – 84 with a percentage of 3% which can be achieved by only one student. Furthermore, the lowest value is in the range of 36 – 42 with a percentage of 3% achieved by 1 student. This proves that the spatial intelligence of experimental class students is still relatively low with an average pretest score of 63. The level of achievement can be seen from the minimum completeness criteria in SMAN 1 Way Jepara, which is 75.

Table 2. Frequency Distribution of the Pretest of Spatial Intelligence in the Control Class

Interval	Frequency	Percentage (%)	
61 – 66	7	21	
55 – 60	12	35	
49 – 54	7	21	
43 – 48	6	18	Mean = 54
37 – 42	1	3	
31 – 36	1	3	
61 – 66	7	21	
Total	**34**	**100**	

Source: Primary Data, 2020

Based on table 2, it shows that the largest percentage is in the range of values from 55 to 60 with a percentage of 35% or as many as 12 students. The highest score is in the range of values 61 – 66 with a percentage of 21% achieved by 7 students. Furthermore, the lowest value is in the range of 31-36 with a percentage of 3% achieved by 1 student. This shows that the spatial intelligence possessed by these students is still relatively low. The low value of spatial intelligence possessed by students may be caused by the selection of the learning model used that is less precise and supportive.

3.2. Spatial Intelligence Posttest Results

Spatial intelligence posttest is a score obtained from the results of the spatial intelligence test in the experimental class after being treated using the tested learning model and the control class that was not given treatment. The following is the posttest data on spatial intelligence in the experimental class and the control class.

Table 3. Frequency Distribution of the Posttest of Spatial Intelligence in the Experimental Class

Interval	Frequency	Percentage (%)	
93 – 99	3	9	
86 – 92	8	24	
79 – 85	14	41	
72 – 78	8	24	Mean = 82
65 – 71	0	0	
58 – 64	1	3	
93 – 99	3	9	
Total	**34**	**100**	

Source: Primary Data, 2020

Based on table 3, it shows that the largest percentage is in the range of 86 – 92 with a percentage of 41% or as many as 14 students. The highest score lies in the range of values of 93 – 99 with a percentage of 9% which can be achieved by 3 students. The lowest score lies in the range of 58 – 64 with a percentage of 3% achieved by 1 student. This shows that there is an increase in spatial intelligence in the experimental class, when compared to the previous pretest value. In the previous pretest the highest score was in the range 78 – 84 with an average of 59 (below the minimum completeness criteria), while in the posttest the highest value was in the range 93 – 99 with an average of 82.

Table 4. Frequency Distribution of the Posttest of Spatial Intelligence in the Control Class

Interval	Frequency	Percentage (%)	
80 – 85	1	3	
74 – 79	3	9	
68 – 73	8	24	
62 – 67	11	32	Mean = 66
56 – 61	9	26	
50 – 55	2	6	
80 – 85	1	3	
Total	**34**	**100**	

Source: Primary Data, 2020

Based on table 4, it shows that the largest percentage is in the range of 62 – 67 with a percentage of 32% or as many as 11 students. The highest score lies in the range of 80 – 85 with a percentage of 3% achieved by one student. The lowest score lies in the range of 50 – 55 with a percentage of 5% achieved by 2 students. This shows that there is an increase in spatial intelligence in the control class, when compared to the previous pretest value. In the previous pretest the highest score was in the range of 61 – 66 with an average score of 54, while in the posttest the highest score was in the range of 80 – 85 with an average of 66.

3.3. Spatial Intelligence Gain Score Data

The gain score data for spatial intelligence is the difference in value between the posttest and pretest in each experimental and control class. The following is the gain score data for the experimental and control class spatial intelligence.

Table 5. Frequency Distribution of Spatial Intelligence Gain Score in Experimental Class

Interval	Frequency	Percentage (%)	
33 – 38	2	6	
27 – 32	6	18	
21 – 26	6	18	
15 – 20	11	32	Mean = 23
9 – 14	6	18	
3 – 8	3	9	
Total	**34**	**100**	

Source: Primary Data, 2020

Table 5 shows that the largest percentage is in the range of 15-20 with a percentage of 32% or as many as 11 students. The smallest percentage is in the range of 33 – 38 with a percentage of 6% or only 2 students. The average gain score for spatial intelligence is 23.

Table 6. Frequency Distribution of Spatial Intelligence Gain Score in Control Class

Interval	Frequency	Percentage (%)	
33 – 38	1	3	
27 – 32	1	3	
21 – 26	3	9	
15 – 20	8	24	Mean = 12
9 – 14	6	18	
3 – 8	15	44	
Total	**34**	**100**	

Source: Primary Data, 2020

Table 6 shows that the largest percentage is in the range 3 – 8 with a percentage of 44% or as many as 15 students. The smallest percentage is in the range of 33 – 38 and 27 – 32 with a percentage of 3% or only one student. The average gain score for spatial intelligence is 12.

The spatial intelligence average gain score in the experimental class is higher than the control class. The difference in the average gain score between the experimental class and the control class is 8 points. This shows that the experimental class and the control class have a different range of spatial intelligence, namely the experimental class with a higher value than the control class. Therefore, it can be said that the Problem Based Learning model based on geographic literacy has an effect on students' spatial intelligence.

3.4. Hypothesis Testing

The following are the results of the spatial intelligence hypothesis using the independent samples t-test.

Table 7. Spatial Intelligence Hypothesis Test Results

		Levene's Test for Equality of Variances		***t-test for Equality of Means***		
		F	Sig.	T	Df	Sig. (*2-tailed*)
Gain Score	*Equal variances assumed*	.319	.574	3.807	66	.000
	Equal variances not assumed			3.807	65.873	.000

Based on the results of the calculation of the hypothesis above, it shows that Sig. (2-tailed) is 0.000 < 0.05, then H_0 is rejected. Therefore, it can be concluded that there is an effect of the Problem Based Learning model based on geographic literacy on spatial intelligence.

3.5. The Effect of Problem Based Learning Model Based on Geographic Literacy on Spatial Intelligence

Based on the results, it was found that the Problem Based Learning model based on geographic literacy had an effect on spatial intelligence in the hydrosphere material for class X Social. This is because the model emphasizes the ability to think critically/ responsively and creatively according to the stages of the model. Critical thinking emphasizes students' spatial intelligence to solve geographic problems that occur in the surrounding environment. Identification in problem solving is done by looking for the origin of the problem, its causes and relationships that are adjusted to the achievement of spatial intelligence indicators. Spatial intelligence is needed by students in solving geographic problems, namely the ability to analyze and abstract problems.

The Problem Based Learning model has a good use value in learning. This is because this model learning emphasizes problems that are real and easy to find or occur in the surrounding community. In practice, the model emphasizes students to think spatially in solving and providing problem solutions. The existence of geographic literacy in the model aims to encourage students to be aware and sensitive to environmental conditions through various literatures. Based on this process, students can be encouraged to have and sharpen their spatial intelligence even more.

Problem Based Learning based on geographic literacy is carried out by observing the problem of inland water pollution and the impact it has on the surrounding environment. These problems need to be analyzed spatially by identifying the origin of the problem, the cause of its existence, and the relationship between the two. The implementation of Problem Based Learning based on geographic literacy at the first meeting was carried out by giving a pretest in the experimental and control classes. At the second meeting the experimental class was given treatment with a Problem Based Learning model based on geographic literacy and the control class used a conventional learning model. At the third meeting a posttest was conducted in the experimental and control class.

Several stages of the Problem Based Learning model based on geographic literacy have benefits in increasing spatial intelligence. The learning model stage consists of (1) providing orientation; (2) coordinating students to conduct research; (3) assist in investigations; (4) describe the research results in the form of a report and present it in front of the class; (5) perform analysis and evaluation of procedures to overcome problems and solutions.

Table 9. Stages in the Implementation of Problem Based Learning Models Based on Geographic Literacy for Increasing Spatial Intelligence

Stage	**Implementation**
I Providing Orientation	1. The teacher give orientation to students about the real problems that will be studied, namely the problem of inland water pollution that occurs in the surrounding environment. The focus of the problem is the pollution of river and lake water in Ponorogo. 2. The teacher also provides information about the achievement of learning objectives. 3. The teacher providing reviews in the form of stories to raise problems and motivate students to solve problems. 4. Students were divided into 10 groups and each group consisted of 3-4 students heterogeneously, so that there is no grouping between students who have high, medium and low abilities or skills
II Coordinating Students to Conduct Research	1. The teacher organizing students to research water pollution problems that occur in the surrounding environment. 2. Students are given student activity sheets, learning materials and articles used for group discussions. 3. The teacher gives orders to students to do assignments in the form of reading problem articles, analyzing, solving problems and providing solutions according to the student activity sheets that have been given to each group.
III Assist in Investigations	1. The teacher assist in the investigation of water pollution problems that occur in the surrounding environment both independently and in groups. 2. The teacher helps students collect knowledge or information related to the problems obtained. 3. Students are directed to relate the problems studied with three geographic literacy variables, namely interactions, interconnections and implications.

IV Describe the Research Results in the Form of a Report and Present It in front of the Class	1. The results of group work are presented in accordance with the writing format found on the student activity sheet. 2. The teacher calls the group at random to present the results of the discussion report. 3. Discussion activities are carried out in steps, one group will present the results of their discussion, and one group that has the same problem theme becomes a comparison in discussion and presentation activities. 4. After the presentation activity was completed, students in other groups were given the opportunity to ask questions about the problems discussed as well as to provide responses to the group that made the presentation. 5. The comparison group was also given the opportunity to participate in answering each of the questions presented.
V Perform Analysis and Evaluation of Procedures to Overcome Problems and Solutions.	The teacher evaluates how the inquiry skills used by students in solving problems, the ways of thinking they use, and the delivery methods in providing answers and solutions.

Source: Primary Data, 2020

At the time of giving the pretest to both the experimental class and the control class, students experienced difficulties in almost all indicators of spatial intelligence achievement. This difficulty is known from the results of the average number of scores on each indicator. In addition, some students also had complaints that were difficult to understand and confused when answering questions. Based on these findings, assisting the investigation of problems both individually and in groups is needed to shape the way of thinking in solving problems.

Group discussion activities are carried out to solve problems and ensure that each group member understands and is able to work. Students conduct discussions with group members, namely analyzing, solving problems, as well as providing solutions according to the problems obtained. In these discussion activities students are required to develop a mindset in solving a problem through group discussions. Discussion activities can lead to an interaction, namely the interaction of students with students and students with teachers when conducting analysis, problem solving, gathering information, and discussing problem topics.

In this process students are directed to understand the problem spatially in accordance with the indicators of achieving spatial intelligence. Furthermore, at the stage of providing conclusions, the teacher helps students in concluding problems and provides comments about the solutions that have been given. Based on this explanation, the existence of the teacher as a facilitator must be able to form and create an effective and interesting learning atmosphere. Teachers must have skills in developing learning innovations, so as to increase students' enthusiasm for learning and creativity.

In fact, every student certainly has a different level of intelligence. If the intelligence is not encouraged through learning activities, then the intelligence will not develop properly. Someone who has spatial intelligence and is well developed is having the characteristics of learning by observing the image of a certain object that has a shape and color. Observing a certain location and then finding a way out, mentally thinking that is applied in the form of pictures, and likes graphs, maps, and diagrams. In addition, they have the ability to have very good imaginations, namely to see things from another point of view and can form real visual images through the information obtained.

Conclusion

Based on the formulation of the problem and the results of data analysis, it can be concluded that: The Problem Based Learning model based on geographic literacy has an effect on spatial intelligence in the hydrosphere material of high school students. The Problem Based Learning model based on geographic literacy can have an impact because it emphasizes that students are able to solve water pollution problems in Ponorogo by using a geographic approach, namely spatial. Students can look at problems by looking at objects in a space, looking for origins, causes of existence, and connecting the two. This is supported by posttest data and the gain score of the experimental class students which is higher than the control class.

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