Spatial Thinking Skills of High Senior School Geography Teachers in Surakarta City

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ABSTRACT
In the 21st century, geography teachers need critical thinking and technology skills to develop instructional materials and learning media. By using them in the learning process, the teachers will be easier to explain the materials to students. The objective of this study is to determine the level of spatial thinking ability of high senior school geography teachers in Surakarta city. The population comprised the teachers of 39 high schools. The samples amounted to 27 geography teachers of 20 high senior schools. It used a purposive random sampling technique. The technique of gathering data of spatial thinking skills employed the STAT test. The data analysis technique applied descriptive statistics. The research results indicate the level of the geography teachers' spatial thinking ability to get an average of 62.33. The percentages at the moderate and high levels were 68% and 32%.

***Keywords**: geography teachers, high senior school, spatial thinking skills.*

1. INTRODUCTION

The education system in Indonesia has been developing with the changing times. Education in a country can be seen in its curriculum structure. The latest change in the education curriculum in Indonesia occurred from the 2006 KTSP (Education Unit Level Curriculum) to the 2013 curriculum (K-13). According to Yulianto (2017), the change in the K-13 is designed for achieving national education goals. Referring to Law Number 20 of 2003 concerning the National Education System of Article 3, the purpose of national education is to develop students' potential to be human beings who believe in one God, adhere to Him, and have noble character. In addition, as Indonesian citizens, they take a healthy, knowledgeable, capable, creative, independent, democratic, and responsible attitude and behavior. Based on the goals of national education, Indonesian education has been developing with curriculum redesign. The difference between the K-13 and the 2006 KTSP relates to the use of the learning approach (Judge, 2017). The K-13 employs a scientific learning approach. This approach causes students to think critically. Juniar (2017) suggested the implementation of the K-13 is relevant to thinking skills and problem-solving approach which requires technology-based learning and critical thinking to keep up with the times.

The current development has come to the 21st century era. In the 21st century, technology and critical thinking skills are needed to realize national education. In the field of education, the 21st century skills are needed for the learning process, known as 4C, consisting of creativity and innovation, communication, collaboration, critical thinking, and problem solving. BSNP (National Professional Certification Agency) (2010) states that the objectives of national education in the 21st century are to realize the ideals of the nation, namely a prosperous and happy Indonesian society with an honorable and equal position with other nations in the global world by building a society with quality sources of independent personality, willingness, and ability to realize the ideals of the nation. The focus of the 21st century learning concept is on the development of students who can explore information from various sources, create innovations, work together, communicate, think critically, and solve problems.

The 21st century learning system is applied to all the subjects, one of which is geography. Geography subject has been introduced to students from elementary school to high school. In elementary

schools, the subject is part of social studies combined with other subjects. It comprises the instructional material of students' life environment (Saputra, 2009). In junior high school (secondary school), geography subject is included in the scope of social sciences integrated into history, sociology, and economic subject. In high school, the subjects of the integrated social studies group have been divided into those studied separately. It means that geography is a subject specifically studied by students. According to R. Bintarto in Sumadi (2003), geography is a science that studies the causal relationship of earth's symptoms and events that occur on earth physically. Similarly, it studies living things with their problems by using spatial, ecological, and regional approaches. Geographical phenomena are interrelated to one another and they are a unity of natural phenomena that occur with other natural phenomena. Studying or learning geography uses spatial, ecological, and regional approaches that are useful for geographical problem solving.

Solving geographic problems requires critical thinking. In Indonesia, all education levels, especially for high school students with instructional materials of geography subject, need to employ thinking skills in solving geographical problems. Senior high school students' thinking skill in solving them has been developing slowly. Nofrion (2018) stated that the K-13 for the class X (semester I) students merely memorize or understand instructional materials. Solving geographical problems requires additional tools such as maps and satellite imagery. Maps are used for explaining objects on the earth's surface. According to Nofrion (2018), in the 2006 and 2013 curriculum, the additional tool of the new GIS map geography are introduced to the students of class XII in the first semester. Thus, it needs revising immediately. Maps can be used as a source of data and tools for facilitating in making a geographical report that can be used for high school students of class X.

Besides using additional tools, solving geographical problems requires spatial thinking skills. Setiawan (2015) suggested that these will be very useful for students when deciding or making simple and complicated decisions of space or location. According to Jo & Hong (2018), spatial thinking skills are very useful for students because of many benefits with valid instrument data. They can help solve complex problems by remembering, understanding, reasoning, and communicating the relationships among objects in space.

Students' spatial thinking is a skill developed by teachers who have spatial thinking skills. However, the teachers' skills are at a low level. According to Shin, et al. (2016), the spatial thinking skill of a prospective elementary and high school teacher at two universities in the United States is quite low and it needs developing for the progress of students' thinking. Therefore, teachers' skills must be in line with the development of an increasingly advanced era.

Surakarta city has a good level of education. Teacher quality is very important to improve student-learning outcomes. The area has 39 state and private senior high schools (SMA) and Islamic senior high schools (MA). They have social science specialization. It means that every school has geography teachers. They join the Geography MGMP (Subject Teacher Association) of Surakarta. Their skills in the use of spatial learning media were under investigation. A research paper describes geography teachers' spatial thinking skills in Surakarta city.

2. METHOD

This study was located in Surakarta city, Central Java Province, Indonesia. It has five sub-districts of Banjarsari, Jebres, Laweyan, Serengan, and Pasar Kliwon. Referring to BPS (Central Statistics Agency) (2021), state and private senior high schools in Surakarta amount to 33 units and state and private Islamic senior high schools amount to six units. Out of the 39 schools, 20 units were included in the study.

The research used quantitative research. The design employed a survey design. The number of the population was 62 geography teachers of the MGMP. The samples comprised 37 geography teachers of 20 senior high schools. The sampling used purposive sampling. The number of the sample was 20 senior high schools. The sampling criteria used included senior high schools that had geography teachers who actively participated in every activity of the Geography MGMP. The data collection technique used written tests adjusted to the high school geography teachers' skills by distributing question sheets. The use of the data collection instrument was to assess the skills by using the Spatial Thinking Ability Test (STAT) with multiple-choice questions.

Data analysis used a descriptive approach for seeing the level of spatial thinking skills. The assessment data analysis for the questionnaires of the spatial thinking skills used true/false test. If the answer was true, the score would be one (1), but if it

was false, it would be 0. The total number of questions in the questionnaires was 16 items. The assessment of the spatial thinking skills used a 100 scale. Based on the calculations carried out, the skills ranged from low, medium to and high level. The calculation to get a score was the number of questions answered correctly, multiplied by 50, and then divided by 8.

$$\boldsymbol{Maximal\ Score} = \frac{correct/true\ answer\ x\ 50}{8}$$

Low, medium and high levels mean to get a score of 0-33.33, 33.33-66.66, and 66.66-100 respectively.

Table 1. Spatial Thinking Skill Level

Levels	Scores
Low	0-33,33
Medium	33,33-66,66
High	66,66-00

Source: Personal data, 2021

3. RESULTS AND DISCUSSION

3.1 Result

Assessing the spatial thinking skill levels used the STAT. In the test, 37 samples answered 8 aspects with 16 questions. The scores for the questionnaires were one (1) for the true answer and 0 for the false answer.

Table 2. Answer Distributions

Aspects	Question	Answers	
		True	False
I	1	33	4
	2	34	3
II	3	30	7
III	4	14	23
IV	5	17	20
V	6	24	13
	7	17	20
VI	8	5	32
VII	9	23	14
	10	26	11
	11	24	13
	12	22	15
VIII	13	28	9
	14	27	10
	15	37	0
	16	8	29

Source: personal data, 2021

Table 2 reports the distribution of respondents' answers with the aspects of spatial thinking skills. In question number 1, 33 samples answered it correctly and 4 samples answered it incorrectly. In question number 15, all the samples answered it correctly and in question number 8, 5 samples answered it correctly and 32 samples answered it incorrectly.

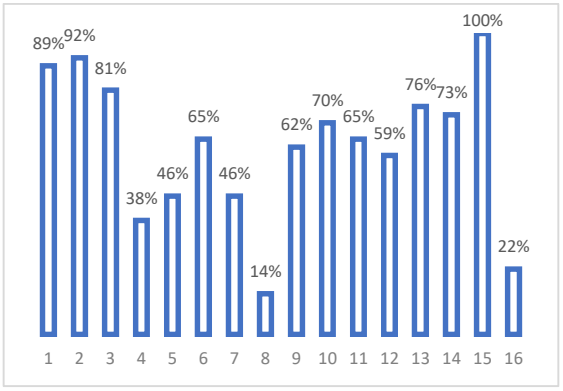

Figure 1. Percentage of True Answers

Source: personal data, 2021

Figure 1 reports the percentage of true answers. The highest percentage was question number 15 with a percentage of 100% while the lowest one was question number 8 with a percentage of 14%.

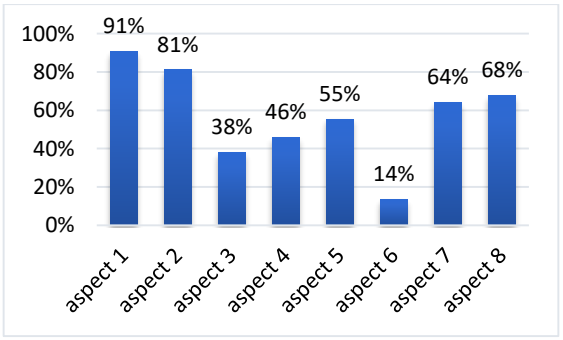

Figure 2. Percentage of Spatial Thinking Aspects

Source: personal data, 2021

Spatial thinking includes 8 aspects. In Table 2, Aspect 1 consists of two questions, numbers 1 and 2. Aspect 8 consists of 4 questions, numbers 13, 14,

15, and 16. Figure 2 describes the percentage of spatial thinking aspects. The highest percentage is aspect 1 with a percentage of 91% and the lowest percentage is aspect 6 with a percentage of 14%.

Table 3. Statistic Analysis of Spatial Thinking Score Distribution

Distribution Statistics	
Mean	62,33
Median	62,5
Modus	56 dan 62,5
Score Min	43,75
Score Max	81,25
Standard Deviation	9,3
Number Of Samples	37

Source: personal data, 2021

The average scores of geography teachers' spatial thinking skills reach 62.33. These are in a moderate category because a score of 62.33 is in the 4th interval class between 61-66. The median score is 62.5. The number of the scores that often appear are 2 (56 and 62.5), each of which amounts to 10. The minimum score is 43.75 and the highest score is 81.25. The standard deviation is 9.3 which means that the data obtained is unvaried. The standard deviation is 9.3 and the average is 62.33. The deviation has lower scores than the average ones.

Geography teachers' skills range from low, medium to high levels. Determining spatial thinking skills uses the STAT questions. The scores of spatial thinking skills in the low, medium, and high level range 0-33.33, 33.33-66.66, and 66.66-100, respectively.

Table 4. Spatial Thinking Skill Levels

Levels	**Scores**	**Total**
Low	0-33,33	0
Medium	33,33-66,66	25
High	66,66-100	12
Total		**37**

Source: personal data, 2021

All the 37 respondents of the geography teachers get medium and high spatial thinking skills. At the medium level, 25 respondents' score ranges 33.33-66.66 and 12 respondents' score ranges 66.66-100. Based on the results of the tests, then, the respondents were classified into three categories: age, gender, and last education.

3.1.1 Age

Geography teachers' age ranges from 28 to 60 years. Then, the age range is classified into 3 classes with an interval class length of 10. The class with the lowest frequency ranges 38-47 years and that with the highest frequency ranges 48-60 years.

Table 5. Frequency of Geography Teachers' Age Range

Class	**Age**	**Frequency**
1	28-37	7
2	38-47	3
3	48-60	27
Total		37

Source: personal data, 2021

The first class with an age range of 28-37 years consists of frequencies; the second class with a range of 38-47 years comprises 3 frequencies; the third class with a range of 48-60 years has 27 frequencies.

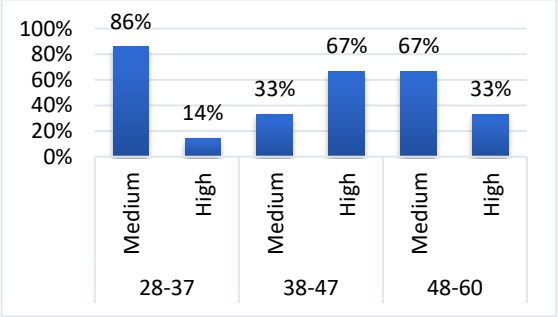

Figure 3. Percentage of Spatial Thinking Skill Level by Age

Source: personal data, 2021

Figure 3 reports the percentage of geography teachers with low, medium, and high levels by age. In the age range of 28-37 years, there are 7 frequencies. 86% of geography teachers are in the medium and 14% of them are in the high class (7 frequencies). The age range of 38-47 years of 3 frequencies is 33% in the medium and 67% of them in the high class. In the age range of 48-60 years of 27 frequencies, 67% of geography teachers are in the medium and 33% of them were in the high class.

3.1.2 Gender

Table 6. Frequency of Geography Teachers by Gender

Class	Gender	Frequency
1	Man	14
2	Woman	23
Total		**37**

Source: personal data, 2021

Table 6 describes the gender number of geography teachers. The male dan female teachers amount to 14 and 23 people, respectively.

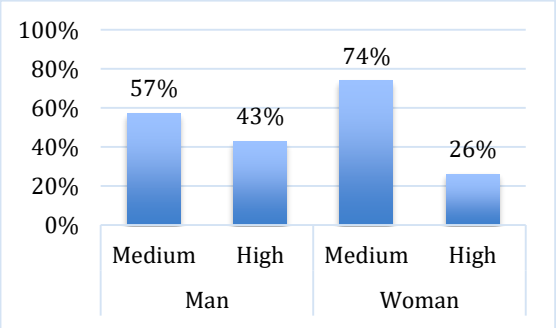

Figure 4. Percentage of Spatial Thinking Skill Level by Gender

Source: personal data, 2021

Figure 4 reports the percentage of low, medium, and high spatial thinking skills by gender. The male teachers with a frequency of 14 amount to 43% in the high class and 57% in the middle class. The female teachers with a frequency of 23, 26% amount to 26% in the high class and 74% in the medium class.

3.1.3 Last Education

Table 7. Frequency of Geography Teacher's Last Education

Class	Last Education	Frequency
1	Sarjana	27
2	Magister	10
Total		**37**

Source: personal data, 2021

The geography teachers' last education amount to 2 people (bachelor and magister). The teachers with the bachelor's education amount to 27 people and the geography teachers' magister education to 10 people.

Figure 5 reports the spatial thinking skill level of the geography teachers' last education. The teachers with bachelor education with a frequency of 27 amount to 37% in the high class and 63% in the middle class. The teachers who take magister education with a frequency of 10 amount to 20% in the high class and 80% are in the middle class.

3.2 DISCUSSION

The spatial thinking skills of geography teachers in Surakarta city are in the medium because the average of the skill test is in the medium classification. Based on the test results, there are no teachers with low scores. The research results by Astawa, et al. (2019) show that the teachers' spatial thinking skills in Bali Province are in the high and very high classification of 90% and 10%, respectively. Astawa, et al. (2019) investigated 50 geography teachers in 9 regencies/cities in Bali. The indicators of the assessment included the aspects of spatial comparison, spatial aura, social region, spatial hierarchy, spatial transition, spatial analogy, spatial pattern, and spatial associations. The research result shows that the geography teachers' spatial thinking skills were in the very high category of 89%.

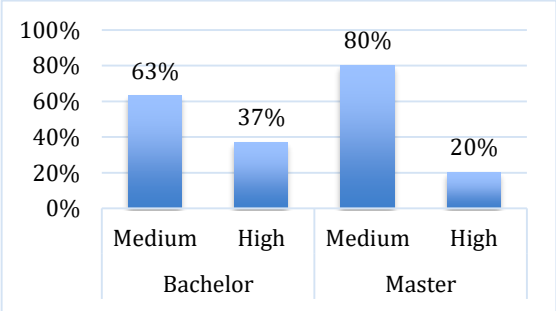

Figure 5. Percentage of Spatial Thinking Skill Level by Last Education

Source: personal data, 2021

Table 3 reports the average research result of 62.33 in the medium category. The spatial thinking skills of the geography teachers in Surakarta city amount to 25 people in the medium category and 12 people in the high category. The geography teachers used the STAT question indicators of eight aspects. Out of the aspects, there are 16 questions regarding the distribution of questions in each aspect (see Table 2). Aspect 1 consists of two questions, namely questions number 1 and 2. For questions 1 and 2, 80% of the teachers answered them correctly. Question number 1 has 33 correct/true answers and question number 2 has 34 correct answers. Aspect 2 only has 1 question and 30 geography teachers answered it correctly. According to Collins (2018), 63% of the people who worked on STAT questions in aspects 1 and 2 answered them correctly. Aspect 1 questions orientation and direction and Aspect 2

questions comparing map information with graphic information. The two are easy questions.

Aspect 3 comprises 1 question (question number 4). Aspect 3 chooses the best location based on several spatial factors. Fourteen geography teachers (38%) answered to these questions correctly. Aspect 4 also comprises 1 question (question number 5). Aspect 4 thinks about the slope profile based on a topographic map. Seventeen teachers (46%) answered the question of Aspect 4 correctly. More than 50% of the teachers could not have used spatial thinking skills about how to choose the best location by considering several spatial factors and slope profiles based on topographic maps. Aspect 5 comprises one question (question numbers 6 and 7). The average Aspect 5 is very good with a percentage of 55%. The correct answers to each question of Aspect 5 are 24 and 17.

Spatial thinking skills of Aspect 6 are the lowest with a percentage of only 14%. Aspect 6 visualizes 3-D images based on 2-D information. Five teachers answered the question correctly. Aspects 7 and 8 have almost the same results with a percentage of 64% and 68%. In Aspect 8, all the teachers answered question number 15 correctly.

Geography teachers' age in Surakarta city ranges from 28 to 60 years. The age classification is categorized into 3 classes, namely 28-37, 38-47, and 48-60 years. The number of the age range of 28-37 consists of 7 frequencies; 86% of the geography teachers are in the medium and 14% in the high class. The age range of 38-47 years of 3 frequencies is 33% in the medium and 67% in the high class. In the age range of 48-60 years consisting of 27 frequencies, 67% of them are in the medium and 33% were in the high class.

In the classification of the spatial thinking skill levels by gender, the male teachers with a frequency of 14 are 43% in the high and 57% in the medium class. The female teachers with a frequency of 23, 26% are in the high and 74% in the medium class.

The geography teachers' last education who get a Bachelor's degree and Magister degree 27 and 10 people. The teachers took a Bachelor's degree with a frequency of 27 amounted to 37% in the high and 63% in the medium class. The teachers who got Magister education with a frequency of 10 amounted to 20% in the high and 80% in the medium class.

4. CONCLUSION

Based on the average results of test answers, the geography teachers' spatial thinking skills in Surakarta city are at the medium level. Twenty-five teachers are the medium and 12 in the high level. None of them is at the low level. The percentage in the medium is 68% and 32% in the high level.

The research paper can be used for readers, especially geography teachers to improve spatial thinking skills. Using these skills will make them easier to explain instructional material to students by practicing and developing them. It can also be beneficial for other researchers in the future. The weak research is that the sampling was carried out during Covid-19 so that there were the samples to be unavailable.

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