Spatial thinking profile for 2017 surakarta senior high school

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Abstract. This study aims to analyze the profile of Spatial Thinking in Surakarta Senior High School. This research is a descriptive study to obtain Spatial Thinking data in Surakarta Senior High School 2017. The assessment using 8 aspects of spatial thinking abilities covered by STAT include comprehending orientation and direction; comparing map information to graphic information; choosing the best location based on several spatial factors; imagining a slope profile based on several spatial factors; correlating spatially distributed phenomena; mentally visualizing 3-D images based on 2-D information; overlaying and dissolving maps; comprehending geographic features represented as point, line, or polygons. The results of the study indicate that Spatial Thinking in Surakarta Senior High School 2017 is relatively low, as evidenced by the average score of the ability to comprehending orientation and direction aspect which have a mean score above standard average of 74.9. The lowest aspect is visualizing 3-D images based on 2-D information of 11.2, these findings will be used as a basis for further research on innovative learning models and strategies that can improve cognitive abilities and Spatial Thinking in high school students.

1. Introduction
Quality Education is one of the seventeen Global Goals of the SDGs program that guarantees equal distribution of quality education and increases learning opportunities for everyone, guarantees inclusive and equitable education and encourages lifelong learning opportunities for everyone [1]. One important aspect of education is being able to make students aware that students are part of community members who are able to make decisions that are broad in scope every day [2]. Geography Education provides knowledge about space, region, environment and nature which are the basic capital of forming behavior. In addition, knowledge of geography supported by GIS and remote sensing technology makes it a major advantage in spatial development and developing students' intelligence capabilities. GIS offers the opportunity for students to explore their own environment using new information technology, so that it can be used to improve spatial thinking skills. Increasing spatial thinking skills makes students familiar with the surrounding environmental conditions [3].

We propose that undergraduate educators should focus some effort on helping students achieve higher levels of spatial literacy by designing tools that encourage students to engage in advanced problem-solving in a wide range of social science domains[4]. Factor analysis would identify independent components of spatial thinking by generating factors that reflected the eight components of previous researchers’ spatial thinking conceptualizations that were represented by questions in the STAT[5]. Spatial Thinking Ability Test (STAT) is a patented measuring instrument of the Association of American Geographers to measure students’ spatial thinking abilities.

High School in Karisidenan Surakarta has geographical diversity, disaster sensitivity, and level of mobility. Geographical diversity appears from upstream, middle and downstream. Schools that are
located in upstream or village areas, for example SMA N 1 Purwantoro are located in the vicinity of mountainous areas, which are sensitive to disasters such as landslides, and low mobility levels and instructions for traffic signs are also small due to the quiet traffic area. This has an impact on students' spatial thinking abilities. In contrast to schools in urban areas, for example high schools in Surakarta, with sensitivity to floods, high levels of mobility coupled with high traffic signs and crowds so that spatial thinking skills will also increase. On the other hand, high schools in Klaten with the title SWALIBA have volcanic disaster sensitivity, are in sub-urban areas and have moderate mobility. Various factors cause students to have varying levels of spatial thinking skills in each school. This study aims to find out how the profile of Spatial Thinking Students at the High School level in Surakarta.

2. Methods
The study was conducted at 8 senior high schools in the Surakarta Karisidenan. The subjects of this study were students who had obtained GIS material, because there was a diversity of curriculum uses in each school. To determine the number of samples the following formula is used:

The following is the formula for determining the sample size [6]:

\[ n = \frac{N}{N(d)^2 + 1} \]

Explanation of the formula above as follows: \( n \) is number of samples; \( N \) is number of population; \( d \) is level significance; 1 is constant. The result on Tabel 1.

| NO | Nama Sekolah          | Sampel |
|----|-----------------------|--------|
| 1  | SMA Jumapolo          | 64     |
| 2  | SMA 1 Purwantoro      | 51     |
| 3  | SMA2 Sragen           | 50     |
| 4  | SMA 2 Klaten          | 46     |
| 5  | SMA 3 Boyolali        | 52     |
| 6  | MAN Sukoharjo         | 43     |
| 7  | SMA 3 Surakarta       | 46     |
| 8  | SMA Batik 1 Surakarta | 69     |
| Total |                     | 421    |

The instrument of test used in this study was the STAT instrument [7]. This instrument of test measures 8 dimensions of spatial ability. The spatial ability test in the study is a multiple choice question. Question ability test consisting of 16 items, namely 2 questions representing the ability to understand orientation and direction, 1 question represents the ability to compare information on maps with graphic information, 1 question represents the ability to choose the right location based on several spatial factors, 1 question represents the ability to imagine a profile slopes based on topographic maps, 2 questions represent the ability to correlate the phenomena of spatial distribution, 1 question represents the ability to visualize 3D images based on 2D information, 4 questions represent the ability of processes overlapping a map, 4 questions represent the ability to understand geographical appearance that looks like points, lines, or polygons.
Table 2. Measurement of spatial thinking skills

| Type | Description | Measurement of Spatial Thinking Ability |
|------|-------------|-----------------------------------------|
| I    | Perform route findings and planning by visually navigating road maps using verbal information provided (i.e. location, direction of purpose, and road information) | Assessing spatial thinking skills related to understanding orientation and direction (for example, back and forth, left right, top down, front rear, north south east west) |
| II   | Students must know the map pattern and present it in graphical form | Evaluating students in recognizing patterns into graphic forms |
| III  | The ability of students to choose the ideal location based on multiple pieces of spatial information such as land use, elevation, population density | Understanding the concept of overlay and dissolve by Golledge then “concludes” the spatial state after overlaying or dissolve, by Gersmehl [8] |
| IV   | Understanding of contour lines and the ability to translate information, spatial, elevation data in this case, to other forms of representation | Understanding spatial 3D shapes (diagrams or images) and being able to present images from one dimension to another, by Golledge [9] |
| V    | Students must identify and compare patterns displayed in a set of maps and to represent spatial relationships such as in graphic form | Assess the ability to identify spatial correlations |
| VI   | Students are asked to visualize 3D based on two-dimensional topographic maps | Students need to change representations and drawings from one dimension to another, by Golledge [9] |
| VII  | Students must visualize and verify the map overlay, then choose the right map layer involved in Overlay | overlay and dissolve map, by Golledge [9] |
| VIII | Students must understand various types of spatial data and be able to apply knowledge to identify appropriate data types | Evaluating understanding symbol maps presented as points |

Source: Lee and Bednarz[10]

Table 3. Indicator achievement

| Predicate | Interval |
|-----------|----------|
| 0-2       | Very low |
| 2-4       | Low      |
| 4-6       | Enough   |
| 6-8       | Height   |
| 8-10      | Very High |
3. Results and Discussion
Based on the results of the study, the results of measurement of thinking skills in each aspect and school compiled based on aspects 1-8, can be like Figure 1. While in general, explaining the height is explained in Figure 2.

Figure 1. Spatial thinking on each aspect
**Figure 2.** Spatial thinking map in every school

**Figure 3.** Resume the value of Spatial thinking on each Aspect

Based on figure 3, Aspects of measurement of spatial thinking skills from the lowest to the highest in Surakarta, namely: aspects of visualizing 3-D images based on low-category 2-D information. Indicators understand the geographical appearance that appears such as points, lines, or polygons; choose the right location based on several spatial factors; the process of overlapping a map; imagine...
slope profiles based on topographic maps; correlate the phenomenon of the medium category spatial distribution. Indicators compare information on maps with graphic information and understand the orientation and direction of high categories.

![Figure 4. Ability to think of spatial thinking on aspect 8th](image)

Based on Figure 4, it shows that 8 schools have low quality categories on the aspect of comparison of the ability to visualize 3D images based on 2D information. This condition is inseparable because the characteristics of the questions to observe topographic maps have contour lines, which students are expected to be able to understand the cross section of the 3D display of contour lines that have been provided. This means that this aspect must be truly supported by knowledge and technological development. Besides that, it also needs to be supported by adequate facilities and infrastructure and to keep up with the times. In reality the facilities and infrastructure and human resources are not sufficient.

Students on the dimensions of understanding the geographical appearance that looks like points, lines, or polygons are included in the low category. This is illustrated when participants are given 4 questions to visualize the appearance of points, lines, or polygons that are associated with real objects in everyday life. So in order to encourage and increase the thinking ability of spatial thinking, it is necessary to have planned, systematic and sustainable efforts by all stakeholders so that technical matters that become obstacles can be facilitated

4. Conclusion
In line with the above problems, based on a needs analysis of the spatial thinking skills of high school or MA students in the Surakarta residency, the results show that the sixth dimension in the STAT instrument is visualizing 2D images based on 2D information having a low score in all research samples.

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