Gender perspective: the spatial thinking of secondary education students

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Abstract. Spatial thinking is defined as an inseparable aspect of geographical skills, the ability to make decisions from a set of choices of environmental conditions related to the needs of life. It is assumed that gender has a relationship with the geographical way of thinking of a person. Male and female have different perspectives on each decision making to assess and choose space both on the scale of rooms and on the surface of the earth. This study aims to determine the differences in spatial thinking based on gender in junior high school and senior high school students. The method used is descriptive. The data were collected through testing technique. The result shows that the correlation coefficient between gender and spatial thinking is not significant, but in some or certain cases there seems to be a slight difference. Men are more likely to think pragmatically about various situations that will occur in a narrow space and time, while women are more anticipatory in broader dimensions of time and space, such as time differences in various cities, season changes, and predictions of space threatened by natural disasters.

1. Introduction

Everyone has the ability of spatial thinking to opt for a place, to arrange household furniture, to predict the weather, to avoid sun exposure, to be alert of slippery floors, to choose the way to go to school and go home, to choose a strategic place to open stall, to drive the vehicle at a safe speed, and the likes. Be it conscious or not, everyone has thought of spatial life daily. In spatial thinking processes, a person will process information with a particular process known as geographical skills. The National Geographic Society website mentions that geography skills are the essential elements and techniques needed to think geographically. Geography skills will assist the understanding of physical patterns and processes, social life, even in making everyday decisions, such as buying a house, finding a job, determining the fastest travel route, finding a place to shop, vacation, and/or going to school. All of these decisions involve the ability to obtain, organize, and use geographical information from data and facts in the form of symbolic drawings, charts, diagrams, and maps.

The ability of a person in terms of spatial thinking varies depends on the field of study, the type of work, motivation, interests, even gender. The gender factor is highly intriguing because it starts from a social phenomenon that each gender has different needs. Society in general considers that women are more capable of managing space than men. Male can still choose communal toilets, but most women prefer more private toilets. In the local case, especially in Indonesia, many women who ride motorbikes turn on the left sign lights when they turn right, or vice versa turn on the right sign to turn left. Based on the background above, this study aims to ascertain whether gender has a correlation with a spatial thinking ability.

In many references, spatial thinking is related to spatial intelligence, the ability of geographical thinking to assess and manage space. Space intelligence is defined as the ability to visualize and interpret locations, positions, distances, directions, relationships, movements, and changes in space. Ness, Farenga and Garofalo (year) argue that spatial thinking is the ability to understand, recognize, or
conceptualize physical or intellectual construction in terms of position or location in a static and dynamic system. Spatial thinking involves interpreting activities about space and construction in it. Furthermore, spatial thinking skills have many dimensions including the ability to conceptualize space using representation, reasoning and proof, problem discovery, problem solving, visualizing relationships, analyzing static and dynamic object systems, object observation, recognize the relationship between two- and three-dimensional constructions, and distinguish between euclidean space and other geometric models.

The object of spatial thinking is broad ranging from how to choose a seat on the train, choosing the way to commute from work, avoiding traffic, predicting the weather, reading topographic maps, assessing potential flooding on the watershed map (DAS), mitigating landslides, and the likes. Understanding the natural conditions and the surrounding environment does not take place at one but through the information process which takes place cognitively. The information process follows the systematic stages which begin with asking geographic questions, organizing geographic information, analyzing geographic information, and answering geographic questions, known as geography skills.

For this study, the research problems in terms of measuring spatial thinking skills are of seven topics, namely (1) reading analog clock; (2) determining the direction of self-reflection from the direction of sunlight at a place with certain map coordinates at a certain time; (3) predicting the season in a place as a result of the apparent circulation of the sun; (4) preparing supplies on a cross-country trip based on terrain interpretation on topographic maps; (5) choosing strategic location for minimarket based on the habits of people returning from work with the consideration being ease of parking without having to cross the road; (6) predicting the river which flows profusely based on the watershed; and (7) skill of avoiding traffic accidents in the blind spot around large vehicles.

2. Methods
This study uses a descriptive method which aims to describe the result of spatial thinking skill tests on junior and senior high school students. The research subjects were junior and high schools in Cimahi and Sukabumi, West Java. The number of research subjects taking the test was 120 respondents consisting of junior and senior high school students, namely:

| No. | Education Level | M   | F   | Amount |
|-----|-----------------|-----|-----|--------|
| 1   | Junior High     | 36  | 24  | 60     |
| 2   | Senior High     | 27  | 33  | 60     |
|     |                 | 63  | 57  | 120    |

Source: Research, 2019

The test was conducted at the end of August 2019 using the quizizz.com application. The research subjects answered questions submitted online conducted in the classroom under the supervision of the researcher and class teacher.

The test instrument was developed using the clustering technique, a package of instruments consisting of three groups arranged in such a way that the level of difficulty varies. The number of items is 45 items; the first cluster is of the elementary school level with the serial number of 1, 4, 7 and multiples of up to number 43; the second cluster is of the junior high school level with the serial number of 2, 5, 8 and multiples of up to number 44; the third cluster is of the high school level with the serial number of 3, 6, 9 and multiples up to number 45. The test result was sorted based on research interests and spatial thinking themes. Of all the questions, 7 questions are selected and analyzed with the following theme:

1. Reading analog clock;
2. Determining the direction of self-reflection from the direction of sunlight at a place with certain map coordinates at a certain time;
3. Predicting the season in a place against the season in its place as a result of the apparent circulation of the sun;
4. Preparing supplies on a cross-country trip based on terrain interpretation on topographic maps;
5. Choosing strategic location for minimarket based on the habits of people returning from work with the consideration being ease of parking without having to cross the road;
6. Predicting the river which flows profusely based on the watershed; and 
7. Skill of avoiding traffic accidents in the blind spot around large vehicles.

The data processing uses tabulation and correlation between genders with test answer patterns on the seven aforementioned items. The correlation calculation uses the formula by Pearson processed through Excel Windows 10 worksheet.

3. Results and Discussion
3.1. Coefficient Correlation between Gender and Spatial Thinking

Spatial thinking has many themes, and is uncountable. In daily life, spatial thinking is inseparable. In this study, only seven themes out of 45 themes were proposed in the spatial thinking test.

The first theme is the geography thinking skill in terms of reading an analog clock. Analog clocks are generally circular in shape with a sign that indicates the number 1, 2, 3 to 12. Some of the analog clocks write down the numbers but some others use symbols. Analog clocks are equipped with two or three hands. The first hand indicates second, the second one indicates minute, and the third one indicates hour. The following is the analog clocks included in the test.

![Figure 1. Analog clocks](image)

The question asked was, “If London is at noon, what time is it in Jakarta?” To answer the question, an understanding regarding the concept of rotational motion of the earth has an impact on the time difference. Since Jakarta is located on the East of London, the time calculation of Jakarta comes first, and the answer is 8:45 pm.

The second theme is spatial thinking in understanding self-reflection from the direction of the sun. The question is simply to display the shadow of someone who was walking in an open space. The question asked was, “On December 22nd, the Sun was at 23.5° latitude. If you stand in an open field that day at around 2:00 p.m., in which direction will your shadow stretch?” The question has a spatial thinking dimension because a number of concepts must be understood, namely the position of the Sun at latitude 23.5° latitude (December 22) and local time of 2:00 pm on the equator.

The third theme is to predict the season in a place while taking into account the season in the place as a result of the apparent circulation of the Sun. The question asked was, “If in Japan is winter, what season is Indonesia expected to be in?” The dimension of spatial thinking lies in the knowledge of the location of Japan in the Northern Hemisphere and Indonesia is in a location affected by monsoons which move between Asia and Australia. In addition, the students must also understand the position of the Sun at a certain time. If Japan is winter, it will be summer in Australia and it will be rainy in Indonesia.

The fourth theme is spatial thinking skill related to cross-country trip based on information of terrain interpretation on topographic map. The students were required to think reflectively. They were asked to observe the contour map as shown below. The question asked was, “What is the important equipment to carry when one is about to hike through the D route?” The correct answer is helmet, carabiner, and buoy because they would pass a river.
The fifth theme is to predict flood-prone areas based on the watershed map. The research subjects were asked to observe watershed map containing distributary symbols. The dimension of this spatial thinking lies in the logic of the accumulation of water in the river which impacts on further hydrological process, namely the potential for flooding and erosion.

The question asked was, “In which number does the river flow the fastest?” The answer is in the no. 1 distributary. The second question was, “If combined with the forest destruction map, what is the benefit of the watershed map above?” The map is, in fact, useful for predicting the amount of erosion volume in the soil layer.

The sixth theme is to be aware and to avoid the threat of traffic accidents in the blind spot area. This theme also contains spatial thinking in daily life. The blind spot area is an area that cannot be observed by the driver of large vehicles, such as trucks and buses. The question asked was, “When driving beside a bus or a truck, how do you avoid the threat of a traffic accident?” The answer is to immediately move from the blind spot area. The dimension of spatial thinking lies in perspective thinking, as if they were behind the wheel of a large vehicle.
The seventh theme is choosing strategic location for minimarket based on the habits of people returning from work with the consideration being ease of parking without having to cross the road. The dimension of this spatial thinking lies in the layout and easiness to go to the minimarket excluding other variables from the marketing aspects, indeed.

The pattern of answers of the seven questions is correlated with the gender of the study subjects and the following result is obtained.

### Table 2. Coefficient Correlation between Gender and Spatial Thinking

| No. | Geographic Thinking Themes                                                                 | Coefficient Correlation |
|-----|------------------------------------------------------------------------------------------|-------------------------|
| 1   | Reading analog clock                                                                      | 0.12                    |
| 2   | Determining the direction of self-reflection from the direction of sunlight at a place with certain map coordinates at a certain time | -0.19                   |
| 3   | Predicting the season in a place against the season in its place as a result of the apparent circulation of the sun | 0.03                    |
| 4   | Preparing supplies on a cross-country trip based on terrain interpretation on topographic maps | -0.15                   |
| 5   | Predicting the river which flows profusely based on the watershed                         | 0.12                    |
| 6   | Avoiding traffic accidents in the blind spot around large vehicles                        | 0.07                    |
| 7   | Choosing strategic location for minimarket based on the habits of people returning from work with the consideration being ease of parking without having to cross the road | -0.13                   |

*Source: Research, 2019*

In general, the correlation coefficient is not significant because the average $r = 0.12$. However, this figure is adequate to confirm the slight difference in perceptions and/or spatial thinking in terms of gender.

### 3.2. Dimensions of Spatial Thinking

The research data were also processed to obtain the percentage of average on each gender; the purpose of which is to map the trends in spatial thinking on both genders. The first result provides information that the following dimensions are more dominant in men than women. The dimensions are as follows.

1. Understanding self-shadow from the direction of sunlight;
2. Preparing supplies on a cross-country trip based on terrain interpretation on topographic maps
3. Avoiding traffic accidents in the blind spot around large vehicles
4. Choosing strategic location for minimarket based on the habits of people returning from work with the consideration being ease of parking without having to cross the road

Meanwhile, the dimensions which are more dominant in women than men are as follows.

1. Reading analog clock
2. Predicting the season in a place against the season in its place as a result of the apparent circulation of the sun
3. Predicting the river which flows profusely based on the watershed.

### Table 3. Difference Score of Spatial Thinking Test

| No. | Geographic Thinking Themes                                                                 | % Score | % Score | Score difference | Dominant gender |
|-----|------------------------------------------------------------------------------------------|---------|---------|------------------|----------------|
| 1   | Reading analog clock                                                                      | 69.84   | 80.7    | -10.86           | Female         |
| 2   | Determining the direction of self-reflection from the direction of sunlight at          | 55.56   | 40.35   | 15.21            | Male           |
Based on the theme chosen, men are more likely to think pragmatically about various situations that will occur in a narrow time and space. In this case, men are better to prepare for supplies during cross-country trips based on topographic map. Men are also more careful when driving, always avoid the threat of traffic accidents in the blind spot area. In other cases, men are more rational in choosing strategic location for minimarket based on the habits of people returning from work with the consideration being ease of parking without having to cross the road. As for women, they seem to be more anticipatory in broader dimensions of time and space, such as being skilled in reading analog clock and skilled in determining time in various cities. Women are more skilled in predicting seasonal changes and predicting a place prone to natural disasters.

4. Conclusions
Based on the result, spatial thinking between men and women has little difference and the correlation coefficient value. However, based on the average score obtained from the test men are more likely to think pragmatically about various situations that will occur in a narrow space and time. As for women, they are more anticipatory in the broader dimension of time and space, so they tend to need more time in considering the situation that will occur in the future. This study implies that all parties should be more careful in giving assignments to men and women given that each gender tends to differ in the dimension of spatial thinking skill.

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