Students’ Spatial Intelligence Measurement on Social Science and Geography Subjects

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Abstract. This research has a purpose to create an instrument model of spatial intelligence measurement which will be developed in further research. The developed instrument was multiple choice questions with theme on spatial knowledge. The instrument was tested on students in junior and senior high school in social science and Geography subjects. Classes and schools selected are Class IX SMP 29 Bandung, Class X SMA 4 Bandung, and Class XI SMA Lab School Universitas Pendidikan Indonesia. Descriptive methods was employed to explain the effectiveness of the instruments based on the superiority of validity, reliability, difficulty level, and distinguishing power. The results showed that the instrument has reliability Test = 0.73; validity of questions’ item were 19 questions, distinguishing power was 32.5% and difficulty level was equitabile.

1. Introduction

Spatial intelligence is a term inspired by the concept of visual intelligence. Part of Multiple Intelligences was divided into eight types that are mathematical logic, linguistic, musical, intrapersonal, spatial (visual), kinaesthetic, interpersonal, and naturalist [1]. Visual/spatial intelligence is interpreted as the intelligence that promotes spatial reasoning through the use of chart, graphs, map, tables, illustration, arts, puzzles, costumes and many other material. Visual intelligence allows students to picture ideas and solution to problems in their minds before trying to verbalize them or put them into practice [2]. Spatial intelligence is characterized in terms of a continuum of research perspectives which range from a physiological or sensory awareness to a complex thought and cultural emphasis [3].

The form of the test to measure visual intelligence is generally designed in the form of pictures to match, differentiate, move, take and pair with a particular image of any object such as cubes, cones, balls, rectangles, triangles, paper folds, Lego, to the orientation of the map and how to read the map. Spatial abilities have to do with individuals’ abilities to search the visual field, apprehend forms, shapes, and positions of objects as visually perceived, form mental representations of those forms, shapes, and positions, and manipulate such representations mentally” [4, 5]. Integrating spatial content into formal and informal instruction could not only improve spatial functioning in general but also reduce differences related to gender and socioeconomic status that may impede full participation in a technological society [6].
Here are example of some items of the test in measuring spatial intelligence shows in the figure 1.

![Spatial Ability Practice Test 1](image)

Figure 1. Spatial Ability Practice Test 1 [3].

Beside imaginative forms, near-real-world problems such as maps are also given. The question posed is the direction and relative position. The form of imaginative questions has been tested and is very appropriately used to measure academic potential. The item of question is "free" from the influence of learning. The problem is whether the implementation of the test will always be separated from the students' learning? Can forms of spatial intelligence measurements coincide with measurement of learning outcomes, and vice versa? This study tried to develop instruments to measure not only students' spatial intelligence but also their learning outcomes, especially on the subjects of social studies and geography.

2. Methods
Descriptive methods was employed to explain the effectiveness of the instruments based on the superiority of validity, reliability, difficulty level, and distinguishing power. The instrument was tested on students in junior and senior high school in social science (IPS) and Geography subjects at High School. Classes and schools selected are Class IX SMP 29 Bandung, Class X SMA 4 Bandung, and Class XI SMA Lab School Universitas Pendidikan Indonesia. Number of participants were 40 students.

3. Results and Discussion

3.1. Assumption and spatial intelligence indicators
The idea of measuring academic potential based spatial intelligence which integrated with spatial intelligence as the learning outcomes has been exemplified in a book entitled Spatial Ability: A Handbook for Teachers [4]. The book are consists of five chapters; (1) construction work in schools, (2) exploiting the Urban Environment, (3) Reading and Using Maps, (4) Mental Shape and Space, and (5) Arithmetic for Spatial Thinkers.

![Spatial ability associated with arithmetic ability](image)

Figure 2. Spatial ability associated with arithmetic ability [6].
Figure 2 shows that spatial intelligence can be measured through five ways and exploiting the Urban Environment, and Reading and Using Maps are suitable for Geography subject.

Although still focusing on previous study, ones tried to choose different direction related to spatial intelligence indicators. With the assumption that spatial intelligence has been owned by people since birth such as children learn to be careful when they know the floor is slippery. The child's caution in stepping over the slippery floor is an actual example of a spatial intelligence as a result of his past learning and experience. In adolescents, someone has been able to calculate the cost of taking a bus or taxi for a considerable distance. In new marriage couples, they can decide and choose their new house by considering the distance with the workplace, the threat of landslides, a good environment, and a number of geographical considerations.

Assuming above, ones developed eight indicators of spatial intelligence:

- Forensic skills (tracing and interpreting the relation of objects seen in the image with previous events).
- Describing the position, direction, and distance (the ability to read and use the map)
- Changing the shape of an object
- Determining the line of transportation and or the fastest moving place
- Choosing the best place
- Observing people, places, and things from different angles.
- Predicting development of a region
- Insights on environmental adaptation

Five questions are developed from each indicator with the type of multiple choice with 5 options. Thus, the total number of questions are 40 items. Each question is presented in the form of stimulus cases or images (photos), ranging from easy to difficult.

3.2. Instrument feasibility

The form of questions for measuring spatial intelligence can vary. The measurement of spatial intelligence on the themes of social science and geography can be for example objects and processes that occur in the environment of the students. Practical skills that can be applied are include estimating length, height, angle, and relative proportions. Activities to improve those abilities are observing, sketching, measuring, taking photo, reading map, and interpreting map. In fact, describing a situation in fiction is part of spatial intelligence [7]. High levels of spatial ability have frequently been linked to creativity, not only in the arts, but in science and mathematics as well [8].

Questions can be in form of multiple choices, short describing, pairing, or essay by using above themes. The data was processed by using ANATES version 4.0.2 developed by Karno To and Yudi Wibisono. The program has been published and can be downloaded for free. The results are as follows table 1 and 2:

| Lowest – Highest Scores |
|-------------------------|
| Subject number          | = 40 |
| Total items             | = 40 |
| Correct answer          | = 1  |
| Wrong answer            | = 0  |
| Highest score           | = 23 |
| Lowest score            | = 10 |

| Reliability Test         |
|--------------------------|
| Median                   | = 16.12 |
| Mean                     | = 4.45 |
| Correlation XY           | = 0.58 |
| Reliability              | = 0.73 |
Correlation
Subject number = 41
Total items = 40
Very significant = 9
Significant = 9
Not Significant = 22

Table 1. Distinguishing power.

| Criteria                  | f | %  |
|---------------------------|---|-----|
| Negative                  | 3 | 7.5 |
| Very bad                  | 17| 42.5 |
| 0.00 – 0.20 Poor          | 17| 42.5 |
| 0.21 – 0.40 Bad           | 7 | 17.5 |
| 0.41 – 0.70 Good          | 12| 30  |
| 0.71 – 1.00 Very good     | 1 | 2.5 |
|                           | 40| 100 |

Table 2. Difficulty level.

| Criteria       | f | %  |
|----------------|---|-----|
| Very Easy      | 5 | 12.5 |
| Easy           | 4 | 10  |
| Medium         | 11| 27.5|
| Difficult      | 9 | 22.5|
| Very difficult | 11| 27.5|
|                | 40| 100 |

With reliability score of 0.73 means that the test instrument can be trusted, consistent, reliable, stable and not contradictory. Although more than 50% of its validity is not significant but it can still be revised. The number of questions that have good distinguishing power was 32.5% and with equitable difficulty level.

The interesting thing in measuring spatial intelligence is the information that is wider than the visible. A phenomenon recorded in an image can provide clues about past events and become the basis for predicting future events. Thus, the picture (photograph) can be used as evidence that explains its situation and condition. Photographs showing flood marks can explain the dreadful of the flood disaster from the amount of scattered waste, the upside-down vehicles, and collapsed buildings. The ability to interpret a picture with actual events is part of spatial intelligence. We should not just think of interactive external visualizations as ways of augmenting spatial intelligence, but also consider the types of intelligence that are required for their use [9].

The problem is, what topic on geography subject can be used as a questions’ formula for measuring spatial intelligence? To identify the theme of geography subject, we should look at the definition of geography. Geography's traditional interest in integrating phenomena and processes in particular places. Thus, all phenomena on the surface of the earth can be the theme in the formulation of spatial intelligence questions [10].

Geography can have themes related to exploiting the urban environment and reading and using maps. However, since every item of question in spatial intelligence is influenced by the material that student learns, it is better that the question suitable with the level of education of the student [10]. In general, themes close to social studies and geography lessons are:

- The ability to read and use maps that are adjust to the scale, theme, and education level.
- Location, distance, density, distribution, and quality of an object on the surface of the earth
- Appearance, phenomenon, and natural physical processes on the surface of the earth such as mountains, rivers, lakes, forests.
- Appearance, phenomenon, and social processes on the surface of the earth that can be proven by
their traces and / or impacts such as poverty indicated by slums, urbanization as indicated by population density, etc.

- Interaction between physical and social physical aspects that can be recorded through visual images such as agricultural activities, mining activities, or activities in the market.

4. Conclusions

The results of this study were expected to be the first step in measuring spatial intelligence integrated with social science and geography competence. So that students’ intelligence will be seen in contextual, visible form, observable, and can be reportable to parties who need the data. This research will be continued to the main research which is exploring on how contextualization of the spatial intelligence, as the basic of geography skills that meet the demands of 2013 Curriculum, will be applied in the process of learning and assessment.

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