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RESEARCH ARTICLE

Mental Rotation of Junior High School Students in Terms of Differences Sex

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ABSTRACT

Spatial ability has been recognized as a significant human skill involving the retrieval, retention, and transformation of visual information in a special context. One type of spatial ability is the skill of performing mental rotations. Mental rotation is is the ability to rotate two or three-dimensional objects rapidly and accurately in the mind. . In other words, by way of rotating objects mentally and thereby solving problems related to space, this test includes the limit of reaction time and the rotation angle, both of which are mutually related to the degree of difficulty. The subject of this research comes from 9th grades students at junior high school in Surabaya were selected from purposive sampling. The volunteer student with high ability in mental rotation based from differences gender were selected from mathematic ability task and interviewed. The result showed that high ability male students able to visualize the result of two-dimensional wake rotation such as right triangle rotated as 45°, 90°, 180° and 360°. While high-ability female students are still somewhat difficult to visualize the result of two-dimensional rotational objects such as triangle too but had difficultness when rotated as 45°.

1. INTRODUCTION.

Spatial ability has been recognized as a significant human skill involving the retrieval, retention, and transformation of visual information in a special context (Rafi&Samsudin, 2009). In several studies it has been shown that spatial ability are important in several everyday activities, influencing academic success in science, technology, engineering and mathematics (STEM; Wai, Lubinski, & Benbow, 2009; Lubinski, 2010; Uttal, Miller, & Newcombe, 2013), navigation and way finding (Labate, Pazzaglia, & Hegarty, 2014; Hegarty, Montello Richardson, Ishikawa, & Lovelace, 2006), and sporting activities (Jansen & Lehmann, 2013). Spatial ability is devided into three-dimensions: mental rotation, spatial visualization and spatial perception (Linn & Petersen,1985). This research focuses on one aspect of spatial ability namely mental rotation.

There is a large difference between the performance of women and men in the ability to mentally rotate (Geiser, Lehman, & Ied, 2008). This difference can be observed at 4-5 years of age (Moore & Johnson, 2008), and will increase with age (Geiser et al., 2008). Therefore, research will be conducted to determine the mental rotation abilities of students based on differences sex in high mathematical abilities with the age range of 13-14 years.

1.1 Mental Rotation

Mental rotation is defined as "the ability to rotate quickly and accurately two- and three-dimensional figures in imagination" (Voyer et al., 1995, p. 25). Mental rotation is the ability to rotate two or three-dimensional objects rapidly and accurately in the mind (Linn & Petersen,1985). Mental rotation is also defined as a specific aspect of spatial thinking that is defined as the ability to mentally rotate 2D or 3D objects (Shepard & Metzler,1971). Mental rotation can be used to understanding area measurement tasks, composing or describing 2D and 3D figures, proving symmetry and finding missing addends in number (Cheng & Mix, 2013). But in this study will be discussed the ability to rotate quickly and accurately two-dimensional figures.

1.2 Sex Differences in Mental Rotation

In view of the apparent pervasiveness of sex differences in mental rotation, two broad approaches can be distinguished to account for them, with specific explanations typically falling into one of these. Biological explanations typically focus on sex hormone levels (Courvoisier, 2013), cerebral lateralization (Hahn, Jansen, & Heil, 2010) and prenatal hormone level (Heil, Kavsek, Rolke, Beste, & Jansen, 2011).

1.3 Mathematics Ability

Mathematical ability is the capacity to use or manipulate numbers effectively in clerical administrative, scientific and other area of application of numbers. It is the ability to understand and work with numbers with ideas related to numbers (Nizoloman, 2013; Fitriana, 2019). In other hands, mathematical ability was considered as a multidimensional construct, including quantitative ability (number

sense and pre-algebraic reasoning), causal ability (examination of cause–effect relations), spatial ability (paper folding, perspective and spatial rotation abilities), qualitative ability (processing of similarity and difference relations) and inductive/deductive ability (Kattou, 2012; Netti, 2019). Mathematical abilities are not innate, but are properties acquired in life and include the following: (1) The ability to obtain mathematical information (i.e. formalised perception of mathematical material), (2) The ability to process mathematical information (i.e. logical thought, rapid and broad generalisation of mathematical objects, relations and operations, the ability to curtail the process of mathematical reasoning, flexibility in mental processes, a striving for clarity and simplicity of solutions), (3) The ability to retain mathematical information (i.e. mathematical memory, which is a generalised memory for mathematical relationships, type characteristics, schemes of arguments and proofs and methods of problem-solving) and (4) A general synthetic component, referred as a "mathematical cast of mind (Szabo, 2017; Misu, 2019).

2. RESEARCH METHOD

2.1 Participant

After the initial framework was developed, the researcher tested the mathematics abilities of students with an range of 13-14 years. From these tests, two students with high mathematics abilities who have differences sex will be obtained. Both of them are then given a mental rotation task to determine the accuracy and speed of completing the given task. In addition to giving mental rotation task, the participants will be interview guide in order to collect data.

2.2 Mental Rotation Test

Mental rotation test will be seen from two aspects: the mental rotation accuracy (MRA) and the mental rotation speed (MRS). An adapted paper and pencil version of the original Mental Rotation Test (MRT: Vandenberg & Kuse, 1978) was adopted . It consists of two parts with ten items each, of the same difficulty, used and tested in previous studies (Moè, 2009, 2012; Moè & Pazzaglia, 2006, 2010). Each item consists of one answer and four deceptive answers. Two of deceptive answers were rotated versions of the target and two of deceptive answers were rotated miror versions of the target. The following rotational angles were used: 45°, 90°, 180° and 360°.

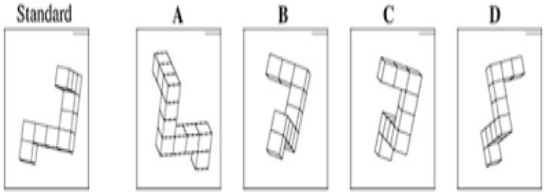

Figure 1 Mental Rotation Test (Vandenberg&Kuse,1978)

Figure 2 Mental Rotation Test

3. RESULTS AND DISCUSSION

The results show that high-ability male students are able to complete 5 items for 45° rotation questions precisely in 5 minutes. There is one wrong answer in this item. While, high-ability female students are able to complete 5 items for 45° rotation questions precisely in 6 minutes. There is three wrong answer in this item.Based on these results then interviews were conducted. High-ability male students do not feel significant difficulties when determining the rotation image at a 45 °. Only when working on a mental rotation is less precise so there is one wrong answer. However,high-ability female students are still somewhat difficult to visualize the result of two-dimensional rotational objects at an angle 45°. This is because they feel confused when asked to determine the rotation results of a certain point. So when asked to determine the results of rotation of a flat building feel difficult. So that only the two items can be answered correctly.

While the questions for rotation 90°, 180° and 360° , high-ability male can be completed in 15 minutes. 3 of the 15 items that were answered incorrectly. High-ability female can be completed this items in 17 minutes. 4 of the 15 items that were answered incorrectly.

Overall high-ability male are able to complete 20 mental rotation questions within 20 minutes. 4 of the 20 items that were answered incorrectly. While high-capable female are able to complete within 23 minutes.7 of the 20 items that were answered incorrectly. High-ability male 3 minutes faster than high-abilty female. Based on these results, it can be concluded that high-ability male have better mental rotation ability compared to high-ability female students.

4. CONCLUSION

This study had demonstrated the students mental rotation ability based on mathematical ability. The result showed that high ability male students able to visualize the result of two-dimensional wake rotation such as rotated as 45°, 90°, 180° and 360°. While high-ability female students are still somewhat difficult to visualize the result of two-dimensional rotational objects such as right triangle too but had a difficultness when rotated as 45°.

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