International Journal of Science and Applied Science: Conference Series P-ISSN: 2549-4635
Int. J. Sci. Appl. Sci.: Conf. Ser., Vol. 2 No. 1 (2017) E-ISSN: 2549-4627
International Conference on Science and Applied Science 2017 doi: 10.20961/ijsascs.v2i1.16742

Profile of Visual-Spatial Intelligence In Solving Geometric of 11th Grades Viewed From Gender Differences

Sigit Rimbatmojo[a)], Tri Atmojo Kusmayadi, Riyadi

Mathematics Education Department of Graduate Program Sebelas Maret University,
Jl. Ir. Sutami 36A Kentingan Jebres Surakarta 57126, INDONESIA

E-mail: Sigit_rrrr@yahoo.com [a)]

Abstract. Visual-spatial intelligence is one of the multiple bits of intelligence that important to solve a mathematics problem, especially in geometry. This present research investigates the profile of students' visual-spatial intelligence. This research focuses on analysis and description of students' visual-spatial intelligence level generally and its aspect when solving the geometric problem. Visual-spatial intelligence aspect, there is imagination, pattern seeking, problem-solving, and conceptualization. Qualitative research with case study strategy was used in this research. The subject in this research involved 12 students of 11th grades chosen with purposive sampling. Data in this research were students' visual-spatial intelligence test result and task based interviews. They were asked to complete visual-spatial intelligence test before interview. The data was analyzed based on visual-spatial intelligence aspect of female and male students. The results of this research show that female students have better pattern seeking and conceptualization. Meanwhile, male students have better in imagination and problem-solving.

1. Introduction

Mathematics is knowledge that plays in many aspects of human life. Mastering it becomes a requirement for us to be able to face the problems of life. As Naomi and Githua [1] state that, knowledge of mathematics as a tool for use in everyday life is important for the existence of any individual and society. It equips students with a unique and powerful set of tools to understand the world and become productive members of the public. Therefore, mathematics has to be learn in all level of formal education. Also, mathematics learning is an important process for preparing and giving students with logical, critical, creative, and systematic thinking ability. Furthermore, mastering it is not only useful for improving students' mathematics achievement, but also to develop and upgrade students' high thinking ability to be able to solve many problems in daily life.

Unfortunately, the importance of learning and mastering mathematics knowledge is contrary to the fact of students' mathematics ability in Indonesia. Many research and assessment showed the low of students' mathematics ability in Indonesia. Based on *Programme for International Student Assessment* 2015 [2], Indonesia ranked 63 out of 70 participants related to mathematics ability. Furthermore, over 60% of Indonesian

Int. J. Sci. Appl. Sci.: Conf. Ser., Vol. 2 No. 1 (2017) doi: 10.20961/ijsascs.v2i1.16742

students were only able to solve mathematics problems to level 1. The results of *Trend in International Mathematics and Science Study* (TIMSS) showed that Indonesian students' rankings in mathematics in 2003, 2007, and 2011 respectively were 34 of 45 countries, 36 of 49 countries, and 38 of 42 countries [3,4,5]. Also, Indonesian students' low achievement in mathematics is also indicated from the national examination results of last three years in senior high school students, as shown in Table 1 [6,7,8]. It shows that students' scores in mathematics always decreased and lower than other subjects.

The low of Indonesian student mathematics achievement was cause by various factors, both factors outside the student as well as factors inside the students. One of the factors is the teachers less attention to the diverse characteristics of students in learning mathematics. The characteristics of the students on the difference in the type of intelligence that is dominant in students as well as gender differences effect of students' mathematics achievement. The results of the national examination and TIMSS 2011 showed that the ability of geometry students in Indonesia is lower if compared to other mathematical materials, like algebra, statistic or opportunities.

Table 1. National Examination Result of Indonesian Senior High School Students for Last Three Years

Year	Subject
	Mathematics Score
2014	60.10
2015	59.17
2016	53.03

Research conducted by Shafiq states that in Indonesia, the Kyrgyz Republic, and Tunisia, girls underachieve in mathematics and science but overachieve in reading, in the research revealed that female students in the State Indonesia, Kyrgyz and Tunisia has a poor performance (children who have high intelligence but low achievement) in mathematics and science but have high achievement in reading [9]. The study showed that girls have lower achievement than the male students. Related to the characteristics of the student's intelligence, every student must have a level of ability or intelligence dominant so Gardner argues intelligence into 8 types (Multiple Intelligence) or commonly abbreviated to MI, namely (1) verbal-linguistic intelligence, (2) logical-mathematical, (3) visual-spatial, (4) rhythmic-music, (5) bodily-kinesthetic, (6) interpersonal, (7) intrapersonal, and (8) naturalistic. Visual-spatial intelligence is the ability to capture the world exactly the visual space [10].

Different characteristics of thinking men and women as submitted Todor states that there were show significant gender differences in implicit theory of intelligence and mathematics self-efficacy beliefs in solving mathematics problem [11]. Results of research Zhu also concluded that there is a difference between the mathematical problem-solving abilities of student male and female [12]. Female students preferred the regular problem solving using algorithms rather than strategy male students. Male students prefer irregular problem solving and using estimation strategies.

Int. J. Sci. Appl. Sci.: Conf. Ser., Vol. 2 No. 1 (2017) doi: 10.20961/ijsascs.v2i1.16742

In some other studies, it is found that not only their differences in math based on the gender point, but how to acquire knowledge of mathematics was also associates with gender differences. Keitel states that gender, social, and cultural dimensions are very powerfully interacting in conceptualizations of mathematics education [13]. This suggests that gender (in this case the male students and female) have a close relationship with the learning of mathematics.

This intelligence has tremendous benefits in education, especially math. Research conducted by Ozlem states that the students who have high mathematical success have more success in the spatial visualization success than others, in the study revealed that students who have success in mathematics can visual-spatial more than other students [14].

Based on the previous description, researchers want to know more about the visual-spatial intelligence of male and female students in solving mathematical problems. By knowing the visual-spatial intelligence of students in solving problems in the geometry class, a teacher is expected to have a reference for decision in choosing the model and the medium of learning for students. Identification of visual-spatial intelligence of students in solving geometry problems need to be done, so it could be an alternative knowledge in mathematics teaching and learning process as well as in continuing further studies for students.

2. Research Methods

This research is descriptive analysis research using a qualitative method with case study strategy. Moleong stated that qualitative research was a research aims to understand phenomenon experienced by the research subjects (e.g. behavior, perception, motivation, action, etc.) holistically and by way of description (in the form of words and language) [15]. Green and Thorogood [16] defined case study as "in-depth study undertaken of one particular 'case,' which could be a site, individual or policy." Thus, qualitative research with case study strategy can be define as a research aims to investigate and understand deeply a specific phenomenon experienced by the subjects. In this context, the phenomenon relates to students' intelligence visual-spatial which specifically focus on its aspect viewed on different gender.

This research was held at SMA MTA Surakarta Indonesia from February until March 2017. Subjects in this research involved 12 students of 11^{th} grade chosen with purposive sampling. Data in this research were students' visual-spatial intelligence test result, interview record, and observation result test. Data collected by interview, visual-spatial intelligence test, and observation. Researcher develops the instrument by considering several indicators relates to the aspect of students' visual-spatial intelligence. In conducting the interview, the researcher was guide by guidance interview sheet which also developed by the researcher based on the several indicators relates to the aspect of students' visual-spatial intelligence. The observation was taken when students attend mathematics test using observation sheet. Those instruments were use after being validated by five expert validators. Also, before using visual-spatial intelligence score test, researcher tested for trial 40 items of the instrument to measure internal consistency

and the reliability. The results of visual-spatial intelligence score test trials were impose on 90 students showed reliability coefficient $r_{11} = 0.91$ with the internal consistency index of items $r_{XY} \geq 0.3$.

Subjects were asked to complete visual-spatial intelligence test and test problem-solving before interviewed and observed. The results of visual-spatial intelligence test, problem-solving test, interview, and observation were analyzed qualitatively to describe students' visual-spatial intelligence level and characteristic. Data were analyze with Miles and Huberman steps of analyzing involve data reduction, data display, and verification [17]. Firstly, researcher analyzed visual-spatial intelligence test results of 50 students to have a description of students' visual-spatial intelligence average score and level. After that, 12 students composed of male and female were interviewed by the researcher to investigate and explore characteristic of students' visual-spatial intelligence. In this case, the researcher focused on investigating and exploring the visual-spatial intelligence aspect.

3. Result and Discussion

Results of this research involve the results of students' visual-spatial intelligence test, interviews and observe. The result of students' visual-spatial intelligence test was described in Table 2. It show the students' mathematics average score and levels either generally or for each aspect (imagination, pattern searching, problem-solving, and conceptualizing). In addition, Table 3 describes data of students' percentage for each visual-spatial intelligence level either generally or for each aspect.

Table 2. Description of Students' Visual-Spatial Intelligence Test Result

Aspect	Subject					
	Male		Female		Total	
	$\bar{x}$	Level	$\bar{x}$	Level	$\bar{x}$	Level
Imagination	8,64	High	3,36	Low	12	Moderate
Pattern searching	6,42	Moderate	8,5	High	14,92	High
Problem solving	8,12	High	4,12	Low	12,24	Moderate
Conceptualizing	4,18	Low	8,91	High	13.09	Moderate
Total	27,36	Moderate	24,89	Moderate	52,25	Moderate

Based on the data of Table 2 and Table 3, students' visual-spatial intelligence level is in the moderate level with the average score is 52.25. Also, there are 54% students in the range of moderate level of visual-spatial intelligence. On the other hand, students with the high and low level of visual-spatial intelligence are respectively 22% and 24%. Based on each aspect of visual-spatial intelligence seems that, generally students' visual-spatial intelligence level for imagination aspect is in the moderate level, with the average score 12 and 58% of students in the range of level, pattern searching aspect is in the high level with the average score 14.92 and 70% of students in the range of level. Problem-solving aspect is in the moderate level with the average score 12.24 and 60%

of students in the range of level and conceptualizing aspect is in the moderate level with the average score 13.09 and 64% of students in the range of level.

Table 3. Students' percentage per each Visual-Spatial Intelligence Level

Subject	Level	Aspect				
		Imagination	Pattern Searching	Problem Solving	Conceptualizing	TOTAL
Male	High	64%	28%	60%	12%	22%
	Moderate	34%	64%	6%	22%	68%
	Low	2%	8%	34%	66%	10%
Female	High	50%	60%	46%	70%	66%
	Moderate	44%	30%	42%	12%	30%
	Low	6%	10%	12%	8%	4%
TOTAL	High	16%	70%	18%	20%	22%
	Moderate	58%	32%	60%	64%	54%
	Low	26%	8%	12%	16%	24%

Data in Table 2 also show students' visual-spatial intelligence levels are various for each aspect. Students' visual-spatial intelligence level for imagination is in the high level of male gender and low level on female gender, pattern searching aspect is in the moderate level of male gender, and high level on female gender, problem-solving aspect is in the high level of male gender and low level on female gender, and conceptualizing aspect is at the low level on male gender and high level on female gender.

The following will be presented a discussion the results of the analysis of valid data characteristic of visual-spatial intelligence of students in solving geometry problems that will be presented in each gender of male and female. The result of students' task in the test of visual-spatial intelligence is as follows;

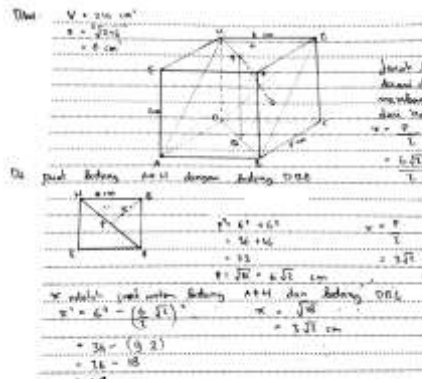

Figure1 The example of male students'

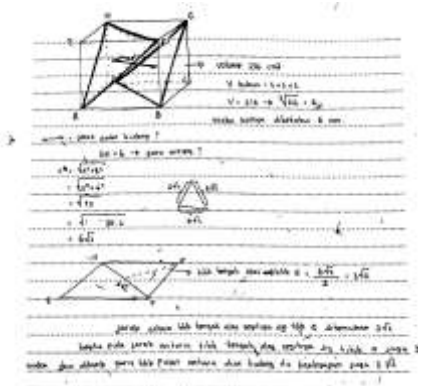

Figure1 The example of female students'

Based on the student's answers can be analyzed further by the interview to know the profile of the visual-spatial intelligence students on every aspect of it.

4. Student Female Gender

In the imagination aspect, one of the three subjects has good imagination characteristics, while the other two have no good imagining characteristics. Subjects are unable to provide relevant information or images according to their imagination. The problem-

Int. J. Sci. Appl. Sci.: Conf. Ser., Vol. 2 No. 1 (2017) doi: 10.20961/ijsascs.v2i1.16742

solving the aspect of the subject in solving the problem, the subject there is no diverse settlement strategy, but it also can't explain the answers he compiled on female students have poor technical problems in solving geometry problems. Furthermore, in the aspect of pattern search and conceptualization give the same result with all three have the good characteristic. The difference in the characteristics of imagining one subject with the other two subjects is because the subject has high visual-spacing resistance, it can imagine a problem well, solve problems in an uncommon way, and can find concepts and connect problems with previous knowledge.

Students of the female gender have good pattern search characteristics and conceptualization. This is based on data analysis that has been done, showing that female students better understand a problem and can link prior knowledge in solving a problem.

5. Student Male Gender

The following describes the results of the analysis of valid data and discussion of the characteristics of visual-spatial intelligence in students of male gender on the aspects of imagination, pattern search, problem solving, and conceptualizing when solving geometry problems.

In the aspect of pattern search and conceptualization, one of the three subjects has a bad characteristic, since the subject can't find a pattern of the material presented and can't find the concept of the problem and the difficulty in relating it to the prior knowledge to complete. Furthermore, in the imagination aspect gives the result that all three have the good characteristic. In the problem-solving aspect, the subject can solve the problem with the right strategy. The difference is caused because the subject has a high visual-spatial intelligence, in addition to imagining a problem well, he can also see a pattern that is formed in the material and can look for the pattern formula then he also can solve the problem well, the thing It is because the subject still understands the previous material or knowledge and can find concepts and relate problems with previous knowledge.

Based on the above description, there are differences in the characteristics of students' visual-spatial intelligence, that female student regarding pattern search and conceptualization are better than men while men are better regarding imagination and problem solving than women. It supported by previous research conducted by Todor stated that there are significant gender differences in the implicit theory of intelligence and mathematics of self-efficacy beliefs [11].

Another study of research conducted by Özerem states that in solving geometry problems related to the terms of reference, the dominant male subject uses the spatial ability while the female subject uses the spatial ability and logical reasoning together [18]. It appropriate with the results of this study that women subjects use logical reasoning to find a pattern, solve problems without the aid of drawings or imagination, and can find concepts and relate problems with prior knowledge. The subject of women

is more likely to think logically than to imagine mentally the rotation of an object in space when solving the problem of space geometry.

Students of male gender have more dominant imaginative and problem-solving abilities likely to be caused by several things. The causes of spatial ability differences particularly related to imaginations between male and female have been widely discuss in various literature. There are many literature was show the causes of these differences which can then be categorized into two broad categories: (1) biological factors, and (2) socio-cultural factors [19]. Biological, researchers focus on human brain development. Humans have two right and left cerebral hemispheres, the right hemisphere is related to the visual-spatial ability, and the left hemisphere is related to language and verbal skills [19]. Woodward explained that the right brain in men is more developed and larger than women, this is what makes men more dominant use of the visual-spatial ability that is imagination than women. In this study women who participated in music, art, or athletic activities had experience with the spatial activity that more had better imagination abilities than women who did not follow the exercise. This indicates that exercise is an important factor that leads to differences in students' visual-spatial intelligence [19].

6. Conclusions

Based on the results and discussion of this research, it can be conclude that the visual-spatial intelligence profile of class 11^{th} female students in solving geometry problem is as follows: female students can find a pattern from given problem and can find problem concept and relate it to previous knowledge. Visual-spatial intelligence profile of male students of class 11^{th} in solving geometry problem is as follows: male students can imagine a problem correctly and can find a pattern of problems and able to solve problems with various problem-solving strategies right.

References

[1] Naomi M W and Githua B N 2013 *Asian Journal of Management Sciences and Education* 2(3) 177-188.

[2] PISA 2016 Results Excellence and Equity in Education Volume I (OECD Publishing: Paris).

[3] TIMSS 2003 International Result in Mathematics, (TIMSS & PIRLS International Study Center: Chestnut Hill).

[4] TIMSS 2007 International Result in Mathematics (TIMSS & PIRLS International Study Center: Chestnut Hill).

[5] Mullis I V S, Martin M O, Foy P, and Arora A, TIMSS 2011 International Result in Mathematics, (TIMSS & PIRLS International Study Center: Chestnut Hill, 2012).

[6] BSNP, Laporan Hasil Ujian Nasional Tahun Pelajaran 2013/2014, (BSNP: Jakarta, 2014).

[7] BSNP, Laporan Hasil Ujian Nasional Tahun Pelajaran 2014/2015, (BSNP: Jakarta, 2015).

[8] BSNP, Laporan Hasil Ujian Nasional Tahun Pelajaran 2015/2016, (BSNP: Jakarta, 2016).

[9] Hafiq M N 2013 Gender gaps in mathematics, science and reading achievments in Muslim countries: A quantile regression approach *Education Economics* 21(4) pp 343-359.

[10] Karamikabir N 2012 Gardner's Multiple Intelligence and Mathematics Education *Procedia- Social and Behavioral Sciences* 31 p 778 – 781.

[11] Todor I 2014 Investigating The Old Stereotype about Boys/Girls and Mathematics:.Gender Difference in Implicit Theory of Intelligence and Mathematics Self-Efficacy Beliefs .*Journal of Social and Behavioral Sciences* 159 (4) 319-323.

[12] Zhu Z 2007 Gender Differences in Mathematical Problem Solving Patterns: A Review of Literature *International Education Journal* 8(2) 187-203.

[13] Iswahyudi G 2012 Aktivitas Metakognisi dalam Memecahkan Masalah Pembuktian Langsung Ditinjau dari Gender dan Kemampuan Matematika Solo: *Proseding Seminar Nasional Pendidikan Matematika*.

[14] Ozlem K 2015 Investigation of Relationship between the Spatial Visualization Success and Visual/Spatial Intelligence Capabilities of Sixt Grade Student Turkey *International Journal A Instruction*: Vol 8 No 1 198 - 199. P-ISSN 1694-609x.

[15] Moleong L J Metodoogi Penelitian Kualitatif (Remaja Rosdakarya : Bandung, 2007).

[16] Crowe S, Cresswell K, Robertson A, Huber G, Avery A, and Sheikh A 2011 *BMC Medical Research Methodology* 11 (1) 1-9.

[17] Sugiyono, Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif dan R&D, (Alfabeta: Bandung, 2013).

[18] Özerem A 2012 Misconceptions In Geometry and Suggested Solutions For Seventh Grade Students. Procedia Social and Behavioral Sciences *SciVerse ScienceDirect* **55**, 720-729.

[19] Yilmaz H 2009 On the Development and Measurement of Spatial Ability *International Journal Electric of Elementary Education* Vol.1 Issue 2 84-96.