Gender reviewed mathematical intuition at 7th grade students through open-ended based-inquiry learning

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Abstract. This study aims to examine the differences in students’ mathematical intuition abilities. Gender was utilized to see the difference through Open-ended Inquiry-Based Learning. The design of this study was a Pretest-Posttest Control Group Experiment. The subject of this study was 156 seventh graders of two Islamic State Junior High Schools in Bekasi, comprising of 77 male and 79 female students. The instrument in this study used 5-item essay with 4 indicators of intuition (globalist, self-evidence, power of synthesis, immediate). SPSS was used to analyze the data. The result of this study showed p-value > \(\alpha\) (0.174 > 0.05). That means there was no difference in mathematical intuition ability between male and female students.

1. Introduction

The mathematicians of the world were Albert Einstein (1879-1955), Jules Henri Poincaré (1854-1912), Christian Felix Klein (1849-1925), and Śrīnivāsa Aiyangār Rāmānujam (1887-1920) works are totally useful and used up until now [1]. The brilliant works of these four are strongly influenced by their intuition. Einstein in his letter [1] put forward a statement: “… the only precious thing in the world is intuition”. The statement was put forward when answering questions asked him about whether intuition guided him in achieving the progress of his research achievements. Furthermore, according to Einstein could have been an invention born through intuition. Based on the above statement explains the importance of intuition for Einstein in creating his remarkable works.

Intuition is an immediate cognition of acquiring and understanding something without relying on a process of reasoning and without justification or evidence [2]. Intuition is not a method, but intuition is a type of cognition that is a thinking activity that was not based on reasoning [3]. Intuition can be learned, acquired, and developed through training and recognition processes [4]. Goldberg views intuition as "intuition as part of a rational and complementary thought toward scientism" [5]. Intuition as part of rational thinking completes science. Medically, the intuition ability is in the right brain [6]. Although often used in mathematical thinking but not maximal and trained, even many do not know the intuition ability importance in solving mathematic problems.

Stanford Encyclopedia of Philosophy defines intuition as immediate apprehension or immediate understanding. The word urgent or immediate does not require causes, abilities (ability) or does not need justification. Studies in the field of cognitive psychology conducted by Davidson et al. [4] devotes attention to the study of the insight process defined as a "sudden" understanding of something. As an example of sudden understanding, if someone after trying to solve a problem in a certain period and failing to resolve it, then a new idea that is questioned appears is a solution then said "aha-this is it…..".
In a study by Davidson et al. [4], intuition was seen as a phenomenon that primarily occurs through implicit and non-analyzable processes. G. Ivinson and T. Bruce stated that intuition is an intuitive idea [7]. In general, intuition is a beneficial idea for explaining how to perceive, observe and think spontaneously and naturally without a lot of deliberate, conscious reflection, and requires no definition and justification.

Zeev and Star [4] states that conclusions based on intuition are typically characterized by explicit information that is slightly/less than the necessary information to conclude. According to Westcott, successful intuitive thinkers tend to have high mathematical intelligence as well as others.

Fischbein [3] defines intuitive cognition as a cognition characterized by self-evidence and intrinsic certainty, perseverance and coerciveness, theory status and extrapolative ness, globality, and implicitness. Fischbein uses the term intuition equivalent to intuitive knowledge: Intuition is not a source, not as a method, but as a type of cognition. The indicators are further defined below [2-5, 7]:

1. Globality, the features: general, simultaneous, not declared step by step, considering other opinions.
2. Self-evidence, the features: righteousness caught straight away, requires no evidence, regardless of premises, no need to be accepted by others, solid and stable.
3. Power of synthesis, the features: assembling separate elements, enjoying challenges, using various means, extrapolating, expanding knowledge based on past experience.
4. Immediate, the features: immediately/ spontaneously, using shortcuts, without careful planning, confident with your own opinion.

Unfortunately, the results of interviews administered to students and teachers infer that there was a problem with students' mathematical intuition. The exercises given to the students were mostly the same as the examples discussed by the teachers, only the numbers were different. When given a slightly different problem from the teacher's example, the students were trapped in confusion and difficulty to solve the problems. This method led students to less creativity development. This method of teaching further directed students to only memorize and imitate the steps of teachers in solving problems without having strong understanding of the mathematical concept.

Based on the survey by giving preliminary tests in some Islamic State Junior High Schools (later mentioned as MTs), students' mathematical intuition thinking ability was still low. From the five intuition skills assigned to 80 students, only 10% answered two questions correctly. 40% only answered 1 question, 50% did not fill out the answer sheets and did not see any idea to solve the problem. The students seemed to find it difficult in answering the questions. However, the results spoke that dominantly, most correct answers came from female students, while male students presented incorrect answers. Such ideas to answer questions are commonly known as intuition.

As a solution to overcome such problems, Inquiry Based-Open Ended (later mentioned as IBOE) learning model had been proven as an effective way to assist students with mathematical intuition enhancement [8-9]. Previously, a number of research using the integration of the two methods of learning was not something new. For instance, a research conducted by Pratiwi, Sarwi, and Handayani [10] who have researched by applying Guided Inquiry with “My Own Dictionary” to improve the mastery of physics lesson concept. However, the model mentioned by [8-9] was originally invented by the researcher. IBOE learning is modified from the steps of the Inquiry learning approach and Open-ended. Based on the second steps of the teaching, the two learning approaches can collaborate into the actions of the Open-ended Inquiry-Based (IBOE) learning. This combination is derived from the defense of both approaches to learning.

The way in which teachers can develop and develop students' mathematical intuitions at school by (1) learning through discovery, (2) learning with the help of visual media, (3) mathematical problems given by teachers is contextual and Non-routine [4]. IBOE posseses those three steps and even more details procedures to conduct learning.

The process of combining the two approaches to learning is an activity carried out through analysis. Researchers analyze the similarities that exist in both teaching, then examine the learning steps that can improve the ability of intuition and mathematical reasoning. Once explained it was rearranged, so it becomes the IBOE learning steps. The process is presented in the following Figure 1.
Five Steps on Inquiry learning and four steps on open-ended learning (Shimada et al.), after being combined have similarities that can merge into one step [11]. The level (syntax) of Open-ended Inquiry-based learning (from now on referred to as IBOE) is a modification of Inquiry learning and an open-ended approach applied to this research as follows:

1. Teachers directly provide open-ended questions/issues that are outlined in teaching materials and student worksheet
2. Collection of verification data with the assistance of teacher guidance.
3. Data collection through experimentation (trial and error) with the media provided by the teacher. In this case the teacher as a consultant and facilitator.
4. Process analysis finds.
5. Teachers guide learners in analyzing to see concepts and answer solutions.

Gender factors improve the way to acquire mathematical knowledge and intuition to acquire mathematical knowledge. Therefore it is necessary to study the intuition characteristics of students in solving mathematical problems in terms of mathematical abilities and gender differences [12].

Gender as expectations culture against men and women (cultural expectations for women and men) [13]. Subjects to be studied in this study were male and female students of 7th grade at MTs. All subjects were given IBOE study on geometry material, then analyzed the difference of their mathematical intuition ability by providing the form test description.

2. Experimental Method

This research employed quantitative approach with quasi-experimental technique, analyzed by t-test because the subjects studied were not randomly grouped, but have been formed and accepted [14].

The design used was nonequivalent pre-test and post-test control-group design [15]. In this design, each subject studied was given a pre-test (O), and after the treatment, they were given post-test (O). IBOE learning was implemented in the experimental class, while control class was treated by lecturing technique in their learning session. The material delivered to those classes were quadrilateral and triangle (geometry).

The seventh graders of MTs schools in Bekasi were the subjects of the present study consisting of four classes (2 classes for each MTs) selected by purposive sampling. The researchers selected class 7.1 and 7.3 in MTs. A, and class 7.4 and 7.5 in MTs. B. The reason of choosing them as the subject was due to the fact that they aged between 11-12 years old, which is potentially in the best phase of intuition development [16]. Time efficiency, financial consideration and the research preparation were also taken...
into account. The total number of samples were 156 students. The Table 1 presents more detail information about the subjects.

### Table 1. Sample Research

| MTs. | Class | Sample Size | Male | Female | Amount (Students) |
|------|-------|-------------|------|--------|------------------|
| A    | 7.1   | 39          | 37   | 40     | 77               |
| A    | 7.3   | 38          |      |        |                  |
| B    | 7.4   | 38          | 40   | 39     | 79               |
| B    | 7.5   | 41          |      |        |                  |
| Total|       | 156         | 77   | 79     | 156              |

The instruments used to measure the ability of mathematical intuition thinking was in form of a test in accordance to the 4 indicators set in advance: globality, self-evidence, synthesis, and immediate [16]. The first step in performing the test was administered by examining the face validity and content (expert judgment) by nine experts with their experience and expertise in Mathematics. Friedman Test statistic was used to measure the diversity due to the scoring technique; in the present research the scoring technique applied was continuum scoring. The results of test was provided in the following Table 2.

### Table 2. Friedman Test

| chi-square | df | Asymp. Sig. |
|------------|----|-------------|
| 5.065      | 4  | 0.281       |

Based on Table 2, the obtained p-value > 0.05, that means that all experts state the same opinion about the research instrument variable ability mathematical intuition. In brief, all instruments of intuition thinking ability are acceptable to use. The instrument was then tested to 40 students of grade 8 in two MTs. (20 students from each).

### Table 3. Instrument Validity Test

| No. Item Problem | r count (Pearson Correlation) | r table n = 40 | Interpretation | Criteria Validity |
|------------------|-------------------------------|----------------|----------------|------------------|
| 1                | 0.577                         |                | Enough         | Valid            |
| 2                | 0.621                         |                | High           | Valid            |
| 3                | 0.639 0.312                   |                | High           | Valid            |
| 4                | 0.675                         |                | High           | Valid            |
| 5                | 0.724                         |                | High           | Valid            |

Shown in Table 3, all instances are valid. Item number 1 is categorized as fair, and item 2, 3, 4, and 5 as high criteria. Then the whole item are valid to use in the test.
3. Result and Discussion

3.1. Result

The data obtained was then tested with the prerequisite test consisting of test of normality and homogeneity. The results are in Table 4.

| Group | Kolmogorov-Smirnov | Shapiro-Wilk |
|-------|--------------------|--------------|
| Score | Statistic          | df           | Sig. | Statistic | df | Sig. |
| Male  | .071               | 77           | .200 | .984      | 77 | .443 |
| Female| .120               | 79           | .007 | .971      | 79 | .072 |

Table 4. Normally Test

* a. Lilliefors Significance Correction

Table 5 shows that p-value (2 tailed) > α (0.174 > 0.05). The hypothesis of the present research is Ho= there was no difference in mathematical intuition ability between male and female students, meanwhile Hi= there was a difference in mathematical intuition ability between male and female students. Ho is accepted if p-value < α, while Ho is rejected if p-value > α.

3.2. Discussion

Mann Whitney-U test result explicitly indicates that p-value > α (0.174 > 0.05). This further means that the research hypothesis was rejected. Overall, there was no difference in intuition ability between male and female students. However, if examined based on the answers of the given questions, especially on the question number 3, it is clear that the intuition of females students are more diverse and unique than male students. The unique intuition emerging based on the analysis of answers of the questions can be seen in Figure 2.

Table 5. Mann-Whitney-U Test

| Value | Value         |
|-------|---------------|
| Mann-Whitney U | 2659.0       |
| Asymp. Sig. (2-tailed) | .174     |

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Better ideas found in female students’ answer, the stages of the idea appeared seems to be more coherent including the presence of declarative sentences. Such ideas are not identified in boys’ answers. Similarly, in question number 4, the difference in a gender-based answer is detected. Figure 3 shows the details.

Figure 3. Student answers to item 4

Two answers to the questions given to male and female students reinforce that although there is no difference in intuition between male and female students, the mathematical intuition raised by female students is unique. The mathematical intuition performed by male students follows the material being studied, thus they drew a rectangular shape in their answer sheet, while female students’ chose to draw a circle although the classroom session did not discuss circle. Such an intuition need further research to see its significance.

4. Conclusion
The findings explicitly indicates that the research hypothesis was rejected, for p-value > 0.05. That shows there is no difference in mathematical intuition ability of male and female students in 7th at MTs. In solving mathematical problems, male subjects use intuition on indicators of globality, self-evidence, and immediate. The power of synthesis is less appears and an attitude of self-confidence is excessive, so that less creativity appears in intuition male students. On the other hands, in solving mathematical problems, female subjects use intuition on indicators of globality, and immediate. So the less immediate indicator appears, because many considerations that ultimately multiply the answers, this increases the consideration of self-confidence in intuition female students. Lastly, the research further suggests that female students’ intuition was considered much better and unique compared to male

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