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The Application of Intuition in Solving the Problems of Math in the Olympiad of Mathematics

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***Abstract*—** *In solving mathematical questions, students are required to use ways of thinking that make easy to get the right answer. The student's way of thinking is not bound by how he uses certain formulas so as to obtain the final answer, but rather how the method used by students as a solution to solve the correct questions. One of the methods used in solving the questions that students need is the intuitive way of thinking. Intuitive thinking is an idea that arises spontaneously in students' minds to solve the questions, after the student understands the problems they face. Intuitive thinking is divided into 2 types, namely: intuitive intensive thinking and intuitive extensive thinking. Intuitive intensive thinking is the spontaneous thinking of students when facing problems in order to get the right answer, and it is supported by feeling and intrinsic. While intuitive extensive thinking is a way of spontaneous thinking of students when facing problems in order to get the correct answer based on past experiences and supported by feelings and interventions. Researchers used a qualitative descriptive method on 4 students who participating in the Math Olympiad when completing math questions. The results obtained that when completing the questions, the students use intuitive thinking to get the right answer. Each student uses a different method, but the results obtained can answer the researcher's problem, i.e. 1 student is able to work with intensive intuition and 3 other students use extensive intuition.*

***Keywords*—** *Intuition, intuitive thinking, problem, question, mathematics, problem solving.*

I. INTRODUCTION

Mathematics education is often complained by many parties because of the lack of students' understanding on the problem solving process at hand. Many students cannot solve math questions given by teachers at school, and this problem causes the results of mathematics lessons not in accordance with community expectations. The world of mathematics education is often a scourge for many people, because the way to solve mathematics questions with formulas and methods is extremely difficult to understand. Mathematics is one of the fields of study that received considerable attention from various parties, both from the community and the government. Various efforts have been made to improve the quality of mathematics education in Indonesia by several parties concerned with mathematics. But the learning outcomes achieved are not in accordance with the targets set. This is evident from the results of students' National examinations both at the elementary and secondary school levels.

Talking about the pursuit of mathematics in school is inseparable from the problems contained in it. Mathematics is often complained of as a difficult and boring field of study for students because it is taught in an unattractive method, where the teacher explains the material while the students just take notes, and then give questions to students to solve. Regardless of whether students understand or not in solving problems, it is often not a special concern of the teacher. This will have an impact that the students' math scores are lower than those of other subjects.

According to Soedjadi (2006) the causes of difficulties can be sourced from within students and also from outside students, difficulties from within students including students' interests, motivation and self-confidence. While the complexity of the students outside includes the way the presentation of subject matter / learning atmosphere is carried out. Furthermore it was said that no matter how appropriate and good the mathematics teaching material applied did not guarantee the achievement of mathematics education goals would be achieved.

The current trend of learning mathematics is learning that focuses on the active involvement of students. But the reality in the field shows that learning mathematics in schools is still running conventionally. Many mathematics teachers dominate the lesson so that student activities tend to be lacking. This of course has an impact on the achievement of student learning outcomes. In line with that, Yuwono (2001: 2) states that conventional mathematics learning causes students to only work procedurally and understand mathematics without reasoning.

Intuitive thinking means working with feeling and having strong belief to make a decision. In making a decision someone needs an appropriate strategy, so that the decision taken can really solve the problem at hand. Intuitive thinking will arise when someone is having trouble finding the right answer in solving a problem. Problem solving is often found in the process of learning mathematics in schools. Mathematical problem solving can be done in various ways, including by analytical thinking and intuitive thinking. According to Kustos (2010) intuitive thinking is a cognitive process through feeling and perception. And intuitive thinking is different from analytic thinking.

Solving mathematical problems is an important part of the process of learning mathematics. Problem solving allows students to use the knowledge and skills they already have. Solving the questions requires a higher level of thinking ability. To solve mathematical problems can be done in a way including analytical thinking, and can also by intuitive thinking. Usodo (2011) says that intuitive thinking plays an important role in determining mathematical problem solving strategies, because with intuition students have creative ideas in solving mathematical problems. Many students are good at

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solving math problems often using clever ways, so that they provide concise and accurate answers. This creative notion is in line with the demands of the 2013 curriculum which require student creativity in the process of learning mathematics.

According to Kustos (2010), problem solving that is not analyzed is a characteristic of intuitive thinking. Intuition is different for each person, students should rely on their own intuition in the process of solving mathematical problems. Mathematical problem solving by intuition will produce answer solutions or different ways of solving from each student. Intuitive thinking in solving mathematical problems often occurs, but is not realized by the teacher or students. Intuitive thinking in general is the appearance of ideas in one's mind to solve problems in their own way, but get the right answer.

To analyze the appearance of students' intuitive thinking in solving mathematical problems, the researcher made initial observations at school. Based on the results of preliminary observations, it was found that many students gave spontaneous answers, without analyzing them first. Regardless of whether a student's answer is right or wrong, what is important for researchers is that students have used their intuition, answering spontaneously. Spontaneous what happened here was concluded by the researcher that the students answered directly, which might be the thought process linking the information now with the knowledge that had been obtained and has been stored in student memory, so as to produce answers without having to prove it or maybe even thoughts that appear suddenly when students understand the problem.

There are three factors that support the appearance of intuitive thinking, namely:

1. Feeling, which means that the appearance of ideas in the mind is a solution to the problems faced so that making decisions to produce spontaneous answers.
2. Intrinsic, meaning that there are thoughts that arise suddenly, as a strategy to make decisions so as to produce spontaneous answers in solving problems. Intrinsic that happens is still related to feeling.
3. Intervention, meaning that the thought process that arises has been linked to prior knowledge as a strategy for making decision so as to produce spontaneous answer in problem solving. Intervention that occurs is still related to feeling. (Note: word "feeling, intrinsic and intervention are not words in grammar on KBBI or general agreement, otherwise those three words given meaning by researchers as theoretical findings for the supporting factors for the appearance of intuition)

The human brain has three parts, namely the left brain, midbrain and right brain. Some experts have examined the location of the thought process in the human brain, including intuitive thinking. The left brain emphasizes analytic thinking, the right brain emphasizes imaginative thinking while intuitive thinking lies in the midbrain. The midbrain is deciding how to act in response to the sensory information that received. It is therefore the first step of the midbrain is determines how people react to what they see and hear. Here's a picture of the intuitive thinking part of the brain:

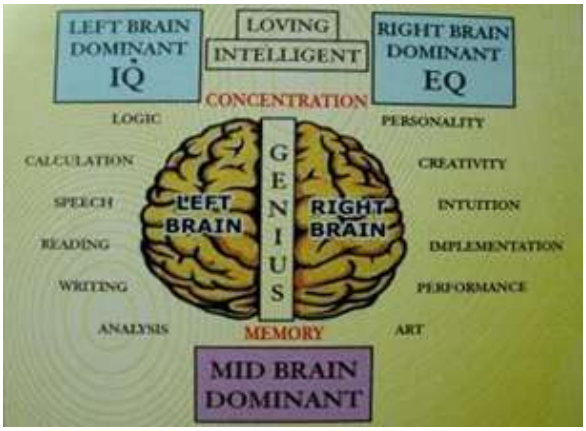

Figure 1.1 Human's brain

From the brain image it appears that the midbrain is very small in size but has benefit that is no less important than the functions of the left brain and right brain. Related to the midbrain, if a question is given to someone then that person will reflexively answer what is asked to him. This is an intuitive way of thinking, because the person will answer according to thoughts that arise spontaneously. The process of intuitive thinking starts from the external environment in the form of problem information, which enters one's mind through the five senses, then is processed in the mind / brain to create a solution to solve the problem. The solution returns to the external environment in the form of spontaneous answers. Intuition produced by someone can be known through vision and hearing.

According to Voskoglou (2006), intuition plays an important role in problem solving. Intuitive thinking is very necessary if students experience obstacles in the process of formal proof of the problem at hand. Following in the opinion of Fischbein (1987) the most practical intuitive thinking in mathematics can be exemplified that if A = B and B = C then A = C, this intuitively can be understood clearly. However, if it is proven by analysis A, B and C, are the value of algebraic operation result. Other examples that can be intuitively accepted like the set of natural numbers and the set of positive numbers are equivalent. According to Fischbein (1987) the two sets are said to be equivalent as follows: "*This is intuitive knowledge - a kind of knowledge which is not based on sufficient empirical evidence or on rigorous logical arguments and, despite all this, one tends to accept it as certain and evident".* Analytically, the example of two equal sets must illustrate the fact that the elements in the set are certain and consistent.

In the process of mathematical problems solving, the teacher should provide opportunities for students to solve problems in their own way, so that problem solving solutions are intuitions that are generated to get the right answers. The teacher can stimulate students' minds when they find a way to solve a problem, or maybe when they are lack concentration to solve a given problem. The stimulus provided can be the final answer to the problem, but not the process of getting the answer.

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II. Research Methodology

The approach used in this study is a qualitative approach to the type of descriptive research (Creswell, 2012). The purpose of this study is to describe the appearance of students' intuitive thinking as a solution to overcome the low achievement of mathematics learning. To uncover or obtain a description of the intuitive thought process used by students, the researchers try to carry out a careful examination on the results of the completion of the questions and in-depth interviews (by exploring) the subjects about what was written, said, or even what they thought when answering the interview questions and solving math problems.

The data collected in this research is descriptive including observational data, and verbal data in the form of data obtained from answers to questions and interviews. The subject of the research was the eighth grade students of junior high school consisting of four persons who were selected based on the results of the intuitive ability test in solving mathematical problems. The reason for the selection of four students is because researchers get saturated data or the answers almost the same that raises the intuition of each test given. The test is given three times where in each test the researchers give one mathematical problem. In three times of the test the researchers found four students from thirty students who can solve mathematical problems. The subjects this research are junior high school students from four different schools in the city of Ende. In this study, the researchers gave two questions to be completed by the subjects of research. The test questions are taken from the materials of National Mathematics Olympiad for Junior High School. The questions are taken from Palette of Problems, NCTM April 2010 for question 1, and from Palette of Problems, NCTM April 2011 for question 2. These two questions have been validated by two experts, namely OSN supervisor and mathematics teacher at SMPK St. Ursula Ende.

Data collection in this study uses two questions that have been validated. The two questions are then given to the research subjects to be solved by bringing up intuitive thinking in the solution process. The data that has been collected, then analyzed using the following steps: 1). Prepare and transcribe data for analysis; 2). Read the entire data; 3). Coding the data; 4). Linking hypotheses with evidence of the appearance of intuitive thinking; 5). Present the data; 6). Interpret the appearance of intuitive thinking; 7). Draw a conclusion.

Data triangulation is carried out to test data credibility or trust in data. There are 3 types of data triangulation as revealed by Wiersman (2009) that triangulation in testing data credibility is defined as checking data from various sources, various ways, and various times. In this study, the data credibility or trustworthiness test of the results of the study was carried out with source triangulation and time triangulation. Source triangulation means that the researcher conducts an interview with the same source or the same subject after the subject has solved the problem to find out the emergence of intuitive thinking from the subject when solving a given mathematical problem. Triangulation of time is also used by researchers to determine the consistency of the subject's answers. Time for the interview is done after the subject has finished solving the mathematical problem.

III. Result and Discussion

Based on the previous description that in this study will be given two questions used for test on research subjects in order to obtain a description of intuitive thinking in the process of completion. The test questions that will be given are:

1. What are the operating results from 202010 x 202012 - 202009 x 202013?

2. Pay attention to the numbers below!

3,9,15,43 and 138

How do you get the numbers 15 and 43 if these two numbers are the results of each operation of the other three numbers?

The following is a discussion on research results from four subjects in solving mathematical problems in bringing up intuitive thinking. The identity of the subject is S1 for the first subject, S2 for the second subject, S3 for the third subject and S4 for the fourth subject. Next is the rinsing of the results of the problem solving.

1). The result of question completion by S1

1).a The answer by S1 is:

202010x 202012 - 202009 x 202013

= 120 - 117 = 3

Questions completion generated by S1 raises intuitive thinking which is supported by factors that arise intuitive thinking. Problem solving 1, intuitive thinking arises when S1 determines to cross out the same numbers from the four groups of numbers operated, namely the four-digit front number, that is number 2020. Furthermore, students make ordinary algebraic calculations, 12 x 10 minus 09 x 13 so they get the result 3. Problem solving 2 also shows that S1 spontaneously after understanding the questions directly solve the problem according to the results of the writing. In understanding the problem, S1 does not use a particular process, for example, illustrate or describe in advance what he/she understands, but S1 understands directly the problem given. This direct understanding is not because S1 already has experienced doing problem solving as provided by researchers or has read articles about the same problem, but it is really happen that shortly after reading the text of the problem S1 actually understands the problem obtained. By this case if it is connected with theory, in order to understand the problem it is used direct cognition (self-evident), meaning that cognition is received directly by individuals without the need for further checking and proof. Meanwhile, if related to the study of Kustos (2010), there is an instinct component, which means understanding the problem with the appearance of a response in thinking the problem being faced. This is also evidenced from the results of interviews with subjects in answering the researchers' questions.

1).b The answer for number 2 by S1

To get number 15 and 43, can be done by calculating formula as follows:

a. 138-3 = 135:9 = 15

b. 138-9 = 129:3 = 43

Based on the answer by S1 in this paper, the researchers then interviewed S1. The results of the interview show that

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after understanding the problem S1 immediately solve the problem in the manner as in this paper. It was also conveyed that thoughts that arose based on calculations shortly after reading the numbers given but not on the scratches / doodles done to answer the question, even though researchers provoked with the question that the material about number operations had been studied by S1 before but the answer remained that S1 thought immediately to solve the problem / question.

Based on the results of problem solving carried out by S1 in the above writing, it can be concluded that S1 uses an intuitive way of thinking because S1 does not use the long way of calculating or scratching an answer first. Intuitive thinking that appears in the form of ideas suddenly as a strategy in making decisions based on feelings, intrinsic and intervention so as to produce answers to solving the problem at hand. This is in accordance with the opinion of Fischbein (1987) that is using the anticipatory intuition where problem solving is contrary to conjecture in general, meaning that S1 claims an unusual procedure but S1 feels the claim it generates is true. Whereas if it is associated with the opinion of Kustos (2010) the method used by S1 is included in the perception and global components, because S1 produces the correct answer solution.

2). The result of problem solving by S2

2). a Question number 1 is:

What is the result of the sum of 202010 x 202012 - 202009 x 202013

The answer by S2 is:

202010 x 202012 − 202009 x 202013

= 10 x 12 − 09 x 13

= 120 − 117 = 3

The problem solving done by S2 rises an intuitive thinking similar to S1. Intuitive thinking arises when students decide to take two back numbers from the 4 groups of numbers given in the problem which are 10 x 12 - 09 x 13. Furthermore students do calculations so that they get 120 - 117 and the result is the same as 3. In solving a problem, S2 directly solves the problem after understanding the problem given.

2). b The answer by S2 for question number 2:

To gain number 15 and 43 can be conducted by calculating formula as follows:

a. 138-3 = 135:9 = 15

b. 138-9 = 129:3 = 43

Problem solving for question number 2 by S2 can be seen from the result of his writing that to get the number 15 that is operating number 138 minus 3 get 135 then divided by 9 the result is 15 and to get number 43 operations number 138 minus 9 get 129 then divided by 3 then get number 43. This is in line with the interviews result with S2 by researchers, which explain that firstly S2 does operation with two numbers so that it gets result and then the result obtained is reopened with one remaining number to get the final answer requested, both number 15 and number 43.

Based on the result of problem solving carried out by S2 on this problem, it can be concluded that S2 uses intuitive thinking. Intuitive thinking is based on feeling, intrinsic and intervention so as to produce answers without any scribbles first. If it is related to the opinion of Fischbein (1987) using anticipatory intuition, namely problem solving contrary to the conjecture in general, meaning that students make an unusual procedure claim, but students feel the resulting procedure is correct. Whereas if it is associated with the opinion of Kustos (2010) the method used by the S2 is included in the perception and global components, because students perceive the answer solutions that will be generated, then resolved to obtain result.

3). The result of problem solving by S3

3). a The answer by S3 for question number 1 is:

202010 x 202012 − 202009 x 202013

= 2210 x 2212 – 2209 x 2213= 120 - 117 = 3

Problem solving produced by S3 rises an intuitive thinking supported by factors supporting the appearance of intuitive thinking. Intuitive thinking arises when students decide to cross out two zeros two numbers per set of numbers. Then S3 crossed out 22 numbers from each number set, then first from each group of numbers, then there was another thought after seeing that there were still two equal numbers remaining in each group of numbers and then proceeded to get the final result 3. So the activity of crossing out numbers occurred twice for each group of numbers then a calculation is made of the remaining numbers in each group of numbers. The results obtained are the same as the results from S1 and S2. By this case if it is connected with the opinion of Fischbein (1987) there is an affirmative intuition that is to understand the problem used direct cognition (self effect), whereas if it is connected with the study of Kustos (2010) then there is an instinct component, which means understanding the problem with the appearance of response in thinking about the problem being faced.

3). b The answer by S3 for question 2

To gain number 15 and 43:

a. Number 15 gained by 138-3:9 = 15

b. Number 43 gotten by 138-9:3 = 43

Problem solving question 2 by S3 is done directly by performing subtraction and division operations so that it gets result. This is in line with the results of interviews by researchers of S3, but the answer is additional to the problem solving process, which is better to deduct 138 minus 3 and 138 to minus nine. Problem solving question 2 is considered by researcher not much different by S1 and S2 rise an intuition in the process of completion.

Based on the results of problem solving carried out by S3 on two problems above, it can be concluded that S3 uses an intuitive way of thinking, in particular to produce answers to the solution in a way that is appropriate for the result of the writing above. The thought process that produced in problem solving is illustrated as an intuitive way of thinking that conducted by S3. If it is related to the theory referenced by the researcher in Fischbein's opinion (1987) using anticipatory intuition, namely problem solving contrary to the conjecture in general, meaning that students make claims of an unusual statement, method or procedure, but students feel that the claim, method or procedure that produced by them is true. Whereas if it is based on the opinion of Kustos (2010) the method used by S3 is included in the perception and global components.

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4). The result of problem solving by S4
4). a The answer by S4 for question 1 is:
202010 x 202012 - 202009 x 202013
= 2010 x 2012 - 20109 x 2013
= 10 x 12 - 9 x 13 = 120 - 117 = 3

The problem solving generated by S4 in question 1 rises an intuitive thinking when deciding to cross out two of the same numbers from the four group of numbers that are operated, namely the two front numbers are 20. Then the students write four remaining numbers to operate. Because there are still the same numbers then crossed out again 2 the same numbers that is 20 in each group of numbers. Then the calculation is done so that it gets result 3.

4). b The answer by S4 for question 2
a. Number 15 is gained by 138 - 3 : 9
b. Number 43 is gotten by 138 - 9 : 3

Problem solving number 2 by S4 according to the result of this paper is that the number asked is obtained by the direct operation of the other three numbers using the same two operation, namely the deduction and division operation. The appearance of intuitive thinking in the settlement process is really done after S4 understands the problem. This is reinforced by the result of interview done researchers to S4, the answer is after understanding the problem, S4 immediately thinking that the largest number, 138, must be placed first in the next calculation operation process as seen in the answer by S4 in his writing.

Based on the result of problem solving carried out by S4 on problem 1 and problem 2, it can be concluded that S4 uses intuitive thinking. Intuitive thinking on solving problems is described when S4 solves the problems. If it is related to the theory referred by researchers, then in the opinion of Fischbein (1987) using anticipatory intuition, namely problem solving contrary to conjecture in general, meaning that students make claims and claims, the resulting is true. Whereas if it is associated with the opinion of Kustos (2010) the method used by S1 is included in the perception and global component, because students perceive the answer solutions that will be generated, then resolved to obtain the result.

IV. Conclusion

Based on the analysis of the results and discussion of each research subject, the researcher can conclude that in the process of solving mathematical problems, students often use intuitive thinking. In line with the purpose of this study that is to find out the appearance of the subject's intuitive thinking on problem solving which is one of the solutions is to overcome the low achievement of mathematics learning. Based on data analysis and discussion of the results of the research above, then it is concluded as follows. Intuitive thinking will appear in mathematical problem solving if students experience obstacles to continue problem solving. Intuitive thinking will appear based on three supporting factors of thinking done by students namely feeling, intrinsic and intervention. The process of generating ideas suddenly is said as a feeling that occurs in students' thoughts. Spontaneous answers resulting from momentary thinking on problem solving faced by students are an intuitive way of thinking, because students do not use the long way to claw the questions given and do not take long time to answer the researcher's questions at the interview.

The appearing of intuitive thinking in mathematical problem solving by students is a solution to get problem solving properly, therefore it can be said by researchers that intuitive thinking is one of the solutions to overcome the low learning achievement of mathematics. By this conclusion, it can be suggested to the teachers as follows: a). in mathematics learning in the class, teachers should provide questions or problems that can stimulate students to bring up intuitive thinking; b). In the process of problem solving, it is expected to involve students using intuitive thinking by giving them freedom to do problem solving. Let students try to do problem solving, their intuition will be involved or stimulated to make decision dealing with problem solving. Here the teachers will get lots ways given by students in problem solving for getting the right answers.

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