Number sense ability of junior high school students

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Abstract. Number sense is a basis for learning mathematics. It can be interpreted as a person’s sensitivity about numbers and its operations with flexibility and intuition about numbers. If students have a good number sense ability, they will not encounter difficulty in solving number related problems. The fact is, number sense ability on various educational stage are still low. Students don’t have the sensitivity on the nature of the order of numbers. This study aims at classifying students’ number sense ability. So, in the near future, an effort to resolve the problem can be done. The subjects of this study were 80 ninth grade students of MTs NW Putra and Putri Narmada. The instrument that used in the study was 10 item number sense questions that were completed in 15 minutes. The result shows that the students’ number sense ability was at a low level with an average percentage of correct answers only 29.75%. Therefore, it can be inferred that the students are still weak in all components of number sense. The lowest skill is in the second component that is knowledge of facility with operations, with the result that the percentage of the number of correct answers is only 16.67%.

1. Introduction

A good number sense ability is a must have for students as a fundamental on learning various mathematics materials at school [1]. Number sense has been introduced even before kids starts the formal education at school. Then, kids are formally introduced to addition and subtraction operations at pre-school until higher education institution [2]. The importance of number sense becomes a fundamental to develop mathematics understanding of students on numbers along with the operations [3, 4]. Number sense also becomes the fundamental to algebra reasoning. So, when a student is weak at number sense, the students will have constant difficulties on learning at the higher stage [5]. Besides, awareness to numbers also becomes an important part that will develop student’s skills on solving the problems that often found in the daily life [1, 6]. Thus, with the better trained skills to utilize number counting operations, students can easily find different easier methods to achieve the most accurate solution.

According to McIntosh, Reys & Reys [7], number sense is one’s awareness on numbers and its operations along with the skills to utilize the understanding on solving mathematical problems using flexible methods. Someone that is aware will be able to flexibly do mental calculation, computational estimation, create various representation of a number and implement the best strategy on solving a problem [8]. Number sense covers the ability to flexibly operate numbers and quantity [9]. The skills and ability on operating numbers can be owned by a student that has good number sense ability [10]. As an example, students are given the question “the estimated addition results of $\frac{13}{14} + \frac{7}{8} + \frac{1}{7}$ is.....”. Many
students are unable to answers flexibly the question regarding the estimations of a fractional calculation. Students abolish mental calculation and choose to calculate using pencil and paper. Another example is when students are given the question “How many numbers are there between 0 and 1?” Most of the students answer there are no numbers between the two mentioned numbers. So, it can be said that students don’t have the sensitivity on the nature of the order of numbers.

The fact is, number sense ability on various educational stage are still low [11-13]. Based on the previous research, it is not yet explained about which components or indicators of students’ number sense test results that are still poor. Some research show that the students’ number sense ability is at the low category. This is because students can’t solve a problem using number sense ability well [13]. Another research also shows the unsatisfying result about students’ performance on number sense problem solving. Only 25% of 790 subjects that can implement number sense-based solution method [14]. Students with a strong understanding of number sense about numbers will be able to represent numbers, understands the correlation between numbers and number system [15]. Students can also create a rational estimation, calculate seamlessly and utilize visual model based on their number sense ability to solve problems. Based on the explanation, this research aims to analyze Junior High School students’ number sense ability and to detect the weaker number sense component. So, in the near future, an effort to resolve the problem can be done.

2. Research Method
This research is a descriptive-quantitative research that was conducted on 3 and 14 December 2019. The data is collected based on the number sense ability test result that is carried to the 8 graders of MTs NW Putra and Putri Narmada. The research subjects are chosen by using cluster purposive sampling technique and 80 students consist of 40 male students and 40 female students are obtained as the research subjects. Subjects are given 10 questions about number sense that are constructed based on number sense components as shown on Table 1 [7, 16, 17]. The questions are answered within 15 minutes. The right answer for each question will be scored 1 and the wrong answer for each question will be scored 0.

After all data are collected, the analysis is conducted using Microsoft Excel. The analysis process in this research aims to collect detailed information about the number sense ability level of the junior high school students. Besides, another analysis to find the weaker component of number sense will also be conducted.

| Components                                      | Indicators                                                                 | Items          |
|------------------------------------------------|---------------------------------------------------------------------------|----------------|
| A. Knowledge of facility with number           | 1. Sense of orderliness of numbers                                         | Questions 4, 5, 6, 7 |
|                                                | 2. Multiple representations for numbers                                   |                |
|                                                | 3. Sense of relative and absolute magnitude of numbers                    |                |
|                                                | 4. System of benchmarks, that is using students’ expertise and experience in assessing a different context |                |
| B. Knowledge of facility with operations       | 1. Understanding the effect of operations                                 | Questions 1, 9, 10 |
|                                                | 2. Understanding mathematical properties                                  |                |
|                                                | 3. Understanding the relationship between operations                     |                |
| C. Applying knowledge of facility with number and operations to computational settings | 1. Understanding the relationship between problem context and the necessary computation | Questions 2, 3, 8 |
Components | Indicators | Items
--- | --- | ---
2. | Awareness that multiple strategies exist | 
3. | Inclination to utilize an efficient representation and/or method | 
4. | Inclination to review data and result for sensibility | 

3. Result and Discussion

The number sense ability data collection process on 80 participants shows that the mean percentage of correct answer is 29.75% with low category [17, 18]. Figure 1 shows the mean percentage of correct answers on each components of number sense.

Based on Figure 1 it is seen that the lowest percentage of the correct answer, 16.67% comes from component B, which is knowledge of facility with operations. The causes of many participants failed to answer the question is, some of them, because students doesn’t have a good ability on numbers estimations, doesn’t understand the nature of the order of numbers, and doesn’t understand the correlations and connections between number operations [19]. Numbers estimations correlates strongly with number sense, as an ability to estimates and to distinguish the sum without using symbols [20]. Students’ ability on estimating will ease students on conducting mental calculation. Meanwhile, a fast, flexible and constructive mental calculation depends on the knowledge development of a student [21]. In the other side, if students can’t understand numbers, then the students will find it difficult to solve mathematical problems and cause major hindrance that is hard to overcome on learning mathematics [22].

Figure 1 also shows that not many students that can complete the test accurately when it comes to number sense. On the Figure 1, the percentage of each components doesn’t surpass 60%. That means, even at each components of number sense are still at a low level [18]. The poor ability of number sense can lead to student’s low achievement on math [12, 23, 24]. This is also shown on the PISA 2018 test result where Indonesia holds the 72nd position of 79 participating countries [25]. Generally, the weak component of number sense will cause students to experience difficulties on solving various given math problems, especially the problems that involve high level reasoning skills [26]. In the future, students are expected to be able to apply what have been learned when given life problems that involve numbers. Not only can calculate using standard algorithms like formulas and written calculations, but also can develop intuitions based on a meaningful learning [27].

Furthermore, the result of this research shows that the question that has the lowest frequency of correct answer is Q2 with only 1 participant or 1.25%. Instead, question with highest frequency of correct answers are Q8 with 49 participant or 61.25%. The frequency of the correct answers from the number sense test result will be explained in detail on Table 2.
Table 2. Frequency of the correct answers from each questions

| Component                                    | Items   | Frequency | Percentage (%) |
|----------------------------------------------|---------|-----------|----------------|
| A. Knowledge of facility with number         | Q4      | 38        | 47.50          |
|                                              | Q5      | 32        | 40.00          |
|                                              | Q6      | 2         | 2.50           |
|                                              | Q7      | 31        | 38.75          |
| B. Knowledge of facility with operations     | Q1      | 3         | 3.75           |
|                                              | Q9      | 26        | 32.50          |
|                                              | Q10     | 36        | 45.00          |
| C. Applying knowledge of facility with number and operations to computational settings | Q2      | 1         | 1.25           |
|                                              | Q3      | 20        | 25.00          |
|                                              | Q8      | 49        | 61.25          |
| Total                                        |         | 238       | 29.75          |

Figure 1 and Table 2 show that on the first number sense component, knowledge of facility with number, some of students can implement their knowledge to answer the question, even if there are still low percentage at Q6 with only 2.50% achieved. In other words, it can be said that students are starting to be able to flexibly calculate numbers. Flexible on calculation can be interpreted as a practical thinking in utilizing mathematical operations, creating various number representations, and can find many solutions to problems in an easier way [28]. One of the number sense characteristic is flexible on calculation without having to be limited by traditional algorithms [10].

Furthermore, Figure 1 and Table 2 also show that on the third component of number sense, applying knowledge of facility with number and operations to computational settings, many students are unable to solve the given problem. This can be seen by the two questions Q2 and Q3 that have lower percentage. Having said that, it can be concluded that students are still unable to implement number sense to solve problems regarding to daily life. Students are not sensitive on crunching information of the questions, especially regarding the given numbers. As a result, so many errors are happened during the calculation process. Number sense, in this matter, can help students to be flexible and creative on solving problems regarding calculation [29]. Students will get used to analysis a problem, develop strategy, create systematic reasoning and find logical conclusion of problems situation [30]. So, a perfect solution with efficient strategy can be achieved.

Based on the result on Table 2, the questions can be grouped to 4 different groups based on the frequencies of the correct answer of each question [17]. First, group A for questions that has correct answer percentage of more than 75% where in this research, no questions actually fulfil the condition of this group. Second, group B for questions that has correct answer percentage between 50% to 75%, which is Q8. Thirds, group C for questions that has correct answer percentage between 25% to 50%, which are Q3, Q4, Q5, Q7, Q9, and Q10. The last one, group D for questions that has correct answer percentage below 25%, which are Q1, Q2, and Q6.
Figure 2. Participants’ performance based on component number sense

Figure 2 shows participants’ performance on each number sense component. The none, poor, average and good categorization with is a modified version from Koleza & Koleli’s [17]. The first category, none, is achieved if the participant doesn’t have any correct answer on one number sense component. The second category, poor, is achieved if the participant can answer correctly $\frac{1}{3}$ of all questions from one number sense component. The third category, average, is achieved if the participant can answer correctly $\frac{2}{3}$ of all questions from one number sense component. The last one, good, is achieved if the participant can answer correctly more than $\frac{2}{3}$ of all questions on one number sense category.

Furthermore, Figure 2 also shows that the performance of participants that achieve poor category dominate all components of number sense with a percentage of more than 50%. This is completely the other way with participant that achieve good category that actually very few. Even the percentage is lower than 10% on each component of number sense. Besides, none category is still dominating the test result on this research. That means there are still many students that are unable to solve the problems on the given number sense ability test. The ability to calculate, implement correlation between numbers and basic operation emerge as a unique construction on numbers that can predict the successfulness on learning mathematics in the future [31, 32].

The following Figure 3 shows the order from the lowest to the highest on the percentage of the questions that can be answered correctly by the participant.

Figure 3. Mean percentage of correct answer from each questions

Based on Figure 3, questions with lowest percentage of correct answers is Q2, which is a part of the third number sense component, applying knowledge of facility with number and operations to computational settings. The Q2 question is “John needs 15 wooden sticks each with 1-meter of length
to be used for scout activity. In a home depot, there are only woods of 2.5 meters long. How many woods that John needs to buy?” There are many students that mistaken on interpreting the given length of the wood. Students answer by directly divide 15 by 2.5 so there are 6 wooden stick. While in fact, in order to create 1 whole wooden stick, complete 1-meter long wood is needed, and it can’t be created by adding an extra 0.5 meter from the initial 2.5-meter length of the wood. So, the correct answer should be 8 wooden sticks. This shows that students don’t have the sensitivity both on understanding and implementing the given numbers in a problem that reflects to daily life. Students are yet unable to correlate between number sense and thinking algebra to solve the problems that need connections between both [8]. Someone is categorized to have a good number sense ability when they can implement the understanding about numbers and its operations to solve the daily life problems with a flexible and efficient strategy [11].

4. Conclusion
All of the analysis result shows that number sense ability of junior high school is still poor with correct answer percentage of only 29.75%. The number sense ability on the knowledge of facility with operations component holds the lowest position with a percentage of correct answer of 16.67%. Students did a lot of mistakes on answering questions that requires students to answer with estimation. Besides, students are also unable to implement the flexibility and sensitivity towards numbers operations on processing information and implementing it to the solution of the problems that reflects the daily life.

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