The effect of using worksheet on students’ number sense ability

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Abstract. Number Sense is a basic thing to learn mathematics, especially on numbers material. As a matter of fact, the preliminary research showed that students’ number sense ability was so poor. Therefore, using students’ worksheet as learning media on numbers material are expected to help students to understand the material. It implies, students’ number sense ability can be better. The aim of this study is to figure out the effect of using worksheet on students’ number sense ability. This study is using quantitative method with Wilcoxon Test. The number of 37 students were involved as a sample and chosen by random sampling technique. The result showed that the average score \(= 75.24\) after students got the worksheet are higher than before they got the worksheet \(= 55.04\). The result of hypothesis with \(Z\) score \(= -5.314\) and \(p\) value \(= 0.000\), so \(H_0\) was accepted. It means that there was different between before and after using the students’ worksheet. This result also showed that there was the effect of using worksheet on students’ number sense ability with an average increase of 19,00.

Keywords: number sense; number sense ability; numbers; students’ worksheet.

1. Introduction
Mathematics courses at school should be a medium for students to improve their knowledge and ability on numerical computation [1]. The ability is not limited to calculation, but also student’s ability on implementing the knowledge to numbers, number operations and its representation. For example, a student is given a problem to guess the most related calculation result of \(\frac{5}{3} + \frac{9}{27}\) without having to actually calculate. The students with strong sensitivity toward number will easily determine the result of the two fractions using estimation method. This type of students will be more flexible upon utilizing their knowledge about numbers and its operations. Besides, the students will be more confident on answering the given mathematical problems. On the contrary, students with low sensitivity on numbers will need more time to calculate using traditional method to get the accurate result [2]. This type of students tends to be stiffer on captivating his knowledge about numbers and its operations. The sensitivity towards number is known as a term: number sense.

Number sense is someone’s understanding about numbers and their operations, along with the ability to use the understandings flexibly to develop a problem-solving strategy about numbers [1], [3]–[6]. An understanding about numbers become one of the number sense complier indicators [7], [8]. The implication is that someone with a good number sense ability will also have a good understanding about numbers. However, based on some research results, it is known that number sense ability is somehow still low so a method is needed to improve it [2], [9]–[13].
In line with the previous research results, the fact found on the field also shows that the number sense ability of students is still low. This fact is proven by the number sense test result using the problems developed by Singh [14] on a preliminary study that is done towards 6 students. Based on the test result, it is known that (1) six students are having difficulties on sorting fractions, (2) six students argue that there are no other fractions between $\frac{3}{5}$ and $\frac{4}{5}$, and (3) six students can sort positive numbers correctly, but there are four students mistaken when sorting negative numbers.

As an addition, the results are also justified based on an interview conducted with math teachers. Math teachers state that most of the students on each class are having difficulties upon understanding the materials and solving math problems. That is, according to the teacher, caused by students’ lack of understanding towards the basic concept of numbers and its operations. Further, the math teacher also gives some examples of mistakes that are done by the students upon solving number operations, both when adding and subtracting fractions such as: $\frac{2}{7} + \frac{2}{3} = \frac{5}{10}$ and $\frac{3}{5} - \frac{3}{8} = \frac{8}{15} - \frac{3}{5} = \frac{2}{3}$. At the same time, when students are given a question, “how many numbers are there between 1 and 2?” or “how many numbers are there between $\frac{3}{5}$ and $\frac{4}{5}$?”, most of the students will answer that there is no number exists between the two numbers mentioned earlier by the math teacher. It can be concluded that the students don’t have the sensitivity toward number yet. As a result, the components of number sense on number understanding and ability that students should own are still low.

Students’ low understanding and ability about numbers can imply the study result. Teachers are expected to be always creative and skillful on giving the best study method and media that can accommodate students’ need [15]. The research about the effect of number sense toward the math study result of Bukit Tinggi Elementary School students shows that number sense affects positively and significantly on math achievement [16]. Meanwhile, a research by conducting a mentoring to develop number sense using learning by playing method [15]. Based on the explanations, students’ worksheet that author developed using contextual approach is expected to give positive impact towards number study material and also to develop the student’s number sense ability. Using contextual approach in this students’ worksheet is because learning must be able to provide opportunities for students to construct knowledge by improving what has been learned so that students will be more independent in learning [17]–[19]. Furthermore, learning must also contain problems that related to daily life, so students are trained in solving daily life problems. So, the purpose of this research is to understand the impact of students’ worksheet toward student’s number sense ability.

2. Method
This research is a quasi-experimental research with pre-test-post-test control group design. The population in this research is all seventh-grade students at a Junior High School in Kediri. There are 37 students chosen as the samples using cluster random sampling technique. All samples are given number sense ability-test before and after being given the number material students’ worksheet with a contextual approach.

The data collection technique is by conducting tests that are divided into two steps: pre-test and post-test. Pre-test is utilized to understand the student’s earlier number sense ability on number material. Meanwhile, post-test is used to understand the student’s number sense ability after being given the study material through number material students’ worksheet with contextual approach. Both given number sense test instruments consisting of 30 problems and should be solved in 30 minutes. The pre-test and post-test instruments refer to the indicators as is stated in Table 1 [3]. The number material students’ worksheet with contextual approach that was used before has been validated by experts so that the students’ worksheet is fit to be utilized in learning.
Table 1. Problems item distribution based on number sense component

| Components | Items |
|------------|-------|
| A. Knowledge of facility with number | 1. Understanding and skills about numbers Questions 6, 14, 15, 16, 17, 21, 22, 23, 24, 25, 26, 27, 30 |
|            | 2. Understanding and skills using numbers Questions 1, 2, 3, 4, 5, 8, 29 |
| B. Knowledge of facility with operations | Questions 18, 19, 20 |
| C. Applying knowledge of facility with number and operations to computational settings | Questions 7, 9, 10, 11, 12, 13, 28 |

The data analysis technique used are normality test and hypothesis test. Normality test is used to detect whether the collected data has normal distribution or not. After that, the hypothesis is tested using Wilcoxon test to understand if there’s an effect of the students’ worksheet toward student’s number sense ability.

3. Result and Discussion
The research that was conducted to 37 samples shows that the pre-test result before students’ worksheet were given has an average score of 55.04 with the highest score of 75.33. Meanwhile, the average post-test score after learning from the students’ worksheet has an average of 75.25 with the highest score of 90.00. Thus, pre-test and post-test average scores have a gap of 20.20. The result shows that there is an increase of the average number sense ability of the students after learning from the students’ worksheet. The detail of the scores are shown on Table 2.

Table 2. Descriptive Statistics

|        | N  | Mean | Std. Deviation | Minimum | Maximum |
|--------|----|------|----------------|---------|---------|
| Pre-test | 37 | 55.0435 | 10.70367 | 30.00 | 73.33 |
| Post-test | 37 | 75.2423 | 8.34554 | 60.00 | 90.00 |

Normality test using Shapiro-Wilk test with the result that can be seen on Table 3.

Table 3. Result of Normality Test

| Shapiro-Wilk | Statistic | Df | Sig. |
|--------------|-----------|----|------|
| Pre Test     | .901      | 37 | .003 |
| Post Test    | .950      | 37 | .093 |

Table 3 shows that the post-test significance level = 0.093 greater than the significance level of 0.05, meanwhile the pre-test significance level = 0.003 smaller than the significance level of 0.05. This shows that the data is not normally distributed. Thus, the data analysis will utilize non-parametric test, which will use Wilcoxon test. The test results are shown on Table 4 and Table 5.

Table 4. Ranks

|            | N  | Mean Rank | Sum of Ranks |
|------------|----|-----------|--------------|
| Post-test - Pre-test |   |           |              |
| Negative Ranks | 0a | .00        | .00          |
| Positive Ranks | 37b | 19.00     | 703.00       |
| Ties         | 0c |           |              |
| Total        | 37 |           |              |

Remarks: a. Post-test < Pre-test  
  b. Post-test > Pre-test  
  c. Post-test = Pre-test
Based on Table 4, there are 37 positive ranks data gap between pre-test and post-test which means that all samples (37 students) experience development on their number sense ability. The average development (mean rank) is 19.00. Meanwhile the overall category on negative ranks shows 0 result. This means that there is no decreasing from pre-test score to post-test score. Besides, ties, which means the similarity of pre-test and post-test score shows 0 result which means that there is no identical score between pre-test and post-test. It is then concluded that this result can also justifies the proof that all research samples (37 students) have higher post-test scores compared to the pre-test score.

### Table 5. Wilcoxon Signed Rank test result statistics

|                      | Post-test – Pre-test |
|----------------------|----------------------|
| **Z**                | -5.314\(^b\)         |
| Asymp. Sig. (2-tailed)| 0.000                |

Remarks: a. Wilcoxon Signed Ranks Test  
          b. Based on negative ranks.

The hypothesis test result on Table 5 shows that the Z-score = −5.314 with p-value of 0.000 where the result is smaller compared to the significance level of 0.05 so the hypothesis decision is to accept \( H_1 \) or there’s a difference between pre-test and post-test. Therefore, it can be concluded that there’s an effect of students’ worksheet application toward student’s number sense ability. Students learning by using games and hands on activity can help students on developing fluency towards orders of numbers [20]. So, students can have a deeper number sense ability on understanding number calculation and pattern. In line with Tan [20], research on learning by using learning by playing method is also known can improve student’s number sense ability on adding and subtracting integers [15]. The learning is conducted by developing different games on each meeting. Student’s number sense ability can be developed and practiced directly through a fun learning.

As an addition, result of study in Turkey suggest that it is important to add a program correlating with number sense along with the development in a curriculum that will be learned by the prospective elementary teacher college students [21]. The program is mainly correlated with numbers estimation, mental calculation, problem solving related with number sense. This is caused by the research result on number sense ability from the prospective elementary teacher college student on various lower level. The result is similar with some earlier researches, so an intervention using special learning method and specific mathematics curriculum in order to improve the prospective teacher college students’ number sense ability [22].

The effect of students’ worksheet implementation on student’s number sense ability is also affected by the involved factors on how significant the effect is. Based on the students’ responses, the involved factors are: (1) attractive students’ worksheet interface; (2) material, problem examples and illustrations that are related with daily life; (3) students’ worksheet and individual evaluation help to improve the understanding the worksheet; (4) the learning process becomes fun; and (5) students’ worksheet can motivate students to learn the given materials.

### 3.1. Attractive Students’ Worksheet Interface

The first affecting factor is attractive students’ worksheet interface. An attractive interface can make students curious to the content details of the students’ worksheet. Based on the interview result towards math teacher at MTS Negeri Ngabang (middle school), it is known that students are very attracted to learn using students’ worksheet with various content interface [23]. As an addition, students’ worksheet development also attracts students to solve flat side geometry problem with the given problem based learning model. Students won’t be bored with monotonous interface [24]. Proportional colour and images in the students’ worksheet can motivate student’s interest to read and thus will motivate students to learn [25]. Figure 1 and Figure 2 are examples of part of the interface on the cover page and content of the students’ worksheet that is being developed in this research.
3.2. Material, Problem Examples and Illustrations that are related with Daily Life

Second, material, problem examples and illustrations that are related with daily life become one of the factors that affect student’s number sense ability. There are five learning principles that can help students to improve their ability to be sensitive toward numbers, which are (1) develop understanding that a student currently has (2) following the natural development when choosing new knowledge that will be taught (3) teach computational fluency an once with the conceptual understanding (4) provides many opportunities to the students to directly explore, solve and communicate their problems and (5) teach the students about how numbers are presented in daily life [26]. Therefore, upon developing a students’ worksheet, it should be ascertained that the problems provided are the problems that are correlated with student’s daily life problem [27]. So, it can be assumed that the problems can provide hints to the students upon developing conceptual knowledge of the problem solving that are learned.

As an addition, the research find a fact that students will be motivated to read mathematical text in the developed students’ worksheet by giving more attention to the things that are normally encountered in the daily life [28]. Based on the explanations, it can be concluded that giving a stimulus through learning media, method or even math assignments that can attract students to explore while also correlating with the daily experience of the students can be utilized by teachers to improve student’s number sense. Figure 3 is an example of mathematical problems inspired from the daily life that are provided in this students’ worksheet.
3.3. Students’ Worksheet and Individual Evaluation Help to Improve the Understanding

Third, students’ worksheet and individual evaluation helps to improve the understanding the worksheet. Students’ worksheet can facilitate students to develop their thinking comprehensive by providing problems or activity command so that students will learn new knowledge based on the answer [23]. In line with that, students’ worksheet can also be utilized as a guide for students to do activities that can develop their knowledge and ability accordingly to the given learning goals [27]. In line with the opinions, students’ worksheet is developed to facilitate students on enhancing their understanding of the learning materials individually and allowing student’s involvement onto the learning process [29].

3.4. The Learning Process Becomes Fun

Fourth, the learning process becomes fun by using students’ worksheet. The learning process using students’ worksheet with good preparation can reduce the role of teacher to be the centre of information in the classroom, while it can also make students to be more proactive [30]. The implication is that the learning process in the class becomes fun and won’t make students bored with the existence of many learning activities that are given in the students’ worksheet. This is also supported by the research result that shows that the activities given in the students’ worksheet are fun to answer. Students are motivated to conduct every process of problem solving, step by step and not only thinking of the end result [31]. Activities that focus on the process will make students more confident on problem solving activities [32].

3.5. Students’ Worksheet to Motivate Students in Learning

Finally, students’ worksheet can motivate students to learn the given materials. Student’s learning motivation can be developed by understanding the benefit of math in the daily life using mathematical implementation that are relevant with the student’s daily life [33]. Moreover, teachers can utilize the correct math techniques, methods, and learning approaches according to the topic that are being taught to the students while this research utilize the students’ worksheet implementation with contextual approach where the students’ worksheet that addresses the daily life problems to teach number material to the middle school students. The result is that the students responds that the students’ worksheet can motivate them on learning number material. Thus, it is expected that by the students’ involvement on the activity provided by the students’ worksheet, the students’ math learning result can overly be improved [23], [34].
4. Conclusion
The implementation of number material students’ worksheet with contextual approach affects student’s number sense ability with Z-Score = −5.314 and p-value of 0.000 < significance level of 5% so $H_0$ is rejected and $H_1$ is accepted. Student’s number sense ability score before being given by a form of learning utilizing students’ worksheet has an average score of 55.04 and after being given a form of learning utilizing students’ worksheet has an increased average of 75.24.

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