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Trends in Class VI Students' Thinking in Understanding Negative Integer Number Through Number Lines

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ABSTRACT
One of the prerequisites for students in studying mathematics is to understand integers, both positive and negative integers. But negative integers have significant differences with positive integers. In addition, negative integers are known to have a significant difference with positive integers. Therefore the purpose of this research is to see how students understand negative integers by using a number line. The subjects of this study were class VI students of Madrasah Ibtidaiyah Nurul Hidayah Nganjuk. From this study, it was found that 50% of students described the position of numbers on the number line by sorting them and without writing negative signs. 8% of students describe the position of numbers on the number line with the appropriate concept. 17% of students describe the position of numbers on the number line correctly but ignore the zeros. And as much as 25% of students describe the position of numbers on the number line by only writing positive numbers on the right side.

Keywords: *trends to think, integers, negative integers*

INTRODUCTION
Elementary school students in learning integers for the first time, did not see any difficulties or obstacles. For example, when students learn to add numbers, students only need to point to objects with the same number, for example by using their fingers and so on. However, when these students learn negative integer material, these students will feel or cannot use their fingers. For example 5 – 6 = …, this example cannot be calculated with the radius. This makes it difficult for students to understand negative integers. Fuadiah & Suryadi (2017) revealed that students still experience many difficulties when dealing with negative integer problems, both at pre-learning and at the formal level.

Students' understanding of negative integers is a necessary condition in getting to know more about integers. In the learning process, negative integers cannot be represented in a concrete context, so students need more time to understand them. One reason is that negative integers are the opposite of real objects, and are rarely found in social norms (Bishop et al., 2015). In fact, for this reason negative numbers are often considered fictitious by students (Vlassis, 2004).

Bishop et al, (2015) have documented some of the difficulties experienced by students in understanding negative integers, namely: First, students have a habit based on early mathematical experience which states that integers are used as a calculation of a real object, so students see numbers based only on just size. For example, you buy five apples or buy three sheets of paper, and so on. Second, students assume that the nature of cardinal numbers corresponds to the representation of natural and real numbers, so this is contrary to negative numbers which cannot be represented by something real or certain objects. Suppose Mother buys -3 paper, this example is unacceptable to students, who think -3 does not exist. Third, during learning, it is impossible for the teacher to give instructions to reduce or delete numbers that are more than they have.

The results of Fischer's research (2005), suggest that students who are faced with negative integer problems will have varied results than problems related to positive integers, this is because students use their cognitive abilities to solve these problems through the number line. Furthermore, Gersten et al., (2009) also revealed that a very powerful tool in supporting students' understanding of various mathematical concepts is the number line. Siegler (2009) also explained that introducing integers through a number line is a very useful way to test students' understanding of numbers, because this task requires students to be able to estimate the exact location of numbers on each scale of the number line. Students can use their

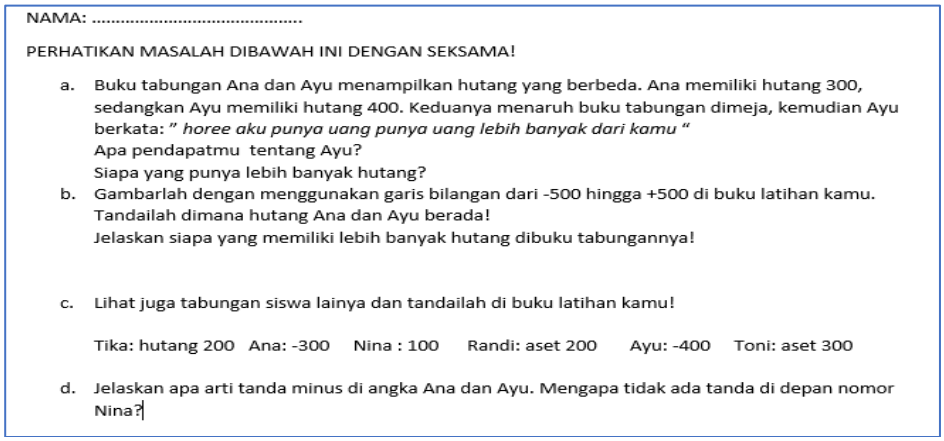
experience with assets (money), debt, and net worth to find positive and negative integer results (Stephan & Akyuz, 2012; Ural, 2016).

One of the factors that can hinder students from understanding negative integers is the presence of a minus sign, which can cause students to find it difficult to find a solution because they do not understand the meaning of these negative numbers (Vlassis, 2008). Students assume that subtraction is more difficult than addition (Karantzis, 2010). Therefore, this study aims to document students' tendencies in understanding negative integers by using a number line.

METHOD

This research is included in quantitative research. This research was conducted to sixth grade students of elementary schools in Nganjuk district, East Java, Indonesia. The researcher chose the sixth grade student as the subject, because negative integer material would be taught after this research was carried out, so the researcher wanted to know the students' initial ability to negative integers based on their perception of thinking. Students can complete tests based on their knowledge and experience without any interference from researchers or from teachers.

The data in this study were obtained from the results of written tests and interviews to explore the subject's tendency to think about negative integers. The tendency to think of students is obtained from all the results of student work and then used as a reference in describing tendencies to think. The researcher recorded the interview process using a tape recorder to simplify the data transcript process. The test instruments used in this study are:



NAMA: .....

PERHATIKAN MASALAH DIBAWAH INI DENGAN SEKSAMA!

a. Buku tabungan Ana dan Ayu menampilkan hutang yang berbeda. Ana memiliki hutang 300, sedangkan Ayu memiliki hutang 400. Keduanya menaruh buku tabungan dimeja, kemudian Ayu berkata: *" horee aku punya uang punya uang lebih banyak dari kamu "*
   Apa pendapatmu tentang Ayu?
   Siapa yang punya lebih banyak hutang?
b. Gambarlah dengan menggunakan garis bilangan dari -500 hingga +500 di buku latihan kamu.
   Tandailah dimana hutang Ana dan Ayu berada!
   Jelaskan siapa yang memiliki lebih banyak hutang dibuku tabungannya!

c. Lihat juga tabungan siswa lainya dan tandailah di buku latihan kamu!

   Tika: hutang 200 Ana: -300 Nina : 100 Randi: aset 200 Ayu: -400 Toni: aset 300

d. Jelaskan apa arti tanda minus di angka Ana dan Ayu. Mengapa tidak ada tanda di depan nomor Nina?

Figure 1. Research instrument adapted from Schindler et al 2017

This researcher uses documentation from the results of student work and interviews. Data analysis was carried out by: observing data, transcribing interview results, data reduction, synthesizing data, categorizing data and making conclusions. The researcher observed the results of the written test to determine the type of the subject's tendency to think about negative integers. Meanwhile, data reduction is used to select and focus data according to the research objectives. Researchers categorize the tendencies that arise in the subject when understanding and completing tests about negative integers. Then the researcher interprets the data for the process of drawing conclusions.

RESULT AND DISCUSSION

Based on the results of the documentation of the students' work, it was found that there are several different thinking tendencies when understanding negative integers with a number line. These thinking tendencies can be categorized into four types, namely: (1) 50% of students describe the position of numbers on the number line by sorting them and without writing negative signs. Such as: 100, 200, 300, 400, 500, 100, 200, 300, 400, 500. (2) 8% of students describe the position of numbers on the number line with the appropriate concepts, namely -500, -400, -300, - 200, -100, 0, 100, 200, 300, 400, 500. (3) 17% of students drew the position of numbers on the number line correctly but ignored zero. -5, -4, -3, -2, -1, 1, 2, 3, 4, 5. (4) 25% of students describe the position of numbers on the number line by writing only positive numbers on the right side, …, … , …, 1, 2, 3, 4, 5. Of the four categories the researcher coded as category 1, category 2, category 3 and category 4.

Category 1

Subjects with the first category describe integers on the number line by sorting them according to the order of the positive integers. This can be observed from the results of the subject's work in Figure 1. Question: determine the location of the money and debts of each student on the number line!

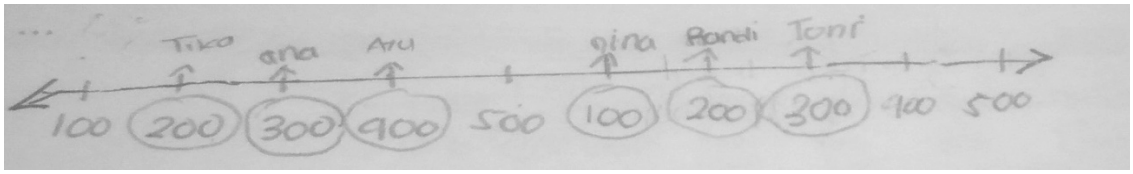


Figure 1: Example of category 1 answers

The results of the answers described in category 1 show that the subject only knows positive numbers, because they do not respond to debts that show negative numbers. This can be seen in the number line they draw, they only use consecutive numbers from 100 to 500 and return to 100 again after writing the first 500. In addition, they do not give a negative sign at all, either on the right or left side of the number line. To find out whether the subject has understood negative integers or not, the researcher gave instructions for the subject to count backwards starting from 5, when it reaches number one the subject stops and does not continue at zero. This shows that the subject does not think there is a zero after the number one.

One of the factors that caused the subject not to mention zero was because the subject was not used to counting something that was not in that number (Utami et al., 2018). According to Bofferding (2014) also explains that students will treat negative integer values like positive integers, because students see negative signs only as subtraction operations. As a result, the subject cannot distinguish the location of numbers as money (receivables) and debts on the number line, so they pile up at the same point on one of the line segments.

Then when the subject says there are no more numbers before zero, this shows that the subject only understands positive integers. Woods et al., (2017) explained that indirectly students have developed positive numbers quickly, so that in their minds an understanding is embedded that there are no more numbers other than positive integers. At the same time, students begin to develop abstract mental representations that can generalize numbers from counting routines (Wynn, 1990).

Category 2

An example of an answer in category 2 can be seen in Figure 2 below:

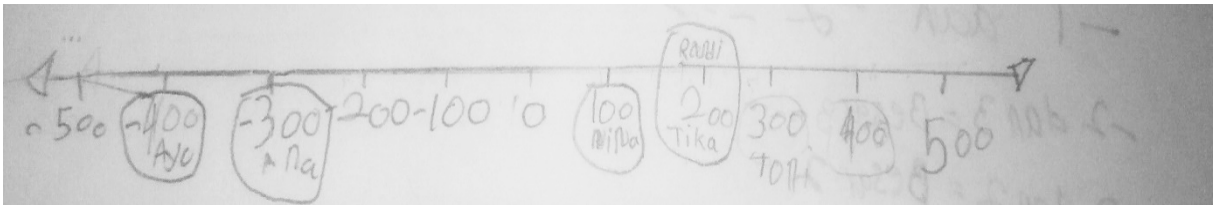


Figure 2. Example of category 2

Based on the answers to category 2 in Figure 2, it shows that the subject draws a number line and writes it down correctly, i.e. in negative order from the far left -500 to the right up to 500, besides that students also do not ignore the zero between -100 and 100. In category 2, it can be seen that students already understand negative integers drawn on the number line. However, students who described correctly only had the lowest percentage, namely 8%.

Category 3

An example of an answer in category 3 can be seen in Figure 3 below:

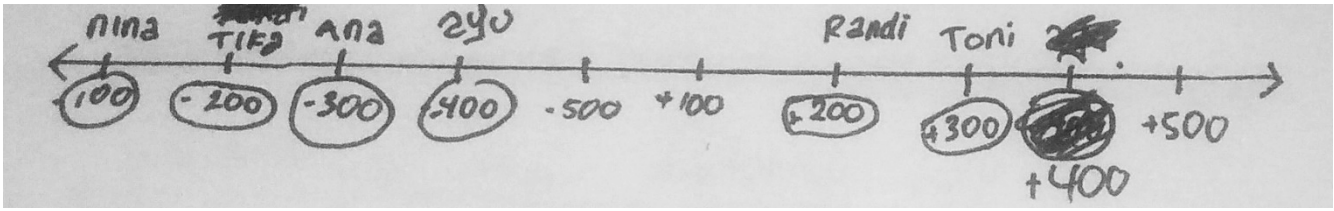


Figure 3. Example of category 3

Based on the answers from subject 3, it can be seen that the right side of the number line is the place for positive numbers, and the left side of the number line is the place for negative numbers. However, the subject did not write zero to distinguish it, so the subject experienced an error when writing on the number line. According to Fischer (2003), students in understanding negative integers on the number line tend to be from an ontogenetic point of view, namely students understand negative integers by assuming that these numbers have a tendency to the left side of the number line. Likewise the subject's understanding of the negative sign, subject 2 has understood the meaning of the negative sign as a number, namely the negative sign that follows the number (Bofferding, 2009).

According to Tzelgov et al, (2009) states that students have long-term memory which states that the numbers 1 to 9 are the only digits that can be represented, while other numbers are generated from these nine digits. Therefore it is very possible if the subject will find and understand negative integers from giving assignments in certain contexts, such as in this research.

Category 4

An example of an answer in category 4 can be seen in Figure 4 below:

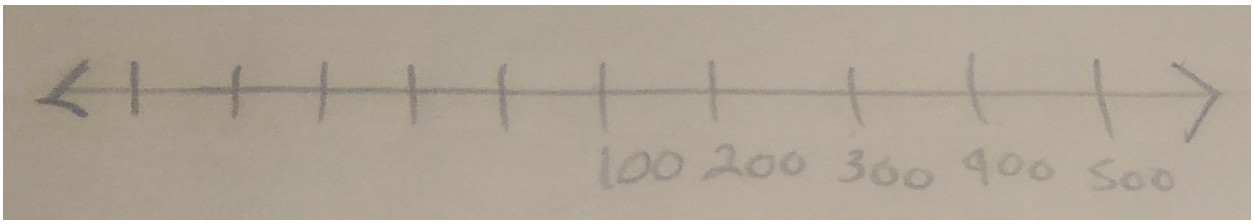


Figure 4. Example of category 4

Figure 4 in category 4 shows that the subject draws a number line and writes only positive numbers. The subject places the debt/money to the right of the number line. Even though he was correct in placing the money position, the subject still did not write negative numbers on the left side of the line.

Based on category 4, the subject seemed to only understand money or positive numbers, debt or negative signs not shown in the picture presented. Even though the subject did not write negative signs and numbers to the left of the number line, the subject already knew the position of debts and receivables. This error occurred because the subject wrote numbers on the number line according to the rules for counting positive numbers, and was hesitant to write numbers other than that.

In the interview, the subjects gave unclear reasons why they wrote only positive numbers. The researcher gave questions to ensure students' understanding of negative integers. The researcher asked the subject to count backwards starting from the number five. The subjects' answers indicated that they remained stuck at ones and zeros. In this category 4 students tend to lead to understanding patterns in positive numbers. This is in line with Young & Booth's research (2015), which revealed that knowledge of the magnitude of negative integers follows a pattern similar to positive numbers, but the performance of negative estimates is far behind positive. The answer to category 4 is similar to the anticipation of the number line put forward by Bofferding (2014) in his research on students' mental models for understanding integers, namely students repeating numbers positively.

Table 1. Categories of students' thinking tendencies towards negative integers

No	Thinking tendency category	%	Category description
1	Category 1	50%	• Orders negative numbers like positive numbers
2	Category 2	8%	• Orders negative integers according to the concept
3	Category 3	17%	• Orders negative numbers but ignores zeros
4	Category 4	25%	• Only write positive numbers on the right side

CONCLUSIONS

Based on the results of this study, information was obtained that in using the number line in learning negative integers there were still many students who had a tendency to think not in accordance with the concept of negative integers. This is in accordance with the four thinking tendencies of students that have been documented in this study, more than 90% of students who do their work still experience the concept

of ordering negative integers incorrectly and only 8% of students describe the sequence of negative integers correctly.

This research was carried out as a first step to determine the extent of students' understanding and thinking tendencies when describing negative integers on the number line. Therefore the results of this study provide an opportunity for researchers to carry out further research on students' cognitive development in understanding the concept of negative integers, so that different findings can be obtained from this research.

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