Attitude of Student Openness toward Relational Thinking

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Abstract. The purpose of this study is to determine the attitude of student openness on relational thinking in terms of arithmetic ability. Five questions were given to three students through an interview. The interview results were analyzed to determine the students' openness on relational thinking that has been previously taught. Students who have high and low arithmetic ability have an openness to relational thinking, while students moderate are reluctant to accept relational thinking.

1. Introduction
Relational thinking has become one of the objectives of the primary school mathematics curriculum in U.S., Singapore, Korea, and China [1-4]. In Indonesia, the curriculum changes that occurred in 2013 have not met that way of thinking. Whereas the application of relational thinking in elementary school can be a solution to various algebra learning problems that arise in junior high school. The characteristic of relational thinking is to look at expressions and equations as a whole, taking into account the relationships between and within expressions and equations [5]. By relational thinking, the problem of misconceptions of algebraic expressions, the simplification of algebraic expressions, and the factorization of which can be resolved [6-11]. Because all of these problems are related to the relation between numbers and variables in terms, the relation between terms in expression, and the understanding of the sign is equal on the equation. As a preliminary study, we use three types of number sentences that have been used by other researchers as an interview instrument to gain a response of students' openness to relational thinking. The results of this study can be used as a guide for teachers in designing learning and implementation of learning oriented to relational thinking.

2. Method
After 6\textsuperscript{th} elementary school students learn math using relational learning design, three students with three levels of arithmetic ability were selected by the teacher to be interviewed. The interview took 15 minutes to evaluate the learning outcomes. Interview results are analyzed to determine the attitude of student openness to the relational thinking they have learned. Students who have an open attitude are defined as being willing to use relational thinking in solving problems. Interview results are also interpreted based on Harel's theoretical framework [12] on how to understand and how students think. The problem in Figure 1 was used in an interview similar to the instrument used by Vishu Napaphun [13].

\begin{align*}
1.7 + 12 &= 8 + 11 & \text{True/False?}
\end{align*}
2. \( \square + 5 = 14 + 6 \)
3. \( \square + 9 = \square + 10 \)

Figure 1. Interview instruments

3. Result and Discussion

The results of the analysis on the results of interviews between the researchers (Q) and the three students (S1, S2, & S3) resulted in several findings. First, all students initially use computational thinking to solve problems. But by questioning with researchers, they can use relational thinking. Although scaffolding is given differently, but has the same pattern that students are asked to pay attention to the numbers that exist on both sides of the equation. They are asked to find the same difference between the two numbers on the right and the number on the left. So, they can use that information as an excuse in determining the truth value of a sentence number. Here is the first research interview transcript (Q) and the first student (S1).

Q: Look at number 1, is this right or wrong?
S1: Right
Q: Why is it answered right?
S1: because \( 7 + 12 = 19 \) and \( 8 + 11 = 19 \) also.
Q: If it does not add up like that does it get an answer that this is true?
S1: (shaking head and says) no
Q: look at the numbers from the left and right sides, does anyone have a small difference?
S1: there
Q: Where?
S1: the 11 and 7
Q: how much difference?
S1: four
Q: Which difference is smaller?
S1: the 7 with 8
Q: How much difference?
S1: one
P: then what else?
S1: the 12 with 11
Q: the difference?
S1: one
Q: Of the two differences, cannot say that this is true?
S1: Yes
P: how?
S1: The differences are one

Two, low and moderate arithmetic ability students still use computational thinking to solve number 2 problems. It is apparent from their statement that they add up the numbers on one segment, then the sum of the numbers is reduced by the numbers available on the other. However, researchers try again to provide guidance so that students switch to using relational thinking. Unlike high-ability students, he immediately uses relational thinking to solve number 2 questions. The following is an excerpt of his interview.

Q: try number 2
S2: 15
Q: Where?
S2: \( 14 + 6 = 20, 20-5 \)
Q: if you see the difference, here 5, here 6, how much difference?
S2: one
Q: Which is bigger?
S2: the 6
Q: this empty box and 14, how much difference?
S2: one, must be one
Q: Which is bigger?
S2: the empty box,
Q: why should big that empty box?
S2: because the 5 is smaller and the 6 is bigger
Q: so, what's the answer?
S2: 15

Q: Try number 2, can you use that way?
S3: Yes, this is 15, the difference is 1
Q: the difference one from where?
S3: 6-5, 14 + 1 = 15

Three, only moderate arithmetic ability students are still using computational thinking in solving the problem of number 3. While the students are arithmetic low and high-ability students are directly using relational thinking. This shows that students who are able to count are not yet open to relational thinking. Here is the interview quote.
Q: This number 3, what is it?
S2: this one is 10 and this is 9
Q: Try looking for something else
S2: here 6, here 5
Q: how do you think to get 6 and 5?
S2: equated the result
Q: if here 2, here?
S2: 3
Q2: Summing this first, then here summing again, to meet the result the same yes, that's the way he thinks?
S2: yes

Q: number 3 how much is it?
S3: left side 11, right side 10
Q: another number?
S3: left side 10, right hand side 9
Q: another number?
S3: left side 9, right side 8
Q: another number?
S3: left side 8, right side 7
Q: How did you get those numbers?
S3: the difference between one
Q: sure, the difference can be used?
S3: sure

Four, High-ability students can create similar problems with question 3 (Figure 2). He also explained well how to make the matter. Here's an excerpt from the interview.
Q: Can I make a problem using the difference?
S3: (writing problem)
Q: How do you make the problem?
S3: like this, about number 3
Q: Why do you take the numbers 15 and 18?
S3: the difference is 3
Q: So, what's the key answer?
S3: 4 and 1
Q: Can the others huh?
S3: Yes
Q: lots?
S3: a lot

Figure 2. Problems students make with relational thinking

How students understand and how students think when questioning with a relational-oriented instrument provides some information. First, the meaning/interpretation of the equal sign and the sentence of numbers can be understood as two types of understanding: "left-hand result = right-hand result" and "left expression = right expression". Second, the solution to the first problem is the true/false value, the solution to the second problem is the number, and the solution for the third problem is the pair of numbers. Third, the justification used by the students is by calculating the result on the left side which is equated with the result on the right-hand side, and gives the result number of the difference between the numbers on both sides. Fourth, two problem-solving approaches used in thinking are computational and relational thinking. Fifth, every student already has belief in two ways of thinking is true and can be used.

4. Conclusion
In this research, we have identified that students with low and high counting ability have an openness to relational thinking. While students who have the ability to calculate are reluctant to use relational thinking, although it was given when learning in class and several times scaffolding given to them. Therefore, the ability to calculate students should be considered in designing problems and in the implementation of learning. The design problems used in the lessons can be developed for each operation [14]. So, after elementary school students have used relational thinking on sentence numbers, then can be used to understand the form of algebra and its operations in the junior level.

5. Acknowledgments

The authors would like to thank many students and teachers who have participated in this research. The authors also say many thanks to DIKTI who has provided funds for this research.

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