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RELATIONSHIP BETWEEN COMPUTATIONAL THINKING AND NUMBER SENSE ABILITY AMONG FIFTH-GRADE STUDENTS IN BANDUNG INDONESIA

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Abstract

Computational Thinking is the skill set of the 21st century that involves logical and algorithmic thinking approach. This skill is a highly valuable skill that has significant benefits associated with it. One of areas in which it may be applied is mathematics education. Number sense is one of major areas of emphasis in mathematics education that has many effects to mathematics achievement. While Computational Thinking focuses on algorithmic thinking, Number Sense contains problems in which both solution and method of solution are not obvious. This research aims to determine the relationship between Computational Thinking and Number Sense Ability of Bandungnese students in Grades 5. The subject of this research is from two different elementary schools (N=62). Data were collected separate tests on Computational Thinking and Number Sense. The test of Computational Thinking contains 3 problems with 7 questions both multiple choice and essay. Number sense test has 25 about multiple choice and short answer questions. Bandungnese students' overall ability on Number Sense was lower than their performance on Computational Thinking. The results revealed correlation between these

two aspects about 0.565 and provide that Bandungnese students have different levels on Computational Thinking and Number Sense Ability.

Keywords

Computational Thinking, Mathematics, Number Sense Ability

1. Introduction

What is computational thinking? Computational thinking is new term of skill claimed as one important skill needed in the 21st century. Computational thinking was first released in 2006 by Jeanette M. Wing as Head of Department of Computer Science at Carnegie Mellon University. Even almost 14 years, the definition of computational thinking is not so clear. However, according Wing (2006) Computational Thinking (CT) is an analytical approach that shares the methods and procedures of mathematical thinking, as well as other ways people usually apply in problem solving, such as logical thinking. Computational thinking can be described as a computing processes whether it is processed by human or machine. Computational thinking is about people who think as well as computer scientists.

Nowadays, many countries announced the integration of computational thinking skill into their curriculums like Malaysia, Vietnam, and Spain. Computational thinking skill now is being designed in Indonesia also. Computational thinking is included in educational realm as an urgent need to equip the schools. It is being located at the focus of educational innovation as a set of problem-solving skills to be acquired by new generations of students (Gonzáles, 2015). It is a process of student' algorithmic thinking to solve problem. It's a fact that computational thinking is not only important on computer subject but also in many areas of study involves mathematics.

Computational thinking is another skill out of the mathematics area but highly valuable skill that should be embedded on the mathematics learning. Johar (2013) shares two descriptions of mathematics and computer science. Firstly, computer science shares many characteristics with mathematics, and it is implied that it will also share problems and problem-solving techniques. Secondly, computer science often deals with creating tools to solve problem. It's also described on PISA 2021 *Mathematics Framework* (Draft). PISA is one of big mathematics tests in the world. Computational thinking is being planned as one and only the new element of the framework. In 2021, PISA involves problem in which students should poss and be able to demonstrate computational thinking skills include pattern recognition, defining algorithms, designing and using abstraction.

Two major areas of emphasis in mathematics education are number sense and problem solving (NCTM, 2000). Number sense is a persons' general understanding of number and operations (Reys,

1998). It's called content strands because almost all of mathematics learning using it. Number sense is an understanding of number and its operation (MacIntosh, Reys, and Reys 1997; National Council of Teachers of Mathematics 1989; Thompson & Rathmall as cited in Schappelle & Sowder 1989 dalam Pilmer 2008). A student has different ability of number sense with another. To solve a number sense problem, students have not to using one obvious way. This solution makes students have skill and creativity to solve problems using flexible and efficient ways instead of algorithms (Ehrenberg dan Robinson 2011; Saleh 2009; Pilmer 2008).

Number sense have five components creating the characters of itself, that are *number meaning, number relationship, number magnitude, number operation,* and *number referent* (NCTM, 1989). It means a student with good number sense ability has well-understood number meanings, has not only one interpretation and representation of numbers, can relate and find the relation between one and another number, can calculate whatever operation of numbers not only integers but also others, and has good system of numerical benchmarks. All that skills included on Elementary School Curriculum of Mathematics in Indonesia.

Now, we know that if the CT focuses on algorithmic thinking, number sense ability concerns with unrigid ways to solve a problem. Much of the recent attention with this case is explanation the relationship between computational performance and number sense. This study used the parallel test to measure the ability. For example, to know the computational performance of students they gave a question $\frac{12}{13} + \frac{7}{8}$ while in number sense test they asked students to estimate $\frac{12}{13} + \frac{7}{8}$ without counting and gave some integer multiple choices. This study concluded that the students in Taiwan perform different levels on written computation compared to number sense. The computational performance in this case is different with computational thinking. The computational performance is like an ability of mathematics itself. In the other side, CT is not a part of mathematics. It's another and new skill outside of mathematics that has to be embedded in mathematics learning. This paper presents the relationship between computational thinking and number sense ability on elementary school in Bandung, Indonesia in order to describe whether this new skill has relation with number sense as an ability in mathematics learning while they have different focus.

2. Methodology

2.1 Background for Sample

Indonesia is a developed country with 264 million people live in it, and each child is 9 years compulsory education. There are 6 years of elementary school, 3 years junior high school, and 3 years senior high school. All levels follow national curriculum. Number sense is included on elementary school curriculum. On the elementary school, students are guided to learn standard written algorithms on operation of the number like addition, subtraction, multiplication, and division, but almost nothing elementary schools in Indonesia teach to estimate the calculation of number instead of using standard procedures. It is so applied in Bandung.

Bandung is the capital of West Java province in Indonesia, the fourth most populous city. There are 187 private and 634 public elementary schools in Bandung. Two private elementary school were randomly selected for this study. The schools are Yakeswa Elementary School and GIKI Elementary School. Students in this two schools were taken in every heterogeneously class. The average age of the students is about eleven and twelve years old. From Yakeswa elementary school there are two class of fifth grade while in GIKI have two class. All class size ranged from 20 to 22 students. A total 62 fifth grade students from 2 this elementary schools participated this study.

2.2 Instrument

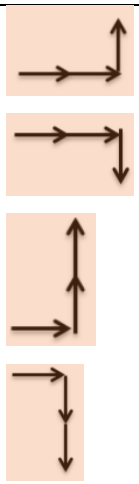
There are two instrument that were used in this study, computational thinking test and number sense test. All tests were presented in native language of the Indonesian. The first test was computational thinking test containing 3 problems. The first and third problems have 2 questions, and the second problem has 3 questions. The test was modified by researchers from the valid and reliable computational thinking instrument developed by a computer scientist (Chen, 2018). Researchers discussed with an expert on Bandung Institute of Technology too. The test had been used for online tests. The CT test included items that were multiple choice and open-ended responses.

A 25-item Number Sense Test was also presented in native language. This test was created by researchers based on original framework of number sense made by McIntosh, Reys, and Reys (1992). Some of items of the test was adopted from McIntosh et.al (1992). The Number Sense Test was served in short answer and multiple-choice questions (see Table 1 and Table 2).

Table 1: *Example of problem and questions on Computational Thinking Test for Fifth-Grade students*

A computer scientist wants to design a robot that can do multiple things at the same time. Below are the codes:

→START.	Robot ready to start
→END.	Robot end program and rest
→ SAY ...	Robot say something what the programmer inputs
→WALK?	Robot walk forward for the number of steps the programmer specifies
→TURN L.	Robot turn left
→TURN R.	Robot turn right

Item	**Response Type**
Someone inputs the code bellow: **→START.** **→WALK30.** **→WALK30.** **→TURN L.** **→WALK30.** **→END.** If the movement of the robot is drawn with directed arrow, which one the correct movement robot does?	

The test of Computational Thinking reliability is 0,703, while the Number Sense is 0.88. This number obtained from a fifth-grade Bandungnese class a week before data were collected. So, it concluded that the tests were reliable (Budiyono, 2003).

The two tests were given on consecutive days on last week in April 2019. Each item on Computational Thinking and Number Sense Test were scored as correct (1 point) and incorrect (0 point). So, the maximum point of Computational Thinking and Number Sense Test were 7 and 25 points.

Table 2: *Examples of Number Sense Test for Fifth-Grade Students* (McIntosh et.al, 1992)

Items	Response Type
How many numbers are there between 3,15 and 3,16? How many days have you lived?	*This item was presented in short answer respon* 400 4000 40 000 400 000

The Number Sense Test was given to all students, the first page had different processing time with another page. Students didn't allow to move to next page until the time of previous page was over. The time was controlled by the researcher when the participants were doing the test. The average of time for student to answer the questions every page is 5 minutes.

3. Results

Table 3 summarizes the mean and standard deviations of the two tests.

Table 3: *Means and Standard Deviations of NS Test and CT Test*

	NS Test	CT Test
N	62	62
Mean	9.508	3.644
Standard Deviation	3.207	1.47

The minimum correct point of CT Test and NS Test are 1 and 3, respectively. There is a student got maximum point on NS Test with 18 point, while on CT Test there are 3 students got perfect point, that is 7 points. The result shows that the performance on Number Sense was lower than their performance on Computational Thinking. The percentages of correct answers of NS Test and CT Test were 37.35% and 51.61%. Correlation between NS Test and CT Test was found about 0.565.

Discussion with students and teachers confirmed that CT Test that researchers gave was a new test they have had. They found an item like the CT Test on last UN (a summative test of Junior High School in Indonesia) in recently year. During the research, students had problem on the open-ended responses questions instead of multiple choice especially on last question on second problem. Most students asked researchers about they should write start and end code on the answer. Number Sense is

something familiar on the mathematics that is still low in Bandungnese students. Figure 1 shows the answer from a student on CT test. The student was asked to write the codes from the robot moving.

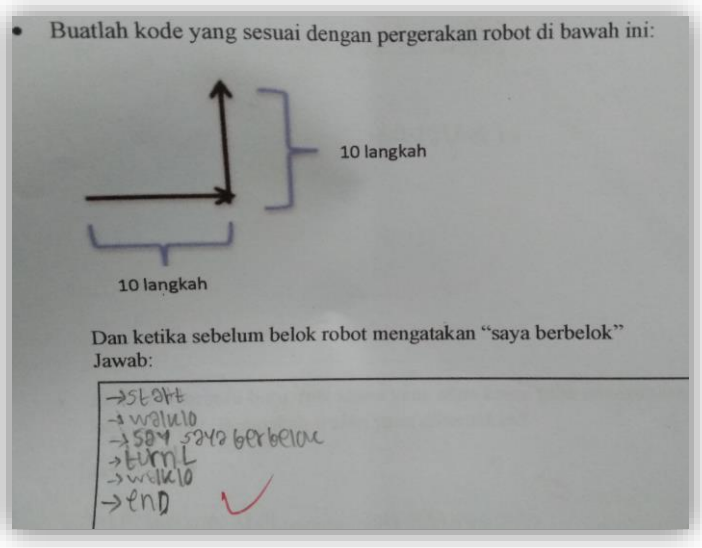


Figure 1: *The Example of Student's Answer on CT Test*

The NS Test gives a fact that there are misconceptions of Bandungnese Students about many parts of numbers, such as fraction and decimal. There are a few items of NS Test that almost all students were false. This case because some of them didn't answer the questions. Most students wasted the time to answer difficult question and they had not enough time to answer the other question. In the other hand, although CT skill is new skill, almost all of students can solve and fill their test. They did several errors that made they got 0 point. The following figure shows the one correct answer from a student about how many years they have lived on NS test.

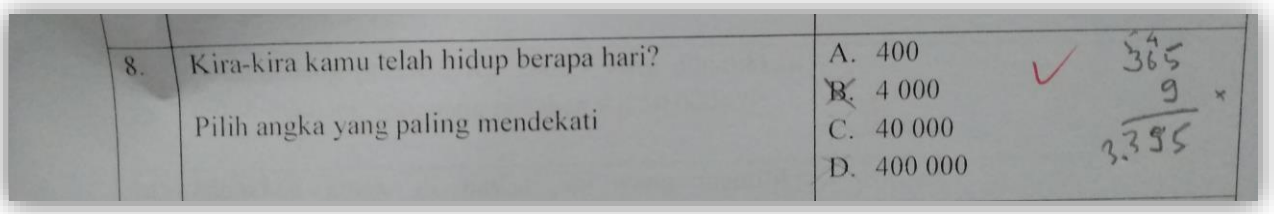


Figure 2: *The Example of Student's Answer on NS Test*

The next table shows that there is relation between Number Sense Ability and Computational Thinking.

Table 4: *Correlation between NS and CT Test*

		ns	ct
Ns	Pearson Correlation	1	.565**
	Sig. (2-tailed)		.000
	N	59	59
Ct	Pearson Correlation	.565**	1
	Sig. (2-tailed)	.000	
	N	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Using the results of student' points, the researchers found t-counting= 10.06 and t-table= 2.0 with significant level is 0.05%. It means there is linear relation between Number Sense Ability and Computational Thinking (t-counting>2.0). In other word, can be concluded that Computational Thinking influences the ability students on Number Sense. Its contributing is 56,5% to student' number sense ability.

CT skill is a part outside of mathematics, this is a new skill in 21st century, but in the real fact, it is related to an ability of mathematics, Number Sense Ability. It shows that mathematics contributes to this new skill. CT Skill have already embeded on mathematics.

Based on this research, even though the CT skill focuses on how students think logicaly and Number sense ability is something that has not rule to think, that means it is a flexible ability about sense of number, it can conclude they have relation and one is a dependent variable of another.

4. Conclusion

This research report is based on only 3 classes in two schools in one city in Indonesia, Bandung. So, its representativeness is still limited. Nevertheless, this research shows a fact that student in Bandungnese Indonesia performance on Number Sense Test were different with the performance on Computational Thinking. Their ability on Number Sense is still lower than their skill on Computational Thinking even though Number Sense is the old thing on mathematics while the CT is something that is considered new on education. So, there is a fact that Computational Thinking skill has relation with Number Sense ability.

This research supports that Computational Thinking should be embedded on mathematics learning because that skill is the new skill needed in 21st century and it has relation with another ability as an achievement of mathematics learning. We hope that these results will encourage those who want

to find another relation between Computational Thinking Skill with others mathematics ability, such as Problem Solving and High Order Thinking Skill, so that we have more fact that this new skill is very important and need to be developed in the future because it influences many abilities of mathematics.

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