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Implementing Bruner's Theory for the Conceptual Understanding of Addition and Subtraction

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Abstract:

This research intends to describe the ability of first-year students to understand numbers and to explain their thinking processes in the arithmetic operations of addition and subtraction studied in Bruner's theory. Under the qualitative method with descriptive research design, this research was carried out during the 2nd batch of the Kampus Mengajar program, which the researcher joined. The research subjects were first-grade students at SD Sumogawe 04. The data were collected through several techniques, including observation, interviews, and documentation. The results indicated different understanding levels of the students. Once a student gets the number conservation laws, s/he is ready to learn the concept of numbers and their operations. The arithmetic operations taught to grade I students are addition and subtraction. Applying Bruner's learning theory could improve the quality of learning the target theme and stimulate the students' active participation in classroom activities which simultaneously led them to conceptual discovery.

Keywords: number conservation laws, arithmetic operations, Bruner's learning theory.

INTRODUCTION

Merdeka Belajar Kampus Merdeka (MBKM) / Independent Campus, Freedom to Learn is a program released by the Ministry of Education, Culture, Research and Technology to provide opportunities for college students throughout Indonesia to hone their skills according to their respective talents and interests (Shabrina, 2022). The Ministry issued the MBKM policy by empowering students

through teaching assistance to help the learning process in village and city schools (Fauzi, Astuti, Nur, & Rahmawati, 2021). Under the MBKM, *Kampus Mengajar*/Campus Teaching was launched to provide solutions during the COVID - 19 pandemic for affected schools.

Numerous primary schools have benefited from the *Kampus Mengajar* Pioneer and *Kampus Mengajar* Batch 1. After the success, *Lembaga Pengelola Dana Pendidikan* (LPDP)/The Indonesia Endowment Funds for Education supports the Ministry of Education and Culture to re-launch the *Kampus Mengajar* Batch 2 in 2021. This program was expected to improve the quality of learning in primary education. Therefore, to assist the school teaching and learning process in both Elementary Schools and Junior High Schools levels, the *Kampus Mengajar* Program Batch 2 was held by sending students to particular schools pointed out by the Ministry.

At the *Kampus Mengajar* Program Batch 2, college students worked as teacher assistants at schools around their domicile, targeting the C-accredited ones, numbering 3,400 Elementary Schools and 375 Junior High Schools. The program focused on improving literacy and numeracy, considering the fact that Indonesia ranked low in the two aspects, and the advancement has become one of the national priority agendas.

Primary educational institutions could ameliorate literacy and numeracy as early as possible. Indonesia's 9-year primary education covers 6-year elementary and 3-year junior high school (Nadziroh, Chairiyah, & Pratomo Wachid, 2018). During these years, the focus is on developing attitudes, knowledge, and basic skills children need while living in society.

Cognitive development, according to Piaget, occurs in four stages, including the sensorimotor stage, pre-operational stage, concrete operational stage, and formal operational stage. Referring to the theory, elementary school students, whose ages range from 6-12, are at the stage of the concrete operational stage (Pitadjeng, 2015). Besides, these elementary school students' thinking progress remains gleaned from manipulating concrete objects. As a result, they require direct experience to lead them to abstract thinking.

Mathematics is an ideational science that relates logic, thinking patterns, concepts, and numbers-related operations. It serves an essential role in advancing thinking in various disciplines. For that reason, the Regulation of the Minister of National Education (2006) Number 22 issued the standard content for mathematics objectives stating that students should have the expertise to understand mathematical concepts. This understanding is carried out in such a way under thinking patterns and characteristics to solve problems, in which they should accurately reinterpret and explain the relationship between concepts, thoughts, and symbols.

Mathematics learning consists of content and process elements; each has five scopes. The content element is materials understood by students, while the process element is conceptual and reconstruction of mental activity. It aims to form a flow of thinking and understanding to develop skills. The content element comprises numbers, algebra, measurement, geometry, data analysis and probability, and calculus. Numbers become the first content element. Its review discusses numbers as

symbols, concepts, arithmetic operations, and the relationship between arithmetic operations in visual representation, properties of sequence, and operations. The objective is for students to comprehend and possess number sense.

Mathematics learning for lower-grade elementary school students begins with number sense. It refers to students' ability to work flexibly and conceptually with numbers (Kholid, 2020). The concept of numbers in elementary schools has been introduced since the first year, as it is the basis for grade 1 students to understand advanced materials. Mathematics for lower-grade students emphasizes basic numeracy skills like addition, subtraction, multiplication, and division. The importance of the four basic operations is as a provision in mastering the following materials at a higher grade level, in addition to their frequent usage in daily life.

Class 1 students' mathematics operations begin with addition and subtraction, whose concepts are manifested through concrete objects or experiences (Runtukahu & Kandou, 2016). Using concrete objects will make students manipulate the objects and use their language to associate them with addition or subtraction symbols. It is in line with Bruner, who explained that learning mathematics covers three stages: enactive, iconic, and symbolic; therefore, students should be allowed to manipulate aids while understanding mathematical concepts. According to Bruner, children actively engage with learning in a way that corresponds to the level of their cognitive development. (Dalyana, 2017; Ningsih, Syahrilfuddin, & Lazim, 2020).

A school in Piji, Getasan District, Semarang Regency, is one of the elementary schools selected as a reference by the *Kampus Mengajar* Batch 2 program. It could be said as a retarded one due to several factors; for instance, its non-strategic location, inadequate school facilities, and unsupportive community as numerous dropped-out children were found. These problems are mainly based on the economic issue worsened by the COVID-19 outbreak. During this time of the pandemic, learning at SD N Sumogawe 04 was carried out blended. However, this model was considered ineffective, considering the insufficient facilities to support the learning process. This condition resulted in low student understanding of literacy and numeracy; even some were unable to memorize letters and numbers. The low ability of these students, especially in arithmetic, is caused by a lack of conceptual understanding of addition and subtraction. To get the concept of counting, students must first recognize numbers. Another factor causing the low ability of arithmetic was the ineffectiveness of school learning due to the COVID-19 pandemic; given grade I elementary school students are included in the concrete operational period, real experiences like the authorship of mathematical symbols.

Based on the problems explained, ineffective learning during the COVID-19 pandemic could result in the poor ability of grade I students to understand arithmetic operations. Therefore, this study's proposed problems included (1) How is the students' understanding of numbers?; and (2) How is the students' thinking process in the arithmetic operations of addition and subtraction studied in Bruner's learning theory?

The objective of this writing is (1) to describe the ability of grade I students to understand numbers and (2) to describe the students' thinking processes in addition and subtraction studied in Bruner's learning theory.

RESEARCH METHODS

This study adopted the qualitative method, a descriptive research design. The research subjects included the 1st-grade students of SD Negeri Sumogawe 04 consisting of 4. The data were collected through observation, interviews, and documentation. Observations and documentation were carried out when the mathematics learning activities were taking place at school, while the interviews were conducted with the classroom teacher. Moreover, documentation serves to complete the required data. The data credibility or validity was examined through various methods to collect data on the same topic, involving different types of samples and data collection methods. This way of cross-validation is called the Triangulation technique (Sidiq & Choiri, 2019). The data analysis technique followed Miles and Huberman's analysis(Sugiyono, 2013) which has several stages, including data reduction, data presentation, and drawing conclusions or verification.

RESULTS AND DISCUSSION

After observing the process of learning mathematics, the researcher concluded that the students needed assistance in manipulating concrete objects. Their understanding developed after going through the learning stages. At last, the students solved addition and subtraction problems with the help of concrete objects.

The First-Grade Students' Ability to Understanding Numbers

Piaget argued that cognitive development is divided into four stages, each having a relationship with age and is composed of different ways of thinking(Wardi, Hayati, & Kurniati, 2021). The first stage of cognitive development is the Sensorimotor stage (0-2 years), the second stage is the pre-operational stage (2-7 years), the third stage is the concrete operational stage (7-11 years), and finally, the formal operational stage (> 11 years old).

Lower-class students, especially class I, are in the concrete operational stage. Students in this period need help manipulating concrete objects or direct experiences to think abstractly. One of the characteristics emerging during this stage is that they begin to realize the concept of conservation-a logical thinking that allows a person to determine that a certain quantity will remain the same despite adjustment of the container, shape, or apparent size (Trimurtini, Ahmadi, & Liftiah, 2018). Parallel with this, Ruseffendi argued that students aged 6-7 years, or in the concrete operational stage, begin to understand the concept of conservation number, the conservation of substance and conservation of

length at age 7-8 years, the conservation of matter at 8-9 years, the conservation of weight at 9-10 years, and finally the conservation of content at the age of 14-15 years (Wardi et al., 2021).

The objective of mathematics learning for first-year students is to demonstrate understanding and acquire number sense. The numbers taught to start from 1 to 20, yet the subjects could only say 1 to 10 sequentially and the rest randomly. The class teacher then trained them by inviting students orally to put the numbers 1 to 20 in order each time they started learning mathematics up to them being able to arrange the number in the correct sequence. Oral is the first form recognized by students, followed by reading and writing skills. The ability to represent numbers is also part of number sense; however, it should be realized that the speed of each child in understanding numbers is different. Student A is undoubtedly different from students B, C, or D.

Student A was able to mention numbers 1 to 20 sequentially. In writing number symbols, student A could write them coherently and correctly. When counting the pictures on the blackboard, student A could say the number of the pictures but had difficulty writing the number symbols. Then, when the pictures were slightly apart but with the same number, s/he kept correctly saying the number of pictures.

Based on observations made on student A, his/her ability to translate the number of pictures into numbers was lacking because s/he memorized the numbers sequentially yet could not mention the number of pictures orderly. Student A has understood the conservation of numbers as s/he understood that the number of pictures remains the same despite the different locations. As Pitadjeng (2015) said, students who recognize the law of conservation of numbers are ready to learn the concept of numbers and their operations.

Bruner's Learning Theory in the Operations of Addition and Subtraction

Bruner's learning theory focuses on the student learning process. Changes in student learning processes are visible in various forms, such as knowledge, understanding, attitudes and behavior, skills, habits, and other aspects obtained through learning (Dos, Gonçalves, Lopes De Araújo, Pereira, & Moreira, 2017). Students learn through active engagement with concepts and principles when solving problems, while teachers can motivate students to gain experience through activities that allow them to discover principles. As Bruner argued, when a person actively selects, retains, and transforms information, the process is the essence of learning(Supriyanto & Fariha Sari, 2021). Following the developmental stage, students should be allowed to manipulate objects or teaching aids.

Class I mathematics learning begins with studying numbers to acquire the number sense. The students master the law of conservation of numbers conceptually; they can continue learning the concept of arithmetic operations, addition, and subtraction. Since grade I students are at the concrete operational stage, their abstract thought should be assisted using natural objects. Therefore, to maximize the learning experience, educators should focus on optimizing the mode of presentation rather than the content being taught. Bruner believed that children can learn complex topics and that even adult learners

can learn new concepts if the presentation method is arranged in three stages: the enactive, iconic and symbolic.

1) Enactive Stage

At this stage, students learn mathematics using natural objects found around the environment, such as leaves. The first operation introduced was the addition, and terms like “add," "join," or “combine” were suggested. After knowing the terms, the students added, joined, and counted the leaves based on the given problems. As for subtraction, the students were introduced to the terms "take" or "move." After recognizing the terms, the students took and moved the leaves according to the requested command, then counted the remaining leaves. In this way, the students were helped to understand the mathematical concepts as they could visualize the abstract principles into tangible actions by manipulating the given media (Uribe-Flórez & Wilkins, 2017).

Figure 1. The Enactive Learning Stage

2) Iconic Stages

This stage allowed students to learn mathematics through images or visualizations as an embodiment of activities using concrete or concrete objects. The students were asked to count the number of pictures on the blackboard. These images served as visualizations of concrete objects previously used in the enactive stage. The addition was performed by summing the number of combined images, while the subtraction was done by counting the uncrossed leaves. This iconic stage is a transitional stage from concrete to abstract concepts (Bronkhorst, Roorda, Suhre, & Goedhart, 2021).

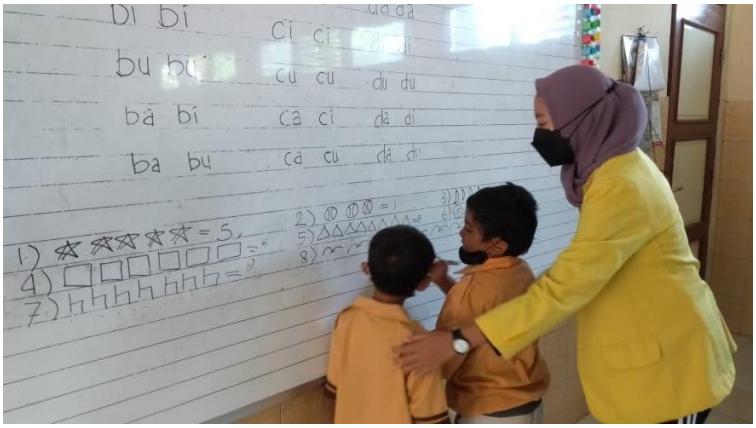

Figure 2. The Iconic Learning Stage

3) Symbolic Stages

Mathematical symbols serve as depictions of mathematical structures. The importance of introducing mathematical symbols is for students to recognize the structure of mathematics broadly and thoroughly. During the symbolic stage, the students experienced an abstraction process by manipulating symbols directly without any concrete object. In this stage, the students recognized that the symbol for addition is "+," subtraction is "–," and the results of addition and subtraction are written after the "=" sign. They could also write down the s numbers 1-20 according to the addition and subtraction results.

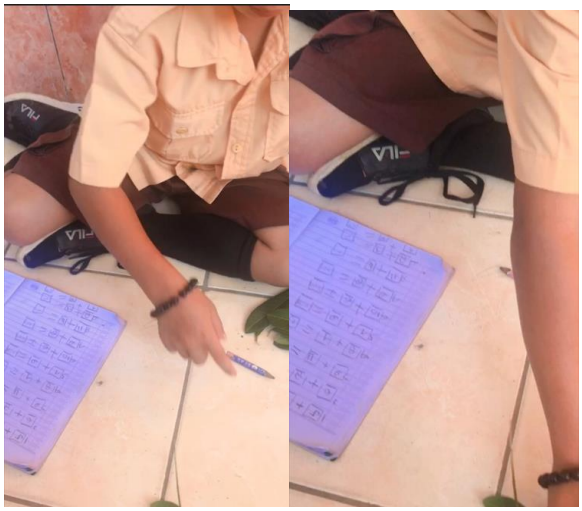

Figure 3. The Symbolic Learning Stage

According to Bruner's three stages of learning mathematics, the student's ability to understand the concept of addition and subtraction arithmetic operations increased as they could understand and work on the questions given. Using concrete objects helped them interpret the addition and subtraction forms in a tangible way. The learning process, which was carried out in stages by involving direct experiments

with concrete objects, was able to make students actively involved gradually based on their experiences. These results align with the application of Bruner's learning theory which has been proven to improve mathematics learning (Ndoen, 2021).

CONCLUSION

The *Kampus Mengajar* Batch 2 Program focuses on improving literacy and numeracy, starting from the basic education level. The objective of grade I mathematics learning is about numbers and the arithmetic operations of addition and subtraction; further, this study found that the students' understanding of numbers varied. When mastered, skills in representing numbers are part of the number sense will help them accept the next level of mathematics learning. The arithmetic operations taught in the first grade include addition and subtraction, and keeping in mind that the students were in the concrete operational, concrete objects were used. Bruner's learning theory can be used in preparing mathematics learning materials which require students to practice skills and thinking skills according to the stage of cognitive development. Applying Bruner's learning theory is expected to improve the quality of learning mathematical concepts as the students could actively be involved in gaining experiences to discover learning concepts.

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