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Elementary School Student's Concept of Linear Equations in One Variable in Bengkulu

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Abstract

This research explores the concept of linear equations in one variable owned by a 3rd-grade elementary school student in Bengkulu City. This student has a high impact on mathematics learning. The concepts explored were the definition of equality, the meaning of variables, and solution procedures owned by the subject. This research was qualitative and used a case study approach. The subject was asked questions that explored the meaning of linear equations in one variable (LEOV) and its solution. The results of this study stated that the subject had the following conception: 1) defining equality as similarity on equal-arm scales; 2) interpreting the variable as something whose value is unknown and is equated with dots, filling in things in a closed box and the like; 3) determining quickly the solution of LEOV for simple problems by counting out loud; 4) simplifying the equation by making a second addition side with a zero-sum generator number (additive inverse); and 5) having a highly practiced ability to solve LEOV involving positive integers and coefficients 1.

Keywords: Conception; Mathematics; Linear equation in one variable

INTRODUCTION

In Permendikbud (the regulation of the Minister of Education and Culture) Number 37 of 2018 concerning Amendments to Permendikbud Number 24 of 2016 about Core Competencies and Basic Competencies for Lessons in the 2013 Curriculum in Primary and Secondary Education, the material on linear equations in one variable (LEOV) is studied first in class VII of Junior High School (SMP). In the core competency section of knowledge, LEOV is found in basic competency 3.6 Explaining linear equations and inequalities in one variable and their solutions (Permendikbud No 37 Tahun 2018 Tentang Perubahan Atas Peraturan Menteri Pendidikan Dan Kebudayaan Nomor 24 Tahun 2016 Tentang Kompetensi Inti Dan Kompetensi Dasar Pelajaran Pada Kurikulum 2013 Pada Pendidikan Dasar Dan Pendidikan Menengah, 2018). However, some material that is a prerequisite, such as determining the weight of an object from the results of a scale, has been studied in class II of elementary school. This material can be a simple example in LEOV.

The LEOV concept is an essential part of the algebra concept that will be studied at every level of education. Algebraic concepts are a significant component of the mathematics curriculum in all countries (Bal, 2016). Algebra is often defined as arithmetic and algebra itself (Twohill, 2013). Algebraic concepts are mathematical concepts that are most widely applied in everyday life. For this reason, students need to learn this concept. In some countries, the LEOV concept is taught at the primary school level. In Indonesia, the LEOV concept begins to be taught in class VII of junior high school.

The LEOV concept is the most straightforward algebra concept. In the PSLV topic, the terms equality/equation, variable, term, coefficient, and constant are introduced. LEOV only contains one variable, which is in order one and is in the form of an open sentence involving an equal sign ("="). Even though it begins to be taught in class VII of junior high school, elementary school students have already introduced this material in comparing the weight of two objects using equal-arm scales. One of the problems is comparing three apples and a watermelon, where the weight of a watermelon is the same as that of six apples (Kemdikbud,

2018). This material provokes children's criticality in finding out the watermelon's weight and finally getting the weight of the apple according to the similarity given. This provokes students' curiosity to use LEOV in a simple way.

Mathematical conception is defined as the way mathematics students explain a rule about what they think, know, and understand (Simon, 2016). In other words, the explanation that students understand, know, and think about a mathematical concept can be said to be a mathematical conception.

Based on empirical data, it shows that student achievement in algebra material is still low. For example, from Sulawesi, it was reported that most (75%) of class VII students at SMPN 20 Palu still experienced difficulties on the subject of LEOV (Tandiayuk, 2012). This has a negative impact on further mathematics learning, especially algebra material. It was also reported from Java that the absorption capacity of junior high school students in Grobogan Regency for LEOV learning was still below the national average (Wijayanti et al., 2014). It was found that the national absorption capacity was 74.65%, and the absorption capacity in Grobogan Regency was 63.84%. In Kalimantan, it was reported that one of the error factors in LEOV material was caused by students' initial misconceptions (Husna, 2019). The initial conception in question is operations on integers, operations on like terms, and the distributive property in multiplication. This means that there are still many problems with LEOV learning.

School is a formal place for students to learn, including mathematics learning. Schools have the authority to modify learning to achieve educational goals (Susanta *et al.,* 2023). However, the role of the school as a place of learning is not the only one. Many other parties can play a role in mathematics learning, one of which is the role of the environment where students live. Environmental conditions influence students' mathematical conceptions. The active participation of parents in children's learning has a significant influence on the formation of students' mastery of cognitive concepts (Pravitasari, 2020). The longer the duration of the child's active interaction with parents, the greater the possibility of developing the child's mastery of cognitive concepts. In this pandemic, the duration of interaction between parents and their children in learning is very long. So, it can be concluded that parents are among the most significant influences shaping students' mastery of cognitive concepts during this pandemic.

Apart from parents, tutoring also significantly influences students' level of understanding of mathematical concepts (Nerimurjiyanti, 2017). Tutoring is designed to add extra understanding to students' concepts. It can be used as a reinforcement of understanding that has been learned at school. It can also increase understanding outside of the formal material studied at school. Apart from parents and tutoring, student learning facilities that students use daily have a significant positive relationship with students' mathematics learning achievement (Aji, 2017). Facilities are very influential in forming students' mathematical conceptions. With the right learning facilities, the formation of mathematical conceptions will improve.

A student in Bengkulu City, still in grade 3 of elementary school, is suspected of having a mathematical conception of LEOV. From the initial information, it was found that the student could determine the value of x for the equations $x + 3 = 7$, $x - 2 = 5$, $4x - 1 = 7$, $3x + 2 = 8$, and $2x - 7 = -3$. From the information, This initial conclusion was that the student already had a conception of LEOV. This student has a unique environment that allows him to learn more than his peers. This student has an older sibling in grade 8 of junior high school with good math

skills. In addition, both of their parents are mathematics teachers. Therefore, they may start learning the concept of LEOV from their parents.

The student's initial abilities and special features interested researchers in exploring their conception of the LEOV material. The research starts from the student's understanding of the meaning of equations and variables, what conceptions he has, and the solution procedures he carries out. As a result, this research aims to describe the mathematical conception of one of the 3rd-grade elementary school students in Bengkulu City on LEOV material. The student was asked questions that led to LEOV and its meaning.

METHOD

This research is qualitative descriptive research with a case study approach. A case study is a qualitative design in which the researcher explores an activity, process, or one or more individuals in-depth, limited by time and specific activities (Priya, 2021). This research focused on the subject's ability to understand LEOV material, starting from the meaning of the material understood by the subject to the completion procedures carried out by the subject. All answers given by the subject are captured as they are, both verbally and in writing.

The subject of this research was a 9-year-old 3rd-grade elementary school student. The research was conducted from 22 December 2021 to 10 January 2022 at the subject's residence, Bengkulu city. The subject has been doing distance learning since 15 March 2020. The subject had no learning achievements while he was an elementary school student. From previous interviews, the subject has a good conception of integer material. The subject has a sibling in grade 8 of junior high school in Bengkulu City. Since distance learning, the subject and siblings are often involved in studying together, especially the subject's favorite material, mathematics. The subject underwent abacus training at a tutoring institution for additional operations. The subject and his siblings usually use an internet network at the subject's residence for distance learning.

This research started by testing the subject's ability to complete the LEOV. Once it is known that the subject has these abilities, further exploration of the subject's abilities regarding LEOV is carried out. The research was carried out by asking the subject questions about LEOV and conducting interviews based on the answers given. The research procedure was repeated several times to obtain consistent data. The essence of the question remains, but it should be in different words so that the subject understands what is being asked. After obtaining consistent data from the subject, conclusions were drawn.

The instruments used were a question paper on LEOV and a list of interview questions. The data obtained was in the form of answers to question scripts and answers to interview questions. The two data are interrelated and form an inseparable whole. Conclusions are drawn after all the data is obtained. The conclusion is in the form of the subject's conceptions about the LEOV material.

RESULTS AND DISCUSSION

Data Condensation

Researchers condensed research data to focus, simplify, and abstract from the results of written tests and interviews. Data condensation refers to the process of selecting, focusing, simplifying, abstracting, and transforming data that appears in a complete corpus (body) of written field notes, interview transcripts, documents, and materials of other empirical studies

(Miles *et al.,* 2014). The results obtained were grouped based on the level of integer material. The research results are presented based on integer material level groups as follows.

The Definition of Equality

The subject already knew the equal and dissimilarity symbols in the 2nd grade of elementary school. In the lesson, similarities were also introduced by using a picture of equal-arm scales. One of the materials was the equality of two different objects. On the right, there are six apples, and on the left, there is one watermelon, as in Figure 1 below.

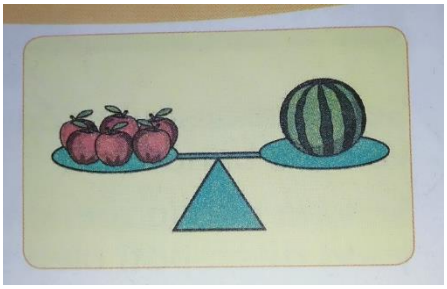

Figure 1. Elementary School Material of Class 2 about Equal-arm Scales

From this material, the subject obtained the concept of equality (Kemdikbud, 2018). The subject answered 12 apples if two watermelons were placed on the left arm of the equal-arm scales. The subject reasoned that both weigh the same. Based on this material, the researcher explored the meaning of equality for the subject. The subject stated that equality meant the two numbers were the same. This means the left and right sides had the same value. If the left side was added to a number, the subject also added the right side to the same number. The subject's reason was to keep both sides the same. If it was not added, then the equal sign no longer existed. The subject stated that apart from the equal sign, there were "less than" and "more than" signs.

The Meaning of Variable

The subject could determine the value of an omitted number in the equation. Subject wrote dots ("..."), question marks ("?"), squares on scales and x or other letters in algebraic writing to replace unknown numbers. The reason was that the symbol indicated an unknown number. All symbols denoting known numbers could be used. However, the subject did not know that the name of the symbol x in algebra was a variable. When it was said it was variable, the subject answered, "Haven't heard of it and never studied variables."

The researcher felt there was nothing to ask the subject about the variables. Because this term was not yet known by the subject. When the researcher provoked the word variable, the subject said he did not know the term variable. However, the subject could be asked what the variable meant to the subject by providing a problem that contains the variable. For simple things, the subject drew equal-arm scales to express the equation in the problem, immediately getting the answer from the picture. Figure 2 shows a description of the variables given by the subject when the researcher gave the problem, "A box contains marbles. Then Dad added seven marbles to the box. After counting, the total number of marbles was 15. How many marbles were initially in the box?".

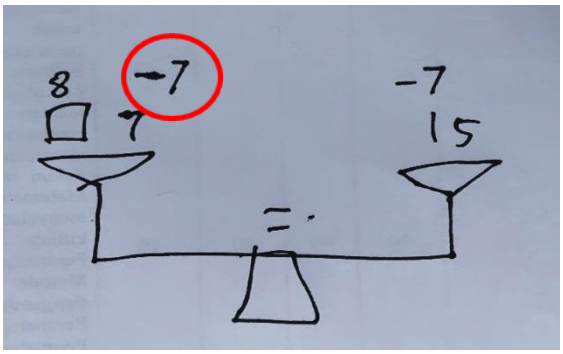

Figure 2. Meaning of Variables in Box Shape on Equal-arm Scales

Figure 2 shows that the subject states the variables in the form of boxes on the scale image given as a simple way of solving LEOV. The subject immediately completed the picture of the scales.

Solving Linear Equations in One Variable

In solving LEOV, the subject had many ways. The first way was to draw equal-arm scales. The second way was to guess the number. The third way was algebra. The three methods used by the subject were used in adapted conditions. The first method was mainly used if it contained positive constant numbers. The second method was used if the numbers involved in the equation could still be operated on in the subject's mind. The third method was the last method to be used if the first and second methods were impossible according to the subject.

The first way the subject did this was by using a picture of equal-arm scales. The subject drew a scale similar to a picture he had seen in 2nd grade. The shape of the scale was equal-arm scales, with the object to be weighed in the form of a disc, and the length of both arms was the same. The scale rested right in the middle. Sometimes, the support was drawn in a triangular shape, sometimes in a trapezoidal shape. However, the subject would correct the trapezoidal image into a triangle if the researcher asked about the shape of the support. It seemed that the subject intended to make a triangle, but it formed like a trapezoid because it was quick. The ideal image for scales is as in Figure 1.

The procedure for firstly solving LEOV is (1) drawing equal-arm scales, (2) writing the variable with a square symbol on the scale plate according to its side, (3) writing a constant number on the plate according to its side, (4) writing an equal sign between the two arms. above the scale, (5) manipulating the constant number to become zero, (6) writing the number on the square as the final result of the calculation. The number above the square was referred to as the value of the variable to be found. All writing was done on top of one scale drawing. There was no drawing of a new scale as a change of writing. Some of the results of the operations were not visible in the picture but already existed in the subject's mind.

The second solution was to guess the number. The subject carried out a fast thought process in his mind and reflected on his guess. The reflection results determined the final result of the calculation. If the guess met the equation, then the calculation was complete, and the guess result was stated as the variable's value. If the guess did not meet the equation, the guess was corrected based on reflection. This happened several times. If they had obtained a number that satisfies the equation, the subject wrote the number as the variable's value. Figure 3 shows an example of a LEOV that is solved by guessing numbers.

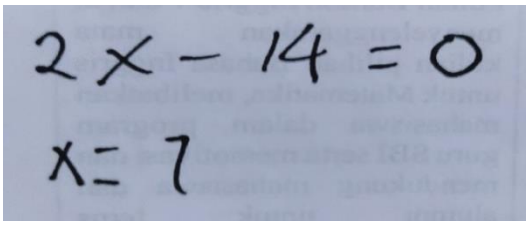

Figure 3. Example of a LEOV whose solution can be predicted

If several guesses were unsuccessful, the subject would carry out another process to determine the LEOV solution. The third way to solve LEOV was to do calculations using algebra. The subject performed algebraic manipulation to leave variables on the left side of the equation. He was very fluent in algebraic manipulation of constant numbers. Figure 4 shows the subject' answers using algebraic manipulation.

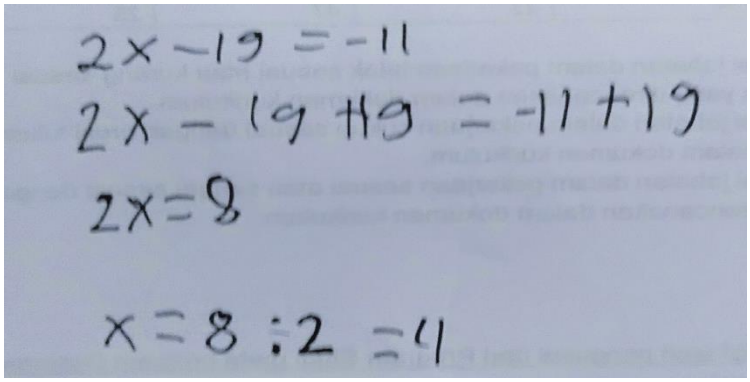

Figure 4. Subject's Answer Using Algebraic Manipulation

The subject added the number 19 as the inverse of the operation -19. Then, the subject divided both sides by the number 2. The operation process was considered complete if the left side only contained x. For several LEOV solutions involving coefficient values that were not one, the subject still often stated that they had finished when the coefficient was not yet one.

The subject was not able to solve problems involving fractional numbers in LEOV well. He was only able to carry out algebraic manipulations to the extent of separating variables on the left side and constants on the right side of the equation. He could not continue solving because he did not receive a number that was not in his mind.

For the LEOV problem presented in the form of a story, the subject was still not fluent in writing the mathematical model. Only problems that were simple and did not involve mathematical material that had not been studied could be written down by the subject. However, for problems involving other mathematical material, such as plane figures, the subject was unable to write down the mathematical model.

Vygotsky, in his book Thought and Language, mentions that there is a concept that is formed in children's minds is a type of pseudoconcept, although it seems like an adult concept, is completely different (Vygotsky, 1986). The subject's conception did not seem to differ much from the truth. However, the subject was still limited to existing material that the subject has been studied. It was believed that the current conception resulted from the subject's thinking on previously studied material and was a prerequisite for the LEOV material. As a result, none of the terms contained in LEOV could be adequately explained formally, including variable, constant, term, left side, and right side. The subject only had a conception similar to the proper concept (Maizora & Juandi, 2022; Maizora & Rosjanuardi, 2021).

In Piaget's book titled The Language and Thought of the Child, children pronounce words repeatedly to obtain the meaning of the words they mention (Piaget, 1959). The unknown numbers were a language that the subject understood regarding variables. The subject began the symbol representing the variable with a dot ("..."). The subject had very commonly seen this symbol since first grade. The meaning of dots was always interpreted as "a place to write the answer", "something that did not exist yet", "something that had not been written down", "something that might be known". That was how the subject tried to convey the variable term. The subject could not answer other terms.

The quality of textbooks greatly influences students' mathematics learning strategies (Sievert *et al.*, 2021). Delivering teaching material that can make an impression on students can provoke students' minds to explore information beyond the limits of the material being taught. Therefore, the subject extracted information about LEOV from learning comparison materials by using problems on the scales. The subject gained a conception of equations and variables. By providing the material that develops various solutions in textbooks, a student's algebraic reasoning improves (Andriani, 2015; Burgos *et al.*, 2024; Kaput, 2017).

Introductory algebra can be introduced to elementary school students (Radford, 2011). At least, Radford found that elementary school students could solve fundamental algebra problems without using algebraic symbols. Not far from the results of this research, the research also found that students could recognize several problem solutions in LEOV by stating variables as unknown numbers.

The subject made guesses or "try and error" in finding variable values, which was the same as what Radford found in Class 2 students. Students carried out calculations that formed patterns according to the problem given (Radford, 2015). Students form certain calculation patterns to arrive at the expected conditions to find the solution. Otherwise, the students had other ways if the guessing method did not find a solution.

The subject could only solve LEOV on whole numbers due to a lack of knowledge about other types of numbers that have not been studied. No information could be extracted from the subject's limitations. A similar thing also happened when the subject solved the problems in the word questions. The subjects had limitations in understanding problems they had never encountered before, such as problems regarding the perimeter of flat shapes. The subject had never studied determining the perimeter of a flat shape.

CONCLUSION

Based on the research and discussion above, it can be concluded that the subject understands the equation of the principle of equal-arm scales, does not know the term variable but understands the word substitute for a variable with an unknown number, and has a way of solving LEOV by guessing, drawing equal-arm scales, and algebraic manipulation.

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