

Problems Related to Linear Equations

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Annotation: A linear equation is an algebra material that exists in junior high school to university. It is a very important material for students in order to learn more advanced mathematics topics. Therefore, linear equation material is essential to be mastered. However, the result of 2016 national examination in Indonesia showed that students' achievement in solving linear equation problem was low. This fact became a background to investigate students' difficulties in solving linear equation problems. This study used qualitative descriptive method.

Keywords: derivation, limit, integral, slopes, graphes linear equations.

Within secondary school mathematics curricula, there are four topics, namely; number, algebra, geometry and measurement, and statistics and probability. Algebra has been widely recognized as one of the most difficult topics [1]. One of algebra materials is linear equation. A linear equation is an algebra material that exists in junior high school to university. A linear equation is important to master more advanced mathematics topics such as derivative in calculus [2, 3], the line of best fit in statistics [4, 5], and to describe nonlinear functions in advanced algebra [6]. Therefore, linear equation material is essential to be mastered. However, students' ability to solve problems related to linear equation is low. It can be seen from the result of national examination of Indonesia junior high school in 2016. It showed that the result at the national level was only 39.82%. The low result was also shown by students of SMPIT Insan Kamil Karanganyar in solving linear equation problem. The result was only 33.33%.

Studies have found that students experienced various difficulties in a linear equation. Students misunderstand linear equations, graphs, slopes, and are not able to comprehend the connection between slope and the x- and y-intercepts [7, 8]. Research has documented procedural and conceptual students' difficulties with slope [9]. The misconception and deficiencies of the students in the linear equation also may lead to severe learning difficulties in the subjects of functions, limit, derivation, and integral in high school and the university years. For this reason, it is important to determinate students' difficulties in solving linear equation problems.

One of the mathematics characteristics is having abstract study objects in the form of facts, concepts, principles, and operations. Objects in mathematics learning such as facts, concepts, operations, and principles influence students in mastering basics competencies of mathematics.

Understanding the linear equation is remarkably complex and involves many levels of abstraction. Students' difficulties in solving linear equation problems can occur due to the lack of understanding of mathematical objects in the form of facts, concepts, operations, and principles. Factual difficulties are the obstacles that students experienced in the mastery of subject matter related to symbols, signs or notations. Conceptual difficulties are the obstacles that students experience in the mastery of subject matter related to the abstract idea used to solve a problem. Operational difficulties are the obstacles that students experience in the mastery of subject matter related to the work of counting and algebra workmanship. Principle difficulties are the obstacles that students experience in the mastery of the subject matter related to the axioms, theorems, relationships between various basic objects of mathematics and formulas of mathematics.

Based on the above explanation, this study is aimed to investigate students' difficulties in solving linear equation problems, especially students of SMPIT Insan Kamil Karanganyar. Students' difficulties are classified to factual, conceptual, operational, and principle difficulties. The understanding of the difficulties faced by students can provide a guideline for teachers as well as researchers to plan better approaches. It is necessary to assist the students which will result in more meaningful teaching and learning process.

1. Solve: $(2x + 5)/(x + 4) = 1$

Solution:

$$(2x + 5)/(x + 4) = 1$$

$$\Rightarrow 2x + 5 = 1(x + 4)$$

$$\Rightarrow 2x + 5 = x + 4$$

$$\Rightarrow 2x - x = 4 - 5 \text{ (Transferring positive } x \text{ to the left hand side changes to negative } x \text{ and again, positive } 5 \text{ changes to negative } 5)$$

$$\Rightarrow x = -1$$

Therefore, $x = -1$ is the required solution of the equation $(2x + 5)/(x + 4) = 1$

2. Solve: $6x - 19 = 3x - 10$

Solution:

$$6x - 19 = 3x - 10$$

$$\Rightarrow 6x - 3x = -10 + 19 \text{ (Transferring } 3x \text{ to L.H.S changes to negative } 3x \text{ and } -19 \text{ to R.H.S. changes to positive } 19)$$

$$\Rightarrow 3x = 9$$

$$\Rightarrow 3x/3 = 9/3 \text{ (Dividing both sides by } 3)$$

$$\Rightarrow x = 3$$

3. Solve: $5 - 2(x - 1) = 4(3 - x) - 2x$.

Solution:

$$5 - 2(x - 1) = 4(3 - x) - 2x$$

$$\Rightarrow 5 - 2x + 2 = 12 - 4x - 2x \text{ (Removing the brackets and then simplify)}$$

$$\Rightarrow 7 - 2x = 12 - 6x \text{ (Transferring } -6x \text{ to L.H.S. changes to positive } 6x \text{ and } 7 \text{ to R.H.S. changes to negative } 7)$$

$$\Rightarrow -2x + 6x = 12 - 7$$

$$\Rightarrow 4x = 5$$

$$\Rightarrow 4x/4 = 5/4$$

$$\Rightarrow x = 5/4$$

4. $x/2 + x/3 = x - 7$

Solution:

$$x/2 + x/3 = x - 7$$

Least common multiple of 2 and 3 is 6

$$\Rightarrow (x/2 \times 3/3) + (x/3 \times 2/2) = x - 7$$

$$\Rightarrow 3x/6 + 2x/6 = x - 7$$

$$\Rightarrow (3x + 2x)/6 = x - 7$$

$$\Rightarrow 5x/6 = x - 7$$

$$\Rightarrow 5x = 6(x - 7)$$

$$\Rightarrow 5x = 6x - 42 \text{ (Transferring } 6x \text{ to L.H.S. changes to negative } 6x)$$

$$\Rightarrow 5x - 6x = -42$$

$$\Rightarrow -x = -42$$

$$\Rightarrow x = 42$$

$$5. 2/(x + 3) = 3/(5 - x)$$

Solution:

$$2/(x + 3) = 3/(5 - x)$$

$$\Rightarrow 3(x + 3) = 2(5 - x) \text{ (cross multiply and then remove the brackets)}$$

$$\Rightarrow 3x + 9 = 10 - 2x \text{ (Transferring } -2x \text{ to L.H.S. changes to positive } 2x \text{ and } 9 \text{ to R.H.S. changes to } -9)$$

$$\Rightarrow 3x + 2x = 10 - 9$$

$$\Rightarrow 5x = 1$$

$$\Rightarrow 5x/5 = 1/5 \text{ (Dividing both sides by } 5)$$

$$\Rightarrow x = 1/5$$

Based on researcher's data analysis about students' difficulties in solving linear equation problems, it can be concluded that students with high mathematics achievement do not have difficulties in solving linear equation problems, students with medium mathematics achievement have factual difficulty related to distinguishing between point and line, and students with low mathematics achievement have factual, conceptual, operational, and principle difficulties in solving linear equation problems. Factual difficulties are related to determining points of Cartesian coordinates. Conceptual difficulties are related to the concept of lines intersection, the concept of x- and y-intercepts, and the concept of slope. Operational difficulties are related to algebra workmanship and calculation. Principle difficulties are related to determining formula; such as formula of the slope and method to determine the point of lines intersection. Based on the result there is a need of meaningfulness teaching strategy to help students to overcome difficulties in solving linear equation problems.

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