

## IMPLEMENTATION OF LINEAR SYSTEM WITH TWO VARIABLES USING GEOMETRY

Jesi Irwanto<sup>1\*</sup>, Anisatul Fauziah<sup>2</sup>, Mimin Yatminiwati<sup>3</sup>, Zainul Hidayat<sup>4</sup>, Mokhamad Taufik<sup>5</sup>

<sup>1,2,3,4,5</sup>Widya Gama Lumajang College of Economics Jl. Gatot Subroto No.04 Lumajang, Indonesia.

Email: <sup>1\*</sup>jesyrwanto@gmail.com, <sup>2</sup>anisatulfauziah@gmail.com, <sup>3</sup>miminyatminiwati02@gmail.com, <sup>4</sup>zd4y4@gmail.com, <sup>5</sup>mtaufikswiga@gmail.com

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### Abstract

**Purpose:** This study aims to understand the concept of a two-variable linear equation system by presenting material in the form of line drawings in the field of Cartesian, this is because at the 2013 Junior High School Examination National Examination many students received mathematical grades below the standard.

**Methodology:** In constructing the concept of a system of linear equations, two variables in the Cartesian plane are carried out in stages. The first stage is obtained four system concepts of two-variable linear equations which include the concept of a straight line position in the Cartesian plane, the concept of the point position towards intervals in the Cartesian plane, the concept of the point position towards the line  $am + bn = c$ , the concept of the relationship of two lines  $m + b_1 n = c_1$  and  $a_2 m + b_2 n = c_2$ .

**Main Findings:** The results of this study are the first stage of the concept of four systems of linear equations which include the concept of straight-line position in the cartesian plane, the concept of point position at intervals in the Cartesian plane, the concept of position points with lines, the concept of two-line relations.

**Applications of this study:** This study is applicable to the junior high school level.

**Novelty/Originality of this study:** a) Evaluating data about constants, intervals for variables and, relations of points with lines, relations of two lines. b) It provides data on stage (a) to visualize various lines determine the position of points against the line, intersect two lines. c) Provide a case for related points a and b to students for evaluation.

**Keywords:** Variables, Constants, Derivation, Relationship, Lines System of Linear Equations, Cartesian Diagram.

### INTRODUCTION

Mathematics, a science of patterns (Devlin, 1996; Oliveri, 1997; Resnik, 1997). To be able to solve a mathematical case correctly, students must understand the mathematical concepts that the teacher provides well (Gearhart & Saxe, 2004; Stipek, 2002; Wilson, Fernandez, & Hadaway, 1993). Teachers are demanded as real as possible in understanding the basic concepts of mathematics to students, so students can understand the concepts given. Many teachers have difficulty understanding mathematical concepts in real terms to students. Because of the limited interactive and communicative learning techniques that can be used to help understand the concept (Laurillard, 2013; Mezirow, 2008, 2018). So students do not understand the concepts given well in solving the questions tested correctly. One of them is to understand the concept of SPLDV material in the courtesies field.

The material requires learning techniques that are able to illustrate the component system of two-variable linear equations in the cartesian plane in a more tangible visual form. So that it can facilitate students in completing existing cases. Data supporting the lack of student understanding of mathematical material can be seen from several data (Ambarwati, Dwijanto, & Hendikawati, 2015; Azis & Sugiman, 2015). The 2013 report on the results of the mathematics National Examination for SMP / MTs in Indonesia showed a low percentage compared to other materials. Three previous studies were conducted. Pulungan (2019) Explains that students do not understand the material of a two-variable linear equation system because they do not understand the concept given by the teacher (Dewi, Mursida, & Marta, 2017). Get results that use computer-based learning media can improve students' understanding of the concept (Semadiartha, 2012). It shows that the development of computer-based learning media increases student achievement and learning motivation. From these facts, it can be concluded that students need appropriate learning techniques to help understand the system concept of two-variable linear.

Problem-solving in school mathematics is usually realized through story problems. In solving the problem of the story first students must be able to understand the contents of the story problem, after that draw conclusions objects that must be completed and for example with mathematical symbols, to the final stage, namely completion. Until now, the skills to think and solve mathematical story problems are still quite low. The most difficulty experienced by students in solving problem stories is the difficulty in understanding questions (Farihah & Nashihudin, 2016).

### LITERATURE REVIEW

A system of linear equations (SPL) is a combination of two or more linear equations that interrelate to one another (Chen, 1998; Rugh & Rugh, 1996). In the SPL there is a name of completion, the completion of the replacement value that causes the equation to be a statement of true value. And the process of completion is usually called a settlement

(always parenthesis). Equations and systems of linear equations- the linear equation is part of an open sentence that has the same basic characteristics as "=" a linear equation all variables have a rank ([Wu & Mohanty, 2006](#))

Equations and Linear Equation Systems of Two Variables- The linear equation of two variables is a linear equation that has two variables, and each variable has a rank (Cholik, 2004). Cartesian field intervals-interval is a set of real numbers that satisfy certain inequalities. There are two types of intervals, namely finite intervals and infinite intervals. Finite intervals are part of (x) or (y) limited below or above. while the infinite interval is not limited to below or above ([Purcell & Varberg, 1994](#)).

Two variable linear inequality- linear inequality of two variables is an open mathematical sentence that contains two variables, with each variable having a degree of one and associated with inequality. Cramer method- the Cramer method is one of the methods for searching variable values using determinants ([Gao, 1995](#)).

## RESEARCH METHODS

In constructing the concept of a system two linear equations in the cartesian plane are carried out in a stage. its obtained by four concepts of linear equation systems of two variables which include concepts and straight-line positions in the cartesian plane, the concept of the position of the point against the interval in the cartesian plane, the concept of the position of the point against the line the second stage is the visualization of each of these concepts

## RESEARCH RESULTS

### 1. Construction of the Line Position in the Cartesian Field

In this concept, it is understood the possibility of three positions of the line  $am + bn = c$  in the Cartesian plane controlled by constants. If  $a = 0$  horizontal formed line  $b = 0$ , a vertical line is formed, and  $a, b \neq 0$  slashes form.

- Provides 8 groups of different constants for the equation  $am + bn = c$ ;
- Emerging three groups of data from eight boarding houses *randomly* with the provisions of 1 vertical line, 1 horizontal line, and 1 slash line 6 times.
- Arrange questions for students to determine 1 of 3 data that appears where data generates vertical lines, horizontal lines, or slashes.
- Evaluating the answer to the question is right or wrong.
- Inform students, the number of correct answers and the number of incorrect answers.
- Make conclusions.

### 2. Visualization of Coordinate Points on the Cartesian Field Interval

In this concept, the position of the variable controlled coordinate point will be understood in the form of a cartesian field interval.

- Providing 4 different interval groups, each 1 group interval contains 1 interval M and 1 interval;
- Showing 1 interval group from 4 groups of intervals *randomly* 4 times.
- Provides two variable linear formula equations namely  $2m + n = 6$ .
- Provides 10 coordinate points  $\{(0.6), (1.4), (2.2), (3.0), (4, -2), (5, -4), (4.2), (2.2), (2, -3), (3.1)\}$ .
- Arrange questions for students to determine all points that meet the equation outside the interval, at intervals, or at intervals.
- Evaluating students' answers that are right or wrong.
- Inform students of the number of correct answers and the number of incorrect answers.
- Make conclusions.

### 3. Position of Coordinate Points Toline $Am + bn = c$

In this concept, the position of coordinate points is understood to be controlled by the line  $am + bn = c$ . The substitution of the variable m and the variable n to the equation has three possibilities. If the result of the substitution of the left section is less than c, the position of the point is below the line. If the result of the substitution of the left segment is the same as the position of the point on the line. If the substitution results in the left side are more than c, then the position of the point is located above the line.

- It provides two types of data, the first 4 different data two-variable linear equation formulas. The second 1 interval group contains 1 interval x and y. , the concept of two-line relations and;

- b. Provides 10 coordinate points  $\{(1,2), (1, -1), (0, -1), (2, -1), (2,4), (-1,6), (3, -2), (-3, -1), (0, -2), \text{ and } (3,0)\}$ .
- c. Arrange 1 question from 3 questions for students to choose all coordinate points located below the line, on the line, or above the line.
- d. Evaluating student answers that are true or false.
- e. Inform students of the number of correct answers and the number of incorrect answers.
- f. Make conclusions.

#### 4. Derivation of Relationship Two Line $am + bn = c$

Suppose that two linear equations are given two variables namely  $am + bn = c$  and  $pm + qn = r$  which are drawn in the form of lines in the cartesian plane. There are three possible relationship lines formed by considering the constant relationship between the two equations. If  $a_p \neq q, p \neq 0, q \neq 0$ , the lines formed intersect and have one solution. Furthermore, if  $a_p = q, r = c, p, q, r \neq 0$  then the formed line coincides and has infinite resolution. If the line is  $a_p = q, r \neq c, p, q, r \neq 0$  which is formed parallel or has no solution.

- a. Provides 4 linear two-variable equation formulas.
- b. Bring up 2 random formulas, so that the combination of equations is obtained (ab, ac, ad, bc, bd, cd).
- c. Provides three choices of constant relationships of 2 equations namely  $a_p \neq q, p \neq 0, q \neq 0, a_p = q, r = c, p, q, r \neq 0, a_p = q, r \neq c, p, q, r \neq 0$ .
- d. Provides 4 choices, which consist of 3 coordinate choices  $\{(0,2), (2,0), (3,1)\}$  and 1 option "none".
- e. Arrange questions for students to determine all points passed by two lines that appear.
- f. Evaluate correct answers and wrong answers.
- g. Inform students, the number of correct answers and wrong answers.
- h. Make conclusions.

#### DISCUSSION

According to [Romberg \(1995\)](#) in education, especially mathematics education, individuals or groups can create a new product to improve learning; this product may be a new learning material product, engineering new learning programs, or new learning programs. The development of this new product involves the engineering process by discovering a particular part of the section and putting it back to create a new shape.

There are four main stages in the development, namely; Result design, result creation, result implementation, and usage results. This form of innovation Dimakhsudkan optimizes the results of a teaching-learning process characterized by increasing students' ability in absorbing concepts of mathematical concepts, procedures, and algorithms ([Orton, 2004](#)).

The development of mathematical learning Model Mathematics learning is one of the efforts to create learning innovations to improve students' ability to understand mathematics. This business is done in connection with the difference between 'material' which is in the mind of the written curriculum (intended curriculum) with 'material taught' (implemented curriculum), as well as the difference between 'material taught' by the material 'students learn' (realized curriculum).

According to Zainurie ([Soviawati, 2011](#)), Realistic Mathematics in school mathematics that is implemented by placing students' reality and experience as a starting point of learning. Realistic problems are used as the source of the emergence of mathematical concepts or formal mathematical knowledge. The realistic mathematics learning in class is oriented on Realistic Mathematics Education (RME) characteristics, so students have the opportunity to rediscover mathematical concepts or formal mathematical knowledge. Furthermore, students are allowed to apply mathematical concepts to solve daily problems or problems in other areas ([Laurens et.al, 2018](#)).

Realistic Mathematics Education (RME) is a theory of learning to teach in mathematics education. The RME theory was first introduced and developed in the Netherlands in 1970 by the Freudenthal Institute. This theory says that mathematics should be attributed to reality and mathematics is a human activity. This means mathematics should be close to the child and relevant to everyday real life. Realistic mathematics learning is essentially the use of reality and environment understood by learners to facilitate the learning process of mathematics, to achieve the goal of mathematics education better than the past ([Fauzan, 2002](#)). The meaning of reality is the real or control things that can be observed or understood by learners by imagining, whereas what is meant by the environment is the environment in which learners are either the school environment, the family And communities that learners can understand. The environment, in this case, is also called daily life ([Soviawati, 2011](#)).

In this phase, the evaluation of the construction procedures of all concepts covering line position in the cartesius field, visualization of coordinate points with respect to the interval in the cartesius plane, the position of the coordinate points to lines, the derivation of the relationship of two lines and the concept of the direction of the equation, In addition, each

concept is shown a line drawing as an implementation of the data provided. This can facilitate students in understanding each concept. In presenting the appearance of the four concepts as interesting as possible with the use of language as clear as possible so as not to confuse students in completing cases. Furthermore, in terms of workmanship students are instructed to work in writing on each concept. This is so students can understand the flow of work on their own in each material completion. In the process of working the data is given randomly, both the main data and the questions. This is so that students cannot memorize data. In the learning game, several opportunities are answered for one case session. Each answer is given feedback to give information to students where the error in answering. It is an interactive action program the concepts in this research by using a graphical approach in the field of Cartesian can facilitate students' understanding in learning the system of two-variable linear equations. this is because students more easily understand the picture than do the calculation approach.

Today there are some problems or difficulties in understanding the system of two-variable linear equations. The difference between the difficulty in determining the value of the variables in the SPLDV equation. Also, the learner struggles to investigate the story in the SPLDV, because students have to contract the question into a mathematical model that is a two-variable linear equation.

To overcome the difficulties in the material, the authors try to use a realistic approach in the hope so learners to determine the value of the variables with daily experience.

## CONCLUSION

The results of the study concluded that to understand the concept of a system of linear equations two variables with geometry techniques are carried out by, a) Evaluating data about constants, intervals for variables and, relations of points with lines, relations of two lines. b) It provides data on stage (a) to visualize various lines determine the position of points against the line, intersect two lines. c) Provide a case for related points a and b to students for evaluation

## SUGGESTION

With this research, researchers feel they have made it easy to understand the system of linear equations of two variables using the geometry approach. Limited in this study is the limited scope of the material discussed. As for further research, researchers hope the material can be expanded not only to the system of linear equations of two variables.

## LIMITATION AND STUDY FORWARD

This research is limited to one case that occurred in the mathematics National Examination for SMP / MTs in Indonesia. Due to the low percentage compared to other materials. The results of this study can be beneficial for education activists and stakeholders. Further, research is needed on mathematics National Examination for SMP / MTs in Indonesia.

## IMPLICATION

Due to a low percentage compared to other materials, the results of this study can be beneficial for education activists and stakeholders. Further, research is needed on mathematics National Examination for SMP / MTs in Indonesia. This research will contribute to the knowledge of education.

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