Penerbit Akademia Baru

Journal of Advanced Research in Social and Behavioural Sciences

Journal homepage: www.akademiabaru.com/arsbs.html
ISSN: 2462-1951

Learning Design of Two-Variable Linear Equation System using Buying Context

Open Access

Dewi Malihatuddarojah[1], Suparman[1,*]

[1] Department of Mathematics Education, Universitas Ahmad Dahlan, Indonesia

ARTICLE INFO

Article history:
Received 29 January 2019
Received in revised form 6 March 2019
Accepted 6 May 2019
Available online 7 May 2019

Keywords:
Design research, two-variable linear equation system, IRME

ABSTRACT

This study aims to design a system of two-variable linear equation learning in class VIII SMP using the PMRI approach. This research is a type of design research with a type of validation study. The results of this study are that buying and selling transactions can be used as a Realistic Context in learning mathematics, especially as an effort to develop students' understanding of the concept of system of two-variable linear equation learning. Because through the learning path that has been compiled using the context of buying and selling students can find and express their own ideas on how to solve problems about system of two-variable linear equation learning.

1. Introduction

The two-variable linear equation system is the material taught at the grade VIII junior high school level. In Indonesia, in the material students are required to be able to explain the system of linear two-variable equations and their solutions that are related to contextual problems. Most teachers teach the material by giving a general form of the equation so that when students encounter contextual problems related of two-variables linear equations system students tend to have difficulty completing [1,2]. Based on the results of the work of students with low mathematics solving problems [3]. Therefore, meaningful learning activities are needed so that students can understand the material of a two-variable linear equation system well.

Teachers play an important role in the implementation of learning, so the method used must be truly following the conditions of the class [4]. Learning mathematics should not only provide memorization in the form of procedural methods in solving mathematical problems but also build an understanding of the mathematical concepts that are being studied [5]. Understanding the concept is the ability that someone has to bring back the knowledge gained both in the form of speech and writing to people so that other people understand what is being said [6]. The teacher needs to present a real situation to facilitate students in understanding the mathematical material that is being

* *Corresponding author.*
E-mail address: suparmancict@yahoo.co.id (Suparman)

studied [7]. In addition, teachers are also encouraged to use various types of representations, such as verbal, tables and images, to improve students' understanding of the material [8]. Therefore, the right learning method is needed so that students are easier to understand the concepts they are learning.

Mathematical concepts that are considered so abstract require a realistic approach so that students better understand the concepts they are learning [9]. In everyday life, of course, many contexts can be used for mathematics learning. For example, the research conducted by Sari [10] shows that the Kasongan pottery craftsman activities can be used as a context for material learning in two-variable linear equation systems. Some research shows that Indonesian Realistic Mathematics Education (IRME) can help students understand in SPLDV material [11,12]. Therefore, PMRI can be applied to help students understand in two-linear variable system material learning in grade VIII.

PMRI is an adaptation of Realistic Mathematics Education (RME) developed by Frudenthal in the Netherlands around 1970 [13-16]. However, in some cases, PMRI is different from RME because the context, culture, social system and nature are different. The characteristics of the Realistic Mathematics Educational Approach (RME), namely: 1) The used of context. The realistic problem is used as the starting point of mathematics learning; 2) The used of models for progressive mathematization. In realistic mathematics education, models were used in progressive mathematization; 3) Utilization of student construction result. Students have the freedom to develop problem-solving strategies so that various strategies are expected to be obtained. The results of work and construction students who are used for the development of mathematical concepts; 4) Interactivity. It is useful to develop students' simultaneous cognitive and affective abilities; 5) Linkage [12]. Meanwhile, students will have the motivation to learn mathematics, if he sees that mathematics is meaningful or considers the benefits of mathematics for him especially problems in daily life. Therefore, PMRI is very suitable for use in system learning linear equations of two variables because in this material many learn problems in everyday life.

Based on the description above, researchers are interested in designing a material learning design for two-variable linear equation systems for class VIII students using the PMRI approach. With the hope that this design can help students in understanding the material two-variable linear equation systems.

2. Methodology

This research is a research design research which includes: preliminary design, teaching experiment, and retrospective analysis [17]. Design research is a method that aims to develop Local Intrusion Theory to improve the quality of learning [18].

In this preliminary design phase, the researcher implements the initial idea about the design that will be used by conducting literature studies, curriculum studies, and conducting interviews with several teachers regarding the context that will be used when teaching material systems for linear equation variables and ending with designing learning trajectories. In this view, the researcher composes a Hypothetical Learning Trajectory (HLT) or conjecture as a guideline of possibilities that will appear in each learning activity. This conjecture is flexible and can be revised during the teaching experiment stage.

In the stage of the teaching experiment, the researcher implements the learning trajectory that has been compiled. The teaching experiment stage is divided into two stages, namely the teaching experiment and pilot experiment. In this experimental teaching stage, the researcher carried out the stages of teaching experiments, namely the compiled learning trajectory was tested on several VII grade junior high school students.

After the experimental teaching stage, the researcher then evaluates the conjectures that have been prepared with the results of the implementation of the teaching experiment. This stage is called retrospective analysis. This evaluation was conducted between researchers and teachers. So, the results of this evaluation obtained a description of the learning trajectory. The two-linear linear equation system uses the context of buying and selling.

3. Results

The results obtained in this study are HLT designs in which there is a learning trajectory in system learning of two variable linear equations using the context of buying and selling. The researcher describes the research data as follows:

3.1 Preliminary Design

The initial idea of the researcher was to design a learning trajectory in the material of two-variable linear equation systems using the context of the sale and purchase of stationery. At the beginning of learning activities, the teacher divides students into several groups heterogeneously by paying attention to students' academic abilities. The sale and purchase rules are described in the following schem^

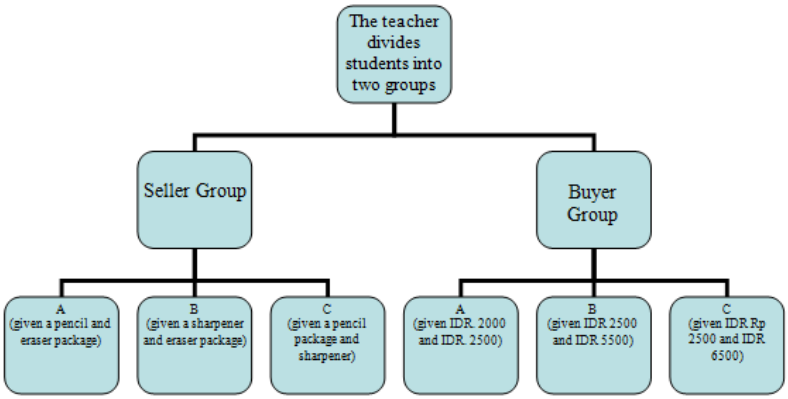

Fig 1. Rules of sale and purchase

In the scheme, it is illustrated that at the beginning of learning the teacher divides students into two groups, namely groups of sellers and groups of buyers. Then for students who enter into the seller group, given a package of stationery consisting of three packages, namely the first package contains a pencil and eraser, the second package contains a sharpener and pencil, and the third package contains a pencil and sharpener. For each package, it consists of two packages of different amounts and different in price. As for students who enter the buyer group, each student is given money of IDR. 2000, IDR. 2500, IDR. 5500, IDR. 6000, and IDR. 6500.

Students from the buyer group will make a purchase transaction by purchasing a stationery package that matches the amount of money they have. Each student looks for pairs of other students who buy and sell the same type of item (but different in number). For example, Fayad as a seller of pencils and erasers while Farez was the buyer, Fayad and Farez became a team and then looked for another team that bought and sold the same type of items namely pencils and erasers. So that one team consists of four students. This division of groups is also to determine the problems that will be solved by each group. This learning track is designed for a total of 24 students. The results of group division and topics can be seen in Table 1.

Tabel 1

Division of groups and topics to be resolved

Kelompok	Topik
A1	1 pencil + 2 eraser = 2.500
A2	1 pencil + 1 eraser = 2.000
B1	4 sharpeners + 3 erasers = 5.500
B2	2 sharpeners + 1 erasers = 2.500
C1	3 pencils + 2 sharpeners = 6.500
C2	2 pencils + 3 sharpeners = 6.000

From the table above it can be seen that for each group the topic of the problem must be resolved. Through these problems, the teacher asks students to understand the context of the problems that have been obtained from the sale and purchase. Then students are asked for how to solve problems given by the teacher in the form of student activity sheets. In the student activity sheet students are asked to represent a rectangle as a pencil, square as an eraser, and a link as a sharpener. Then students are asked to solve these problems with their own strategies. It is hypothesized that many strategies will emerge from each group such as by imagining, doubling purchases, separating the same items of goods and taking (eliminating) items bought from one another. After that each group was asked to present the results of the discussion. And finally, the teacher directs the conclusions of learning that has been done.

The development of HLT in each learning activity is the most important part of designing student learning activities. The design is inseparable from the learning trajectory that contains learning plans from the material to be taught. In this case, the learning trajectory is a concept map that students will go through during the learning process. The learning trajectory used in this study is students' understanding of the concept of two-variable linear equations using the context of buying and selling, then after that, deepened understanding of making mathematical models, after achieving that understanding will be obtained substitution formula and elimination of concepts a two-variable linear equation system and its application in solving everyday problems.

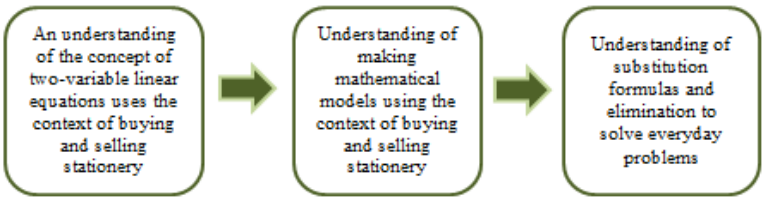

Fig 2. Leaning Trajectory Learning of Two-Variable Linear Equation Systems at the Junior High School Level

A set of learning activities system two variable linear equations based on learning trajectory and the results of student thinking will be hypothesized in HLT. It aims to achieve students' understanding of the two-variable linear equation system and be able to apply it in everyday life. The relationship between learning pathways, activities, and achievement of learning designed to be HLT can be seen in Figure 3.

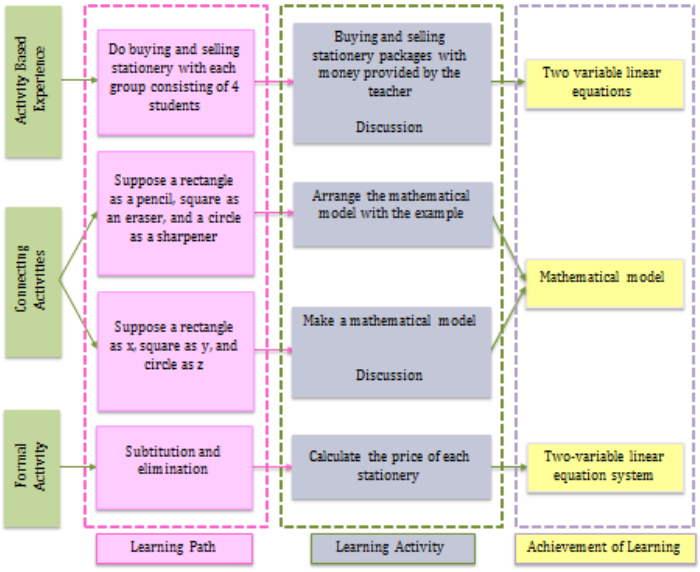

Fig. 3. Design of a Hypothetical Learning Trajectory (HLT) at the Junior High School Level

Based on the HLT described in Figure 2, the student learning trajectory design, in general, is obtained in the system of linear equation learning two junior high school level variables using the context of buying and selling which is illustrated in the iceberg form in Figure 4.

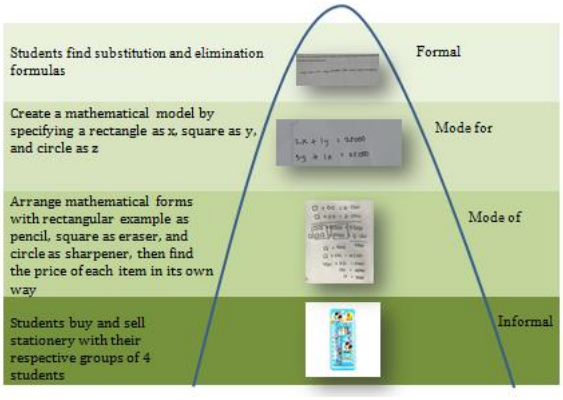

Fig. 4. Iceberg HLT in Learning a system of two-variable linear equations at the Junior High School level

3.2 Teaching Experiment and Analysis Retrospective

At this stage, the researcher conducts a learning trajectory experiment that has been designed for several seventh-grade students of junior high school. Then, the researcher conducted a retrospective analysis of the results of the experiments obtained in the experimental design stage. There are 5 activities carried out in the experimental design stage and are classified in several stages, namely activities in the informal stage, mode of, for mode and formal stages as follows:

3.2.1 Informal stage

At this stage, the activity carried out is the first activity, namely students doing buying and selling activities in accordance with the rules that have been arranged. The teacher starts learning by giving questions, what is needed when we are going to buy and sell. Then students answer what is a requirement when going to buy and sell. After that, the teacher divides students into several groups. Then the teacher explains that in this activity the teacher will ask students to buy and sell and explain the rules of sale and purchase.

In this stage, students are familiar with the activity of buying and selling stationery because it is part of the daily activities that students often do. So that students have no difficulty when doing it. After that student are asked to write the package of stationery they have purchased.

3.2.2 Mode of stage

Activities carried out at this stage are the second activity. After students make buying and selling and record packages of stationery that have been purchased, students are asked to discuss with the group. In the discussion, students are required to be able to write packages of purchased stationery into mathematical forms with agreed upon examples. With this example, students are asked to find out what the price of each stationery is.

In this activity, there are some students who are still not right in making an example. However, most students can easily find the price of each of the stationery they have purchased. This is estimated because students are familiar with stationery packages that are used as realistic contexts. The results of students' work in writing mathematical forms with agreed upon examples can be seen in Figure 5.

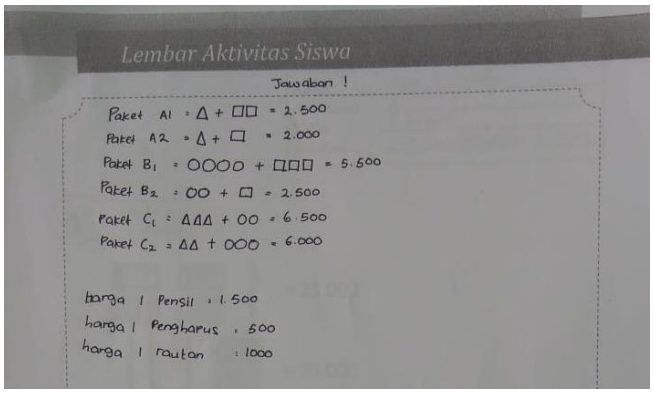

Fig. 5. Student Activities in Making Forms of Mathematics

3.2.3 Mode for stage

Activities carried out at this stage are the third activity. After students can write a mathematical form with a predetermined example, then students are asked to write problems into a mathematical model, which consists of coefficients and variables. Most students can easily write it down. The results of students' work in writing mathematical models can be seen in Figure 6.

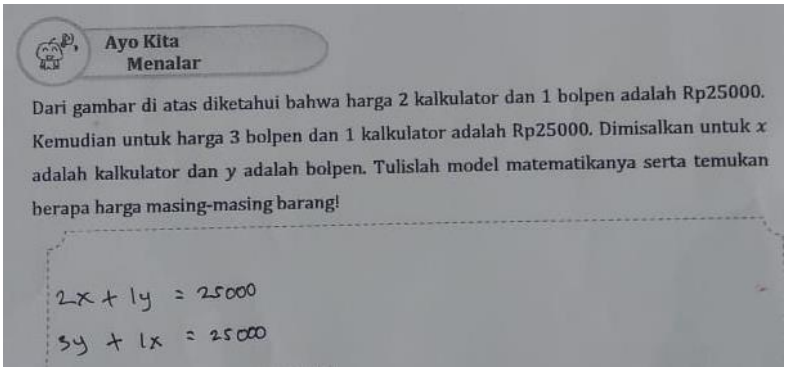

Fig. 6. Student Activities in Making Model of Mathematics

3.2.4 Formal stage

At this stage, the activity carried out is the fourth activity. In this activity, students are given errors in daily life related to the system of linear two-variable equations. Then students are asked to write down the mathematical model and find the price of each item.

Next, the teacher guides students to find the formula for substitution and elimination. From these activities, most students realize that the formula they have used is substitution formula, namely by estimating the price of each item and then calculated according to the number of items. However, from this activity, no answer has emerged which uses the method of elimination in the process. So that it is still necessary to improve the learning trajectory that has been compiled. The following are students' answers to the explanation of the ways they use to find the price of each item can be seen in Figure 7.

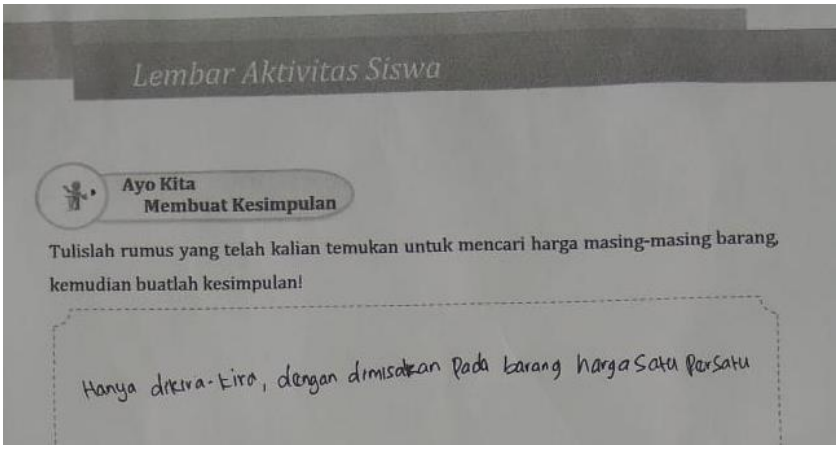

Fig. 7. Students' answers about how they find the price of each item

4. Conclusions

The results of this study indicate that in system learning linear equations two variables can be used learning design using context easily found in students' daily activities. This can help students to understand mathematical concepts easily, pleasantly, close to the daily activities of students and to the students' imagination. In addition, it can facilitate students in solving problems encountered in students' daily lives.

This research is in line with the reform of mathematics education which was initiated by Indonesian mathematics educators through Indonesian Realistic Mathematics Education (IRME) to create learning methods that are not only concerned with the final results, but rather emphasize the processes that occur during learning and are oriented towards problem solving in daily life and oriented to the rediscovery of mathematical concepts [19]. The role taken from the results of this study is to add to the study of mathematical learning design, namely the design of a two-variable linear equation system learning using the context of buying and selling.

References

[1] STILLMAN, Gloria, and Gabriele KAISER. "The International Community of Teachers of Mathematical Modelling and Applications."
[2] Suhaedi, D. & Purniati, T. (2014). AN ANALYSIS OF DIFFICULTIES ON MATHEMATICAL MODEL INTERPRETATION OF JUNIOR HIGH SCHOOL STUDENTS ON THE MATERIALS OF TWO-VARIABLE LINEAR EQUATION SYSTEM
[3] Puspitasari, Lila, Akhsanul In'am, and Mohammad Syaifuddin. "Analysis of Students' Creative Thinking in Solving Arithmetic Problems." *International Electronic Journal of Mathematics Education* 14, no. 1 (2018): 49-60.
[4] Richards, Jack C., and Theodore S. Rodgers. *Approaches and methods in language teaching*. Cambridge university press, 2014.
[5] Schoenfeld, Alan. "Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics." *Colección Digital Eudoxus* 7 (2009).
[6] Nonaka, Ikujiro, and Georg Von Krogh. "Perspective—Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory." *Organization science* 20, no. 3 (2009): 635-652.
[7] Irfan, M., and R. Rahardi. "Characteristics of students in comparative problem solving." In *Journal of Physics: Conference Series*, vol. 948, no. 1, p. 012007. IOP Publishing, 2018.
[8] Murtianto, Yanuar Hery. "EXPLORING OF MULTI MATHEMATICAL REPRESENTATION CAPABILITY IN PROBLEM SOLVING ON SENIOR HIGH SCHOOL STUDENTS." *Problems of Education in the 21st Century* 75, no. 6 (2017).
[9] Ortony, Andrew, and David E. Rumelhart. "The Representation of Knowledge in Memory 1." In *Schooling and the acquisition of knowledge*, pp. 99-135. Routledge, 2017.
[10] Sari, Ana Easti Rahayu Maya. "MATHEMATICAL ASPECTS OF KASONGAN POTTERY ART."
[11] Riyanto, B., and R. I. I. Putri. "Mathematical modeling in realistic mathematics education." In *Journal of Physics: Conference Series*, vol. 943, no. 1, p. 012049. IOP Publishing, 2017.
[12] Sirait, Asril Rais, and Zainal Azis. "The Realistic of Mathematic Educational Approach (RME) toward the Ability of the Mathematic Connection of Junior High School in Bukhari Muslim Medan." *American Journal of Educational Research* 5, no. 9 (2017): 984-989.
[13] Sembiring, Robert K., Sutarto Hadi, and Maarten Dolk. "Reforming mathematics learning in Indonesian classrooms through RME." *ZDM* 40, no. 6 (2008): 927-939.
[14] den Heuvel-Panhuizen, Van. "Reflections from abroad on the Netherlands Didactic Tradition in Mathematics Education. Abstracts." (2016).
[15] Revina, Shintia. "Influence of Culture on the Adaptation of Realistic Mathematics Education in Indonesia." PhD diss., University of Hong Kong, 2017.
[16] Sumarto, Sylvana Novilia. "Design Research on Mathematics Education: Ratio Table in Developing The Students' Proportional Reasoning." *Unpublished Thesis of Freudenthal Institute for Science and Mathematics Education, Faculty of Science. The Netherlands: Utrecht University* (2013).
[17] Gravemeijer, Koeno, and Arthur Bakker. "Design research and design heuristics in statistics education." In *International Conference on Teaching Statistics-ICOTS*, vol. 7. 2006.
[18] Gravemeijer, Koeno, and Dolly van Eerde. "Design research as a means for building a knowledge base for teachers and teaching in mathematics education." *The elementary school journal* 109, no. 5 (2009): 510-524.
[19] Sembiring, Robert K., Sutarto Hadi, and Maarten Dolk. "Reforming mathematics learning in Indonesian classrooms through RME." *ZDM* 40, no. 6 (2008): 927-939.