INSTRUCTIONAL DESIGN OF LINEAR EQUATIONS WITH ONE VARIABLE USING A BALANCING TOOL FOR GRADE VII

R Novitasari1[3], Zulkardi[2], Darmawijoyo[2]
[1]Magister of Mathematics Education Programme, Sriwijaya University, Jl. Srijaya Negara, Bukit Besar, Palembang, Indonesia
[2]Sriwijaya University, Jl. Srijaya Negara, Bukit Besar, Palembang, Indonesia
ranny.novitasari@gmail.com

Abstract

This research is a design research that aims to generate the learning trajectory of students in linear equations with one variable using a balancing tool. Resolve problem related to linear equations with one variable is one of the basic competencies in the high school curriculum for grade 7. But in fact, many students are having difficulty in solving the story problem on linear equations with one variable, so that causing students to make mistakes. Mathematical learning should begin with the introduction of contextual problems. By posing contextual problems, learners are gradually guided to master mathematical concepts. One approach to mathematics learning in accordance with that is the Indonesian Realistic Mathematics Education (PMRI). Researchers designed the hypotetical learning trajectory to be used as guidelines for teachers during the learning process. The appropriate starting point for studying the concept of linear equations with one variable is about balance activity. The contextual problem chosen by researcher is about using a balancing tool. The results showed that the learning of linear equations with one variable using PMRI can help students develop from the informal to the formal stage of mathematics and can be used as alternatives in learning.

INTRODUCTION

One of the algebraic materials students learn in school is the linear equation of one variable [1]. The material of a linear equation of a variable becomes a prerequisite material for studying subsequent algebraic material such as a two-linear system of linear equations and a system of linear equations of three variables. That matter can be a prerequisite for other materials, or certain concepts are needed to explain other concepts [2].

However, many students who have difficulty in solving the story in linear equations with one variable material that causes students to make mistakes [3]. That the difficulties that students often encounter when working with linear equation problems are their inflexibility in applying strategies to solve an equation [4]. The location of the errors of the students is in the form of modeling, computing, and making conclusions. The types of errors students make are abstractions, concepts, computing, and interpreting [5].

In accordance with the Curriculum 2013 learning using a scientific approach where one of the learning criteria is fact-based or realistic problems [1]. The learning process will only occur when the learned knowledge is meaningful for students and the process of mathematics learning in the classroom is emphasized on the interrelation between mathematical concepts and the daily experience of the students [6][7].

One approach to mathematics learning in accordance with the above explanation is the Indonesian Realistic Mathematics Education (PMRI). The PMRI approach starts from the "real" context or situation experienced by the students from the real stage to the formal mathematical stage. The context function in PMRI where context as a starting point for students in developing the understanding of mathematics and simultaneously using the context as a source of mathematical applications [8]. Learning with PMRI approach will have several characters, namely: 1) Students are more actively thinking; 2) Context and teaching materials are directly related to school and student environment; 3) The role of teachers is more active in designing teaching materials and class activities. Principles in learning PMRI in accordance with the principle of RME [9]. There are three principles of mathematics learning based on the RME approach, namely: 1) guided reinvention and progressive mathematizing; 2) didactical phenomenology; 3) self-developed models. Characteristics in PMRI learning are in accordance with the RME credentials. The five characteristics of realistic mathematics learning by Gravemeijer (1994) are as follows: 1) Using context; 2) Using model; 3) Using student contributions; 4) Interactivity; and 5) Linkage to other learning topics [7].

In addition to using the appropriate learning approach of learning can also be maximized by using props. In the mathematics learning for students in junior high school / MTs required appropriate props to help students think abstract about mathematics [10]. The use of props can make students motivated to generate positive attitudes toward the teaching of mathematics, the abstract concept of mathematics is served in concrete form and the objects around are more quickly understood at the lowest level, and the abstract concepts presented in concrete form can be used as research objects or as tools for researching new ideas [11]. The props are part of a teaching medium that contains or is carried from a learned concept. With props, abstract objects that can be presented in the form of models in the form of concrete objects that can be seen, held, rotated so that more easily understood [12]. The visual aids are tools used by teachers to clarify learning materials so that students can understand easily so that the learning process of students is more effective and efficient. In this research will be used props in the form of balancing tool that is child's educational toys scales.

Figure 1. Props

METHODOLOGY

This study uses a design research approach, which is an appropriate way to answer the research questions and achieve the research objectives that start from Preparing for experiment and preliminary design, teaching experiments, and retrospective analysis [13]. Design research aims to develop Hypothetical Learning Trajectory (HLT)

and also develop Local Instrucion Theory (LIT) with the cooperation between researchers and teachers to improve the quality of learning [14][15].

After studying the literature, researchers formulated a Hypothetical Learning Trajectory (HLT) consisting of three components: (a) learning objectives, (b) planning learning activities (making learning devices) and tools to be used, (c) Making conjectures or hypothesis (conjecture of student thinking) about the process of learning where teachers and researchers can anticipate the development of mathematics collectively and how the development of students' understanding, because learning activities in the classroom based on the design of learning that has been designed.

In the research, the design developed is a predicted learning trajectory or Hypothetical Learning Trajectory (HLT) which is contained a series of student learning activities. The activity consists of the strategy conjecture and students' thinking related to the learning objectives. The subject of the research is the students of grade VII-2 at SMP Negeri 07 Palembang. The Six students became the subject of research at the pilot experiment stage and all students of grade VII-1 became the subject of research at the teaching experiment stage. The data collection of the research was done through several activities such as observation, interview, pretest, post test and video / photo documentation.

RESULT AND DISCUSSION

This study yields learning path for linear equations of one variable using balancing tool with PMRI approach in class VII. This research was conducted at SMP Negeri 07 Palembang at pilot experiment stage involving 6 students of class VII-2 consisting of 2 high-ability students, 2 medium-skilled students and 2 low-ability students. While in the teaching experiment stage involving 38 students of class VII-1.

Preliminary Design

Activities undertaken at the preliminary design stage are reviewing the literature and designing Hypothetical Learning Trajectory (HLT), Student Activity Sheet (LAS), test questions, Learning Implementation Plans (RPP), teacher manuals and assessment rubrics.

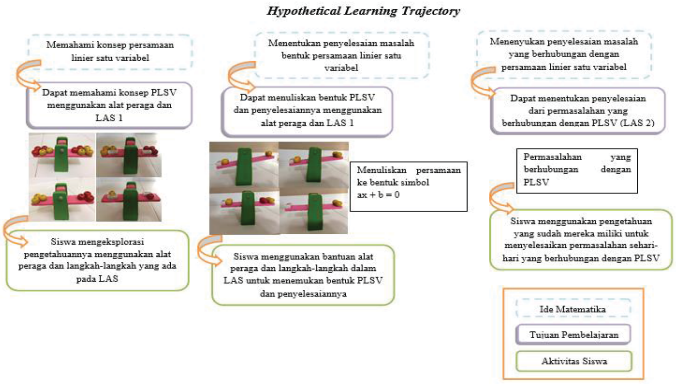


Figure 2. Hypothetical Learning Trajectory (HLT)

Design Experiment

Pilot Experiment

Pilot experiment is a stage to test the design of linear equation with one variable using props and HLT which have been designed in preliminary design stage to 6 students of class VII-2 (nonsubject) in SMP Negeri 07 Palembang. Each 2 students are highly capable, 2 medium-skilled students and 2 low-ability students. Trials include two meetings. The first meeting was conducted by pretest followed by learning using props. Pretest is done to see students' early ability on linear equation with one variable material. The first meeting aims at understanding the concept of the linear equation with one variable and the completion of the linear equation with one variable form. The second meeting aims to resolve the problems associated with the linear equation with one variable. At this meeting students are given an activity sheet containing problems related to linear equation with one variable. At the end of the meeting both students were given posttest to see students' understanding of linear equation with one variable material after learning using props.

After the pilot experiment was completed, the researchers revised based on the findings obtained during the pilot experiment. Revisions were made in order to obtain maximum results during the teaching experiment stage. The researcher along with the model teacher discussed to determine what to do revision.

Teaching Experiment

After a revision based on the results obtained at the pilot experiment stage, the next step is to test the revised instrument in the class of research subjects, namely class VII-1 with 38 students. Similarly, at the pilot experiment stage at this stage there were also 2 meetings. The first meeting before the teacher starts the students' learning is given a pretest problem consisting of 3 questions. Pretest is done to see students' ability before studying linear equation with one variable material. The results obtained after the pretest is from 38 students, 16 students can answer about the number 1, 14 students can answer the number 2, and for question number 3 no students who answered.

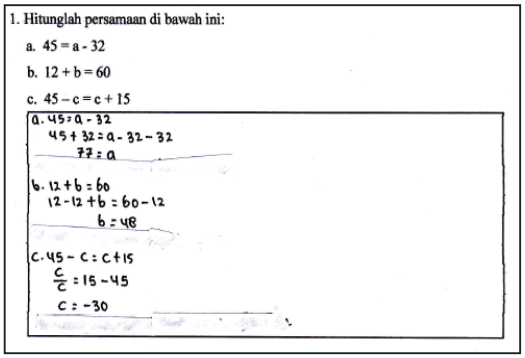
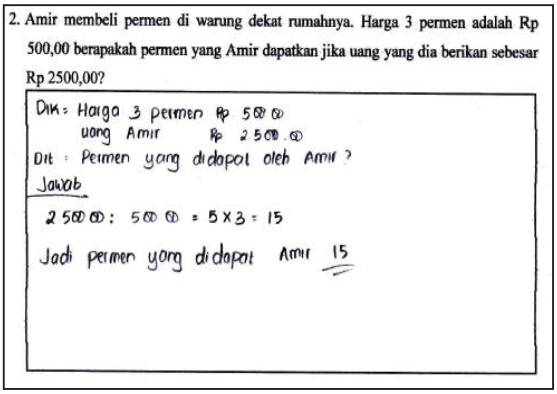


Figure 3. Student’s answer number 1


2. Amir membeli permen di warung dekat rumahnya. Harga 3 permen adalah Rp 500,00 berapakah permen yang Amir dapatkan jika uang yang dia berikan sebesar Rp 2500,00?

Dik: Harga 3 permen Rp 500
uang Amir Rp 2500
Dit : Permen yang didapat oleh Amir ?
Jawab
2500 : 500 = 5 x 3 = 15
Jadi permen yang didapat Amir 15

Figure 4. Student's answer number 2

Based on the pretest results in the teaching experiment stage, it can be seen that the students still have difficulty in answering the problems related to the linear equation with one variable because they do not know about the material.

At the meeting students are given props and activity sheets that contain about activities that use props to help students understand the concept of linear equation with one variable. The problem given (a) find out how to make the tool to be balanced if on the left side there is one eraser and one ball while on the right side there is 1 ball, the second (b) one eraser will be balanced with how many balls, and the third (c) write down the steps taken on the second problem (b) into the symbol form.

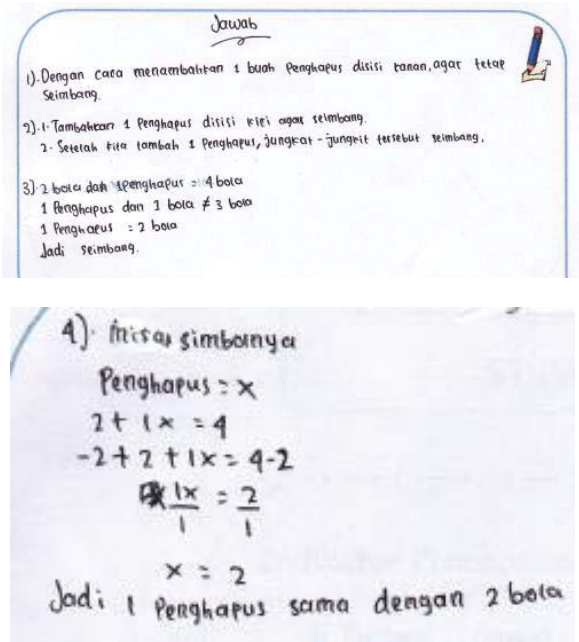


Figure 5. Student's answer

At the second meeting students were given an activity sheet containing problems related to linear equation with one variable. The second meeting aims to look at student strategies in solving problems related to linear equation with one variable. The results

obtained are on the first problem students already understand the problem well and students are able to use previous knowledge about the balance and can write the matter into the form of equations. The strategy used by students in working on the problem is to find the difference in the weight of the seesaw on the right to the left. Students are of the opinion that if the weight on the left 45 kg then the weight on the right should also be 45 kg.

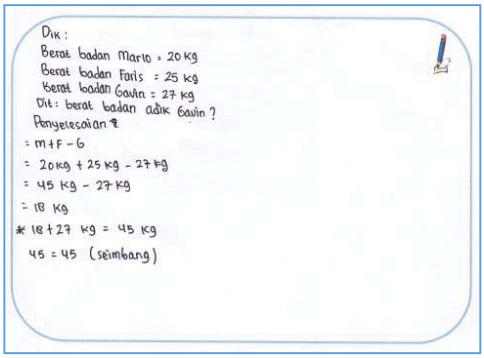


Figure 6. Problem 1

In the second problem students have been able to determine what steps should be done in solving the problem. First the students write down what is known, then make it into a mathematical equation, then perform the count operation.

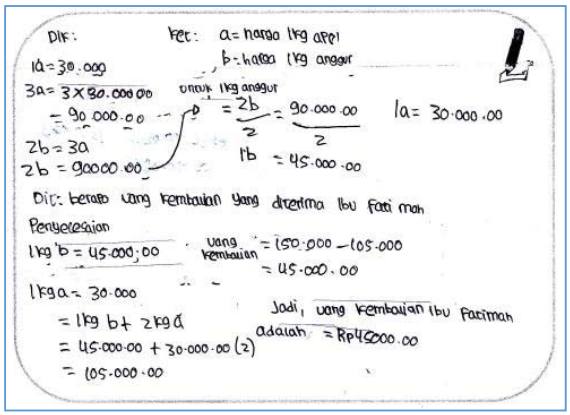


Figure 7. Problem 2

After the pilot experiment stage is completed, the researcher gives posttest to 38 students who worked individually within 15 minutes. This test aims to see if the students have understood the linear equations with one variable after doing the 1st and 2nd activities for 2 meetings. Posttest consists of 3 questions related to linear equations with one variable. The type of problem given in the posttest is the same as the pretest question given before the first meeting. The first question of 38 students, 29 students have answered correctly while 9 students answered wrong because of mistaken when performing the count operation. This shows that the student can solve the linear equation with one variable. As for the second of 38 students, 28 students answered correctly and 10 students answered wrongly. Problem number 3 is a matter of a story related to the

form of linear equations of one variable with different difficulty level with problem number 2. This issue aims to look at the ability of students in understanding and determining the solution of the problems associated with the linear equation of one variable. Of the 38 students, 5 students answered correctly, 14 students answered wrongly because they misunderstood the problem, and 16 students did not answer at all. Based on the results obtained from 3 posttest questions that have been given can be said there is an increase from the previous pretest results. Especially for the number 1 and number 2 problems seen a significant increase. As for the question number 3 almost all students answered wrong because they failed to understand the problem.

Restrospective Analysis

The first activity aims to familiarize students with props and balance. Students work according to predictable conjectures. All students answered correctly. The second activity is still about balance but in this activity it aims to make students know how to keep balance. In the second activity the students were able to answer with their own language. Students are able to use props well in accordance with the given steps. The activity of the three students has begun to be directed to the form of linear equations of one variable and its completion. Based on the three activities can be said that the students already have knowledge about the linear equation with one variable.

The second activity aims to determine the ability of students in determining problem solving related to linear equation with one variable. Based on the results of students' answers already seen that students already understand how to determine the solution of the problems associated with the linear equation of one variable. First the students write down whatever information on the matter, then from the information the student will make the mathematical equation, and last student performs the count operation to get the result.

CONCLUSION

Based on the results and discussions that have been described, it can be obtained some conclusions:

First on the matter of linear equations with one variable, the use of props with learning using Indonesian Realistic Mathematics Education (PMRI) approach can help understanding the concept of students. The two learning paths produced are in the form of trajectories that assist students during the learning process begins from the students exploring the initial knowledge in understanding the concept of linear equations with one variable using balancing tool, students can solve the form of linear equations with one variable using the balancing tool, and students can determine the solution of problems related to linear equations with one variable.

Second Hypothetical Learning Trajectory (HLT) that has been implemented in this study has become the Learning Trajectory that can help improve students' understanding of linier equations with one variable.

Acknowledgements

Reseacher would like to say thank you to all that support this research. Thank you to Prof.Dr. Zulkardi, M.I.Komp., M.Sc., as the first advisor and Dr. Darmawijoyo as the second advisor, to Zulfadilah, S.Pd. as the model teacher, to SMP N 01 Palembang, to all students as research subject, to all my friends in mathematics programs in Sriwijaya University, and my beloved family, and also thanks to SULE-IC 2018 that gives a chance to publish this article on Proceeding of SULE-IC 2018 and/or Journal of Physics: Conference Series (JPCS).

REFERENCES

[1] Kemendikbud. (2013). Materi pelatihan guru implementasi kurikulum 2013 SMP/MTS Matematika. Jakarta: Kemendikbud.

[2] Suherman, E. (2003). Strategi Pembelajaran Matematika Kontemporer. Bandung: UPI.

[3] Fitria, N. T. (2013). Analisis kesalahan siswa dalam menyelesaikan soal cerita berbahasa inggris pada materi persamaan dan pertidaksamaan linear satu variabel. Universitas Negeri Semarang [skripsi]

[4] Khuluq, M, K., Zulkardi., & Darmawijoyo. (2015). Enhancing students' strategies to solve linear equations with one variable through balancing activities. Proceeding the 3rd SEA-DR.

[5] Suhita, R., Sjahruddin, R., & Aunillah. (2013). Analisis Kesalahan dalam Menyelesaikan Soal Cerita dalam Matematika. Jurnal Pendidikan Matematika STKIP PGRI Sidoarjo, 1(2), 37-46.

[6] Freudenthal, H. (1991). Revisiting Mathematics Education. Dordrecht: Kluwer Academic Publisher.

[7] Gravemeijer, K. (1994). Developing realistic mathematics education. Utrecht: Technipress, Culemborg.

[8] Zulkardi & Putri, R. I. I. (2006). Mendesain sendiri soal kontekstual matematika. Prosiding in konferensi nasional matematika ke-13. Semarang: Indonesia.

[9] Sembiring, R. K. (2010). Pendidikan matematika realistic Indonesia (PMRI): Perkembangan dan tantangannya. IndoMS.J.M.E, 1(1), 11-16.

[10] Nasriadi, A. (2016). Representasi persamaan linear satu variabel menggunakan alat peraga model cangkir dan ubin pada siswa kelas VII SLTP. ISSN 2355-0074, III(2), 1-10.

[11] Harliastuti, E., Murtiyasa, B., & Anief, S. (2012). Pengelolaan alat peraga dalam pembelajaran matematikadi sekolah menengah pertama negeri 2 karanganyar. Universitas Muhammadiyah Surakarta. [skripsi]

[12] Grinting, I, N, B & Surya, E. (2017). Use of figure tools to increase mathematics result learning students class V prymary school 101796 Patumbak. International Journal of Sciences: Basic and Applied Research, 34(1), 247-260.

[13] Gravemeijer, K., & Cobb, P. (2006). Design research from the learning design perspective. Educational Design Research, 17-55.

[14] Akker, J.V.D., Gravemeijer, K., Mckenney, S., & Nieven. (2006). Educational Design Research. London : RoutledgeTaylor and Francis Group.

[15] Gravemeijer, K., & Van Eerde, D. (2009). Research as a Means for Building a Knowledge Base for Teaching in Mathematics Education. The Elementary School Journal, 109 (5), 510-524.