Preliminary research of development learning design of system of two linear equations based on realistic mathematics education

Debby Eriyenti Putri
Postgraduate student of FMIPA Padang State University
Jln. Prof. Dr. Hamka Air Tawar, Padang Indonesia
epdebby@gmail.com

Abstract. Students in junior high school learned "system of two linear equations" materials focusing on the procedural steps of problem-solving provided, they become difficult if given problems with higher levels or different problems. This is because the ability of students mathematical reasoning is relatively low. Based on observations and interviews with teachers, one way to overcome this problem is developing the learning design using Realistic Mathematics Education (RME). In this research, the instructional design developed is Local Instruction Theory (LIT), teacher book and student book. The purpose of this research is to develop the characteristics of learning design. The topic of the system of two linear equations based on RME in class VIII SMP is valid, practical, and effective. This research will combine two types of research and research. Tjeerd Plomp and Gravemeijer & Cobb. Learning implementation of this research has been validated by expert or lecturer of Mathematics Education, Educational Technology, and Language. Practicality has been seen from the observation learning implementation, practicality and interviews questionnaire with students and teachers. Effectiveness has seen from the results of student activities and the final test of learning. The data is analyzed descriptively.

1. Introduction
Mathematics is the work of humans. Mathematics is born and grows from human activities. The implication of this thinking is the process of learning mathematics is the provision of opportunities given to students to rediscover (to reinvent) mathematics through teacher guidance. Rediscovery (reinvent) the mathematical ideas and concepts starting from browsing Hattush various problem situations "real world".[1]

Many contributions are given knowledge in life, ranging from the simple to the complex so that mathematics needs to be taught starting from a low level of education to the college level. The 2013 curriculum is prepared to live as individuals and citizens who are faithful, productive, creative, innovative, and effective based on Permdendikbud number 68 of 2013. Two-Variable Linear Equation System (SPLDV). In everyday life, many calculation problems can be solved by implementing SPLDV, including money, business, age, and so on. To be able to solve the problems above students expected to be able to understand the concept of SPLDV and be skilled in solving problems in everyday life. In addition, SPLDV material is also a prerequisite for advanced mathematics learning (SMA / MA). Students in junior high school learned "systems of two linear equations" materials focusing on the
procedural steps of problem-solving provided, they become difficult if given problems with higher levels or different problems. This is because the ability of students mathematical reasoning is relatively low.

The presentation of the SPLDV topic directly focused on the concepts and questions without any direction for students to find the SPLDV concept. The teaching materials used have not been able to guide teachers and students in achieving the learning objectives of mathematics. In fact, mathematical reasoning abilities and student learning outcomes are still low. Mathematical reasoning ability is a very important aspect of mathematics learning. Reasoning (reasoning) is a standard process contained in the NCTM. [2]

Based on the results of observations and interviews conducted at SMPN 1 in Sungai Penuh City in mathematics learning teachers focus more on the procedural steps to solve the problems given, so that when given a question with a higher level or a different problem with examples of students' questions unable to answer correctly and make mathematics learning not run effectively and not on target. Learning like this causes students to be passive and only memorize information received from the teacher. The form of the questions was tested to several students and students' answers in Figure 1.

"It was known that the price of 4 notebooks and 2 pencils was Rp. 13,000, the price of three notebooks and a pencil Rp. 9,000. what is the price of 5 notebooks and 2 pencils?"

![Figure 1. Examples of Student Answers](image)

Students have not used their reasoning well in solving the given questions. They immediately give answers to the prices of each of the notebooks and pencils without any way to get them. Based on the results of an interview with one of the eighth-grade math teachers at SMP Negeri 1 Sungai Penuh, he stated that the teacher had attempted to apply the learning model and approach that could activate learners or learner-centered learning models. But the purpose of learning mathematics is still not well achieved, such as the low mathematical reasoning ability of students. Students are also not active at the time of learning. This can be seen when the teacher starts the lesson there are still students who sleep, talk with friends, and do not pay attention to the teacher's explanation. In addition, teaching materials that use a contextual approach in presenting school mathematics materials are still limited. Figure 2 is one illustration of the teaching materials used by the school.
The contents of the teaching material above are taken from one of the eighth-grade mathematics teaching materials used in schools. Based on the analysis of teaching materials, the material is delivered very briefly. The sentence used to explain the material is not enough to help students construct their understanding independently of the completion of a two-variable linear equation system. The teaching materials used are still emphasized on the delivery of material with formulas and evaluation questions, less emphasis on the contextual aspects of the material itself. Thus, the knowledge they acquire does not last long in the memory.

In mathematics learning activities on SPLDV material, the difficulty that is generally felt by students is that it is difficult to find the concept of counting from SPLDV so that if the form of the problem is changed students are unable to solve the given problem so that the learning outcomes obtained by the students decrease.[3]

When students have difficulty answering the questions given, the students tend to wait for answers from the teacher so that students only receive and are not trained in constructing their own knowledge in solving the questions learned. This is what shows the lack of active students, which results in low learning outcomes which are evident from the value of mathematics learning outcomes which are still below the Minimum Completeness (KKM) criteria of 70.

Difficulties faced by students in learning are actually not a result of the students themselves but can be sourced from the way the teacher presents the material or teaching material used when learning occurs. In addition to students, teachers also experience difficulties especially in designing learning designs. Designing a learning design is not easy, because learning design is a picture or scenario that must be passed by the teacher in delivering material to students.

To overcome some of the problems above, learning is needed that can help students to understand SPLDV properly. Students will easily understand a material and be able to solve problems if they are directly involved in learning. Thus students can build their own knowledge so that the knowledge gained can last a long time in their memories. Teachers are expected to design learning paths that can be used to achieve learning goals. Learning design should be designed with an alternative strategy to anticipate
student problems and various possible student responses that occur during the learning process or the diversity of learning trajectories (Hypothetical Learning Trajectory or HLT)

Learning design should be designed with alternative strategies to anticipate student problems and various possible student responses that occur during the learning process or the diversity of learning trajectories (Hypothetical Learning Trajectory or HLT). Learning design based on learning trajectory is known as Hypothetical Learning Trajectory (HLT). HLT is a learning flow consisting of learning objectives, learning activities, and learning process hypotheses to predict how students’ thoughts and understanding will develop in the context of learning activities.[4]

The SPLDV topic learning design is designed with the RME approach so that students follow the learning path that has been compiled following a series of contextual questions, and the SPLDV concept and SPLDV operation will be formed in itself with learning using real problems and close to the lives of students. Based on the above, the researchers will conduct research on the development of learning design such as lesson plans and HLT. Student book and Teacher book to be compiled in the research that will be relevant to the principles and characteristics of RME. Formulation of the problem in this research What are the characteristics and impacts of the learning design on the topic of the two-variable linear equation system (SPLDV) based on Realistic Mathematics Education (RME) in the eighth grade of SMP which is valid and practical?

2. Research Method
This type of research is the development of research using Plomp (2013) and Gravemeijer and Cobb (2006) models. The design of the Gravemeijer and Cobb (2006) models were used in the prototype/learning flow development phase of the Plomp model design. To implement a learning trajectory designed teacher books and student books using Plomp's design research design. Furthermore, for the development of the learning path, it was designed using Gravemeijer and Cobb design research. The combination of these two designs aims to produce HLT, student books and student books that are valid, practical and effective.[5]

Plomp models, ranging from the initial investigation phase (preliminary research), the phase of development or prototyping stage and assessment phase (assessment stage). The phase of preliminary investigations (preliminary research) consists of a needs analysis, curriculum analysis, analysis of the concept and analysis of students. Needs analysis is implemented by way of observation and interviewed teachers at school. The purpose of the analysis is to determine the basic problems that are required in the development of learning tools. Needs phase analysis is done through the collection of information. [6]

Book-based analysis is done by gathering information through questionnaires. Analysis of students examines the characteristics of students include: age, a motivation of the subjects, academic ability, psychomotor and level of maturity. Behavior and characteristics of the students are very necessary to know how to be used as guidance in lesson planning. The analysis conducted here is a book like what is needed by the student, include: Are learners want to book in learning, the preferred color, size of the book is desired, whether in the book learners prefer books contain images or animations.

While the development design of Gravemeijer & Cobb also has three steps, namely:
1. Stage preparing experiment (the preparing for the experiment)
2. Experimental stage design (the design of experiment)
3. Retrospective analysis phase (the retrospective analysis)

The above development stages are important to do in this study. Stage 1 is done to formulate LIT, find out the learning objectives, find out the initial conditions of learning, plan the LIT to be developed, determine the characteristics of the class and the role of the teacher and determine the theoretical objectives to be achieved. Phase 2 is carried out to carry out the experimental design that has been prepared, test and develop LIT, as well as being cyclical. Stage 3 is done to analyze the data that has been obtained to know whether it supports or not in accordance with the conjecture that has been designed. [7]
3. Result and Discussion

SPLDV became one of the mathematics learning materials taught in junior high school (SMP). Based on Permendikbud Number 24 of 2016 concerning the SMP Curriculum, SPLDV material is taught in class VIII in the even semester. Core Competencies (KI) and basic competencies (KD) from SPLDV material in accordance with those developed in the 2013 Curriculum.

Based on theseo achieve KI and KD are then drafted indicators are written in the In this study focused on the use of students’ initial knowledge about SPLDV. The learning flow is designed to overcome students' difficulties in learning SPLDV material with the RME approach. The focus is on using models to support the development of understanding student. In general, a plot is prepared learn as follows:

1. Putting students’ initial and informal knowledge
   It is important to know the previous knowledge and informal knowledge of students as a first step. Previous student knowledge must be activated to build deeper learning.

2. Models and symbols in an activity by taking part in the whole activity.
   A meaningful context will support students in bringing up the model. In the first activity, they will work using the media provided.

3. Generalization
   In this activity, all parts are no longer mentioned. In mathematical congresses and small learning in the last lesson guided by the teacher, students will make generalizations using symbols

Teacher's Books and Books for students and as a reference in making learning devices:. Based on questionnaires given to students seen that learners prefer to learn by using HLT, Teacher Books and Student Books as more attractive. HLT Learners, Teacher Books and Student Books using pictures and animations. Additional information is from the questionnaire that is the dominant color preferred by learners are blue and white. As for HLT, desired size Teacher Books and Student Books are A4 sized learners

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