KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Hypothetical Learning Trajectory Through the Problem-Based Learning in Junior High School Students

Nilam Sari[1,3]*, Sahat Saragih[1], Elvis Napitupulu[1], Siti Rakiyah[3], Dwi Novita Sari[1,4], Syahriani Sirait[1,2], and Anim[1,2]

[1]*Postgraduate Program, Universitas Negeri medan, Jl. William Iskandar PSR V, Medan, Indonesia*
[2]*Universitas Asahan Jl. Jendral Ahmad Yani, Kisaran, Indonesia*
[3]*Universitas Quality Jl. Ngumban Surbakti, Medan, Indonesia*
[4]*Universitas Muslim Nusantara Al-Washliyah Jl Garu 2 B, Medan, Indonesia*

ORCID
Nilam Sari: https://orcid.org/0000-0001-9347-371
XSahat Saragih: https://orcid.org/0000-0001-7972-8886
Elvis Napitupulu: https://orcid.org/0000-0002-3566-0442
Siti Rakiyah: https://orcid.org/0000-0003-2825-8049
Syahriani Sirait: https://orcid.org/0000-0001-8544-5217

Corresponding Author: Nilam Sari; email: nilamsarie@gmail.com

Published: 26 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

Abstract.

The purpose of this study was to determine the hypothetical learning trajectory through a problem-based learning model to class VIII junior high school students. Learning mathematics requires a meaningful process and that process cannot be obtained in a relatively short time because it requires good preparation in conveying mathematical concepts to students. The preparation is designed according to the characteristics of students so that the delivery of the material goes well as expected. The preparation referred to in this case is to design a good hypothetical learning trajectory (HLT) according to the needs and subject matter. Hypothetical learning trajectory (HLT) is a temporary hypothesis about students' activities in the learning process on certain materials. This study uses a design research method with stages referring to Plomp (2013) which consists of three phases including (1) preliminary research; (2) development or prototyping phase; and (3) assessment phase. However, in this research, it is only in the first phase, namely preliminary research. In designing the HLT, it is based on a problem-based learning model which has five stages in each process. The instrument used in this study was a teacher and student interview sheet. The results obtained are the HLT design on linear equation material that is adjusted to the stages in the problem-based learning model. The results obtained from this study can be used as an initial reference for mathematics teachers in designing learning material for linear equations that are in accordance with the real context of students.

Keywords: Learning Trajectory, Problem-Based Learning, Junior High Students

OPEN ACCESS

1. INTRODUCTION

The results of interviews conducted by researchers at a mathematics teacher at a private junior high school in Medan showed that in solving linear equation problem in class VIII, students had difficulties in making mathematical models and determining what strategies were appropriate to solve the problems given. Student difficulties arise when the teacher gives different questions from the sample questions. In addition, most of the teachers at the school usually give questions directly in the form of a mathematical model and do it in front of the class, then students are given questions according to the examples given because according to the example questions, students can easily work on these questions without the help of the teacher. This often happens in mathematics learning at school, for that we need a meaningful learning by making thorough preparations before learning takes place. The preparation is designed according to the characteristics of students so that the delivery of the material will run well as expected. The preparation is to design a good Hypothetical Learning Trajectory (HLT). HLT is a temporary hypothesis about student activities in the learning process on certain materials. The material raised in this study is a linear equation system for class VIII students who designed a learning trajectory for linear equation material through a problem based learning.

Student learning activities carried out with problem based learning involve student collaboration in small groups of 3-5 students [1]. This study group has an important role in the learning process because in the group there is an active interaction process between students or between teachers and students. With this interaction, there are advantages in learning, namely the occurrence of various ideas emerging from students' thoughts and students' opinions will also appear, reflection of the thoughts of each study group, arguing with each other with their opinions and respecting each other. The role of a teacher in problem-based learning is to provide clear problems by asking questions related to the problem and then providing facilities to students by providing assistance/scaffolding when needed. So the learning trajectory that will be generated through problem-based learning can support the teaching and learning process which can be said to be meaningful.

The learning trajectory by applying problem-based learning is expected to change the way students learn, so that students can find a new concept by exploring a learning experience that they usually go through. This shows that with the learning trajectory, students are expected to not only memorize formulas but students can also learn to find new learning experiences that students can apply in different contexts [2]. Based on

research results that with the existence of a learning trajectory in learning mathematics in schools students will achieve the expected learning goals [3–6].

Based on the explanation above, it can be seen that the learning trajectory with problem based learning can help students find their own series of processes to find answers. So this study focuses on designing the HLT through problem-based learning on the material of linear equation system in class VIII Junior High School.

2. RESEARCH METHOD

The method used in this study is design research with the stages to be followed referring to Plomp which consists of 3 phases including 1) preliminary research 2) development or prototyping phase and 3) assessment phase [7]. However, in this research, it is only in the first phase, namely preliminary research. In designing the HLT it is based on problem-based learning which has 5 stages in each process. The instrument used in this study was a teacher and student interview sheet. In this study, the characteristics of the initial HLT design will be obtained according to the stages of the problem-based learning model. The research subjects were students of class VIII SMP Suci Murni Medan, Indonesia. The instrument used is an interview sheet for teachers and students who have studied linear equations in two variables. At the preliminary design step, it was very helpful to continue the research at the next step.

3. RESULTS AND DISCUSSION

Learning design is a design process for implementing learning in the classroom. Usually the design of the learning implementation process can be seen in the Learning Implementation Plan which contains a series of learning processes from the beginning of learning. However, the Learning Implementation Plan, which is usually made from the beginning to the end, only displays teacher activities and student activities in no detail. It is still rare or even almost never to find a teacher who prepares assumptions/hypotheses on how students solve problems given in each lesson. The hypothesis of students' thinking in solving problems is usually called a HLT and usually HLT is designed on certain materials. There are so many alleged lines of thinking that may arise from students during the learning process so we need a learning process that pays attention to in detail how students think to solve problems related to mathematics [8].

Simon states that there are 3 components in the preparation of HLT, namely learning objectives, learning activities and hypotheses/allegations of the learning process [9,

10]. In the first component, namely the learning objectives, it contains the direction of activities during the learning process in the classroom. To predict how students' thinking, a HLT is drawn up. HLT is compiled based on the experience of students' activities during the problem solving process and is based on theory in learning. The HLT that has been prepared can be used as a verification tool between theory and students' concrete activities. In this study, the hypothesis is formulated through a problem-based learning model with a linear equations. The steps in the problem based learning model according to Arends there are 5 steps, namely [11]:

1. Orienting the students to the problem
2. Organizing students to learn
3. Guiding individual and group investigations
4. Developing and presenting the work
5. Analyzing and evaluating the problem solving process

The five steps above are steps taken in obtaining the alleged flow of students' thinking (HLT). In the process of solving problems in the students' class go through the steps in the problem-based learning model. At each of these stages, there will be an alleged flow of student thinking that appears during the problem solving process. The learning process in the classroom will be designed using HLT, namely buying and selling illustration activities. This is done because with these illustrations it is hoped that students can better understand mathematical concepts that are in accordance with daily life.

The instrument used in this study was a teacher and student interview sheet. Interviews were conducted related to preliminary studies including curriculum analysis, and needs analysis. In the curriculum analysis, it is seen whether the learning related to the linear equation material being taught is in accordance with the demands of the current curriculum. Furthermore, in the needs analysis, the advantages and disadvantages of the learning process that have been carried out so far have been sought, both in terms of the strategies carried out by the teacher and from the students' point of view, whether they really understand the concept of learning related to linear equations. So from the results of interviews conducted with teachers and students, it was found that the material for linear equations of two variables that had been taught so far was not in accordance with the objectives of the curriculum because the teacher had not linked learning with students' real concepts. Furthermore, related to the learning that has been carried out so far, it was found that learning only uses lecture strategies and the teacher

as a source of information. Students do not understand the concept of a linear equation of two variables.

From the results of the interviews above, in order to improve students' ability to solve problems, learning that focuses on problems is chosen, namely problem-based learning. For this reason, this study uses the stages of problem-based learning as a reference in the learning. Furthermore, related to the results of interviews where the linear equation material taught is not in accordance with the demands of the curriculum, this study will later raise the concept of the real world (contextual), namely students will illustrate buying and selling activities in front of the class. In this activity, the concept of linear equations of two variables will be linked. After this preliminary stage is completed, the researcher has obtained sufficient data for the preliminary study. Furthermore, the researchers designed the hypothesis of student learning flow related to the material of linear equations of two variables using problem-based learning. Allegations/hypotheses of students' thinking (HLT) that may appear in learning with linear equation material through problem-based learning are as follows:

1. Orienting the students to the problem

Teacher's activity

1. Reminding about previous learning related to the ongoing lesson.
2. Motivating students, that is, if students master this material, it will help a lot to be able to calculate story problems related to linear equation systems in daily life.

Alleged student activities

1. Paying attention to teacher's explanation.
2. Asking and responding to teacher's explanation.
3. Organizing students to learn

Teacher's activity

1. The teacher organizes students to form heterogeneous study groups. Each group consists of 3-5 students.
2. Distribute student s' worksheets in each group and ask the group leader to lead the discussion in his group.

Alleged student activities

1. In a group according to the teacher's instructions.
2. Discussion of students' worksheets in groups: students plan completion steps by collaborating, communicating and asking each other in each group
3. Guiding individual and group investigations

Teacher's activity

1. Guiding and assisting students in planning the solution of a two-variable system of linear equations problems.
2. Monitoring students while working on the distributed worksheets

At this step, there are 4 steps of learning that students will go through, namely:

1. Definition linear equation system of two-variable goal: understand the meaning of a system of linear equations of two variables and be able to distinguish between them.
2. Contextual problems related to the linear equation system through illustration activities of buying and selling traditional snacks; Goal: Understand about real-life problems related to the linear equation system.
3. Make a mathematical equation of the given problem; Goal: understand how to create a mathematical equation/model from a given problem.
4. Solving the problem of the linear equation system with mixed methods; Goal:Understand how to solve of linear equations system using mixed methods.

Alleged learning activities at point 1
Students' Activities:

1. Students mention the meaning of linear equation system of two variable is a system consisting of two linear equations that have two variables.
2. Students mention that the linear equation system of two variable has the sign "=" (equal to)
3. Students assume the variables with the alphabet for example x and y, a and b, m and n, and others.
4. Students mention the notion of a two-variable linear equations system, which are equations that arise from the given problem

Teacher's Anticipation

The teacher asks possible questions such as:

1. What is the meaning of the system?
2. Try to remember the previous lesson on linear equations. Try to define what a linear equation looks like and make an example?
3. Try for example the object with a certain variable
4. From this equation 2x+4y=9 which one is said to be a variable?

Alleged learning activities at point 2

Teacher's Activities

The teacher directs the students to relate the selling and buying illustration activities with the material on the linear equation system of two variable.

Students' Activities

Students mention that one of the problems that exist in daily life about linear equation system is buying and selling in the market.

Teacher's Anticipation

Try to look for other problems related to linear equation system?

Alleged learning activities at point 3

Teacher's Activities

From the problems given, the teacher directs students to create mathematical equations/models.

Students' Activities

1. Students can create equations/models from the given problems related to the linear equation system of two variable
2. Students are not able to make equations/models from the given problem related to the linear equation of two variable
3. Students make a mistake in making the example.

Teacher's Anticipation

The teacher asks possible questions, such as:

1. Try to remember to assume the existing variables!

2. Take a look at the definition of linear equation of two variable that was discussed earlier?

Alleged learning activities at point 4

Teacher's Activities

The teacher directs students to solve the given problem by using a mixed method, namely elimination and substitution.

Students' Activities

1. Students can solve problems and present solutions to the linear equation of two variable by using the methods of elimination and substitution.
2. Students are not able to solve problems and present the solution of the linear equation of two variable by using the method of elimination and substitution.
3. Students are only able to use one method.

Teacher's Anticipation

The teacher asks possible questions, such as:

1. What is mixed methods?
2. Try to remember how the steps of the elimination method are?
3. Try to remember how the substitution method steps are?
4. Try to remember the meaning of linear equation of two variable!
5. Can you use the substitution method first followed by the elimination method?
6. Developing and presenting the work

Teacher's Activities

1. Asking each group to deposit the results of problem solving on the Students' Worksheet.
2. Directing each group to prepare presentation materials on solving problems that have been made.
3. Managing the process of presenting the work and encouraging students to be actively involved.
4. Asking a representative of one group to present (present) the results of problem solving, and other group members are asked to provide feedback/input.

Alleged Students' Activities:

1. Collecting the work of the Students' Worksheet.
2. Preparing materials to be presented
3. Listening to the teacher's directions to make a presentation
4. Presenting the work in front of the class (one of the students is the representative of the group) and other groups pay attention and ask questions and answers / provide feedback.
5. Analyzing and evaluating the problem solving process

Teacher's Activities

1. Directing each group to re-check the problem solving process that has been made.
2. Helping students to evaluate, reflect (cooperation, communication, and asking questions).

Alleged Students' Activities:

1. Checking the problem solving process that has been done
2. Evaluating and reflecting on the results of problem-solving abilities.
3. Students are not able to evaluate the results of the solution of the given problem
4. Students are confused about using the appropriate variable to be substituted into the equation. (Inversely entering the variable)

Teacher's Anticipation

The teacher asks possible questions, such as:

1. How do you check the correctness of the solutions you get?
2. How to see that the solution is correct?
3. Which variable is appropriate to substitute in the equation?

The following is a sketch of the HLT that has been made:

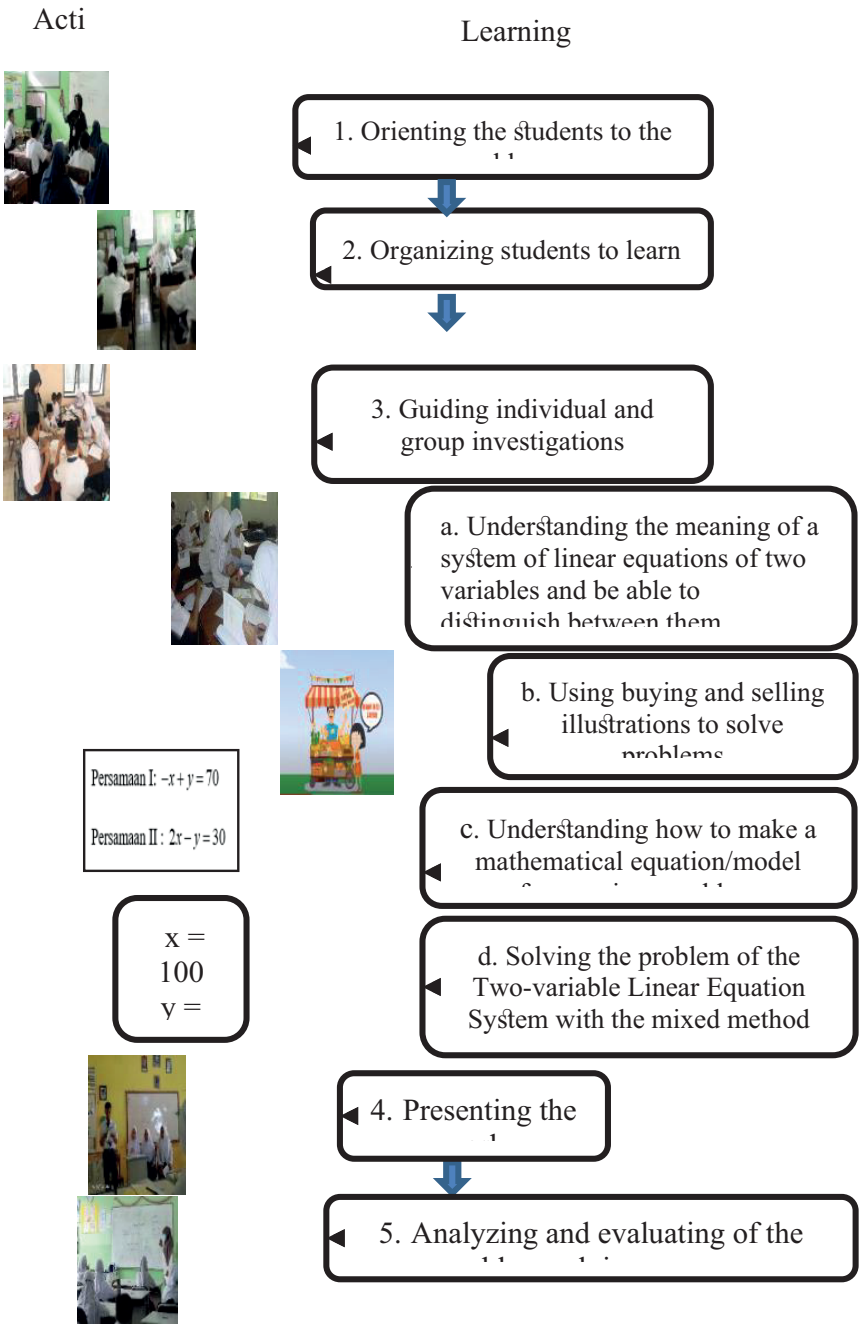

Figure 1: HLT linear equation through a problem based learning model.

4. CONCLUSION

From the description above, the HLT of linear equation of two variable material through the resulting problem-based learning model can be a teacher's reference in making linear equation material learning designs. The learning design is made by considering the HLT that students go through to be able to solve the given problem, besides that from the HLT it is obtained that the problem based learning model is very suitable for

related materials because the model has contextual characteristics. However, teachers can also choose other learning strategies/models that are considered appropriate to the material to be taught.

5. Acknowledgments

Acknowledgments to the Principal of SMP Suci Murni Medan and to the teachers in the field of mathematics studies who have allowed me to do research and made it easy for me to collect data in the field as well as thanks to other parties who cannot be mentioned one by one who have helped the author so much. this paper has been completed.

References

[1] Rosmala A. Model-model pembelajaran matematika. Bumi Aksara; 2021.

[2] Sukma E, Ramadhan S, Indriyani V. “Integration of environmental education in elementary schools.,” In: *Journal of Physics: Conference Series*. pp. 12136. *IOP Publishing* (2020). https://doi.org/10.1088/1742-6596/1481/1/012136.

[3] Kara M, Simon MA, Placa N. An empirically-based trajectory for fostering abstraction of equivalent-fraction concepts: A study of the learning through activity research program. J Math Behav. 2018;52:134–50.

[4] Khoirudin K, Rizkianto I. Pengembangan perangkat pembelajaran problem based learning dan learning trajectory yang berorientasi pada kemampuan penalaran matematis siswa. Mosharafa: Jurnal Pendidikan Matematika. 2018;7(2):207–18.

[5] Lede YK, Kii YI. “Lintasan belajar untuk membelajarkan materi membuat Model Matematika Sistem Persamaan Linear Dua Variabel (SPLDV) bagi Siswa Kelas VIII.,” In: *Prosiding Seminar Nasional Pendidikan Matematika Etnomatnesia* (2018).

[6] Sari N. Peningkatan pemahaman konsep matematis melalui pembelajaran kontekstual pada siswa sekolah menengah pertama. Jurnal Mathematic Paedagogic. 2019;3(2):144–50.

[7] Plomp T. “Educational design research: An introduction.,” *Educational design research*. pp. 11–50, 2013.

[8] Rezky R. “Hypothetical learning trajectory (HLT) dalam perspektif psikologi belajar matematika.,” *Ekspose: Jurnal Penelitian Hukum dan Pendidikan*. vol. 18, no. 1, pp. 762–769, 2019. https://doi.org/10.30863/ekspose.v18i1.364.

[9] Simon MA, Tzur R. Explicating the role of mathematical tasks in conceptual learning: An elaboration of the hypothetical learning trajectory. Hypothetical learning trajectories. Routledge; 2012. pp. 91–104.

[10] Simon MA. Reconstructing mathematics pedagogy from a constructivist perspective. J Res Math Educ. 1995;26(2):114–45.

[11] R.I. Arends, “Learning to teach (Belajar untuk mengajar) pustaka Pelajar, cetakan ketujuh,” (2008).