Designing HOTs-oriented learning material using PMRI approach

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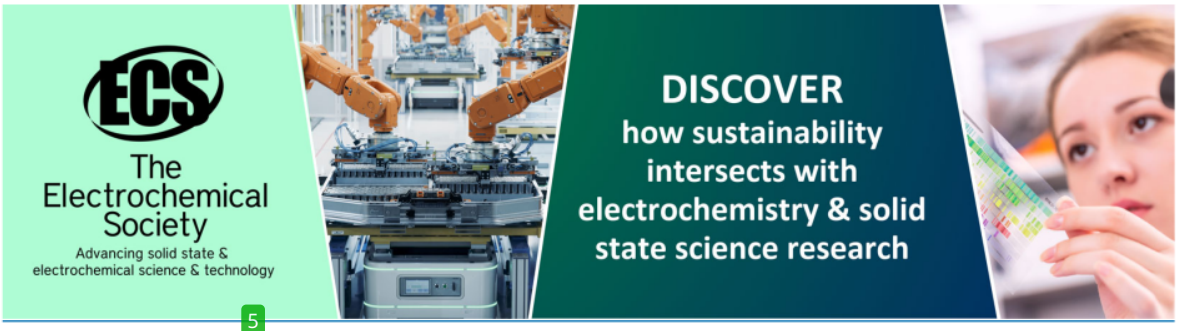

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Designing HOTs-oriented learning material using PMRI approach

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Abstract. This research aims to generate higher-order thinking skills (HOTs)-oriented learning trajectories that can help students to understand the material of two-variable linear equation using Indonesian realistic mathematics approach (PMRI). There are three stages in this research, namely preliminary design, learning experiments, and retrospective analysis. The subjects in this study are eighth grade students of SMPN 46 in Palembang. Data collection techniques use observation, interviews, video recordings, pre-test and post-test, and field notes.The results of this study is the development of Hypothetical Learning Trajectory into learning trajectory with 3 activities namely identifying problems and making examples, making mathematical models, and being able to solve problems in daily life.

1. Introduction

Algebra is one branch of mathematics that is the unifying thread in mathematics, but there are still many students who make mistakes in doing and understanding algebra operations. There are five students' mistakes in completing algebraic operations, namely errors in variables, negative signs, completing the form of algebraic equations, operating the algebraic forms, and solving fraction forms [1]. One of materials in algebra is linear system with two variables. It has the characteristics of being close to daily life, as a prerequisite material in linear programming, and a challenging problem that promotes children think critically and creatively. The subject material contained in the 2013 curriculum requires a change in the learning paradigm, namely 21st Century skills. The elements of 21st century skills are critical thinking, creative, communicative, and collaboration [2]. The implementation of linear system with two variables requires HOTs oriented learning.

HOTs require someone to apply new information or prior knowledge and manipulate information to reach new possible answers [3]. In principle, HOTs is a way of thinking logically or reasoning processes whose assessment process focuses on third level ability [4]. The third level reasoning includes: analyzing, evaluating, and creating [5]. The steps for the preparation of HOTs-oriented learning design are as follows: determine and analyze basic competencies, determine the learning goal, create a project in a combination of knowledge dimensions and thought processes, formulate indicators of competence achievement, determine learning steps in lesson plan [6, 7].

The prediction questions of national exam based HOTs have a potential to help students answer national exam questions [8]. Likewise with learning activities using train structure context can improve students' understanding in understanding linear system with two variables material [9]. Factors that cause students to erroneously solve HOTs problems are difficulty understanding contextual based story problems, lack of student understanding of problems, and difficulty in converting story problems to mathematical forms, and the teacher gives LOTS level math problems [10, 11, 12].

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HOTs learning is a learning technique that is needed at this time by using context, therefore the teacher designs HOTS-oriented learning scenarios by applying innovative and varied learning so that students can use the new skills they have acquired [13, 14, 15]. Then the learning approach that best meets these characteristics is the PMRI approach. PMRI is used by mathematics teacher experts in developing students' ability to think, reason, communicate, and solve problems both in lessons and in everyday life [16, 17]. Two important views from Freudenthal about PMRI are 1. Mathematics should be close to students and related to daily life, 2. Mathematics as human activity, so students can discover mathematics in their own way [18, 19, 20]. So realistic here does not mean concrete physically and invisible, but also including what can be imagined by students' minds [21].

2. Method

This study uses a design research method which is one of the qualitative research approaches. The subjects of this study were 32 students of class VIII SMPN 46 in Palembang in odd semester of 2019/2020. There are three stages in design research, namely preliminary design, teaching experiment, and retrospective analysis [22]. The focus of this research is the trajectory of learning using HOTs-oriented learning and PMRI approach that can help students understand the linear system with two variables. The instrument used is student worksheet. This research collected data by observation, interview, documentation, pre-test and post-test, field notes.

3. Result and Discussion

The teaching experiment consists of some activities. The first activity aims to enable students to identify problems about laundry notes and water boom and also write the information of the problems. All groups can understand and write correct information from the laundry problem. Students can also make an example by using the math sentences of variables x and y.As seen in Figure 1.

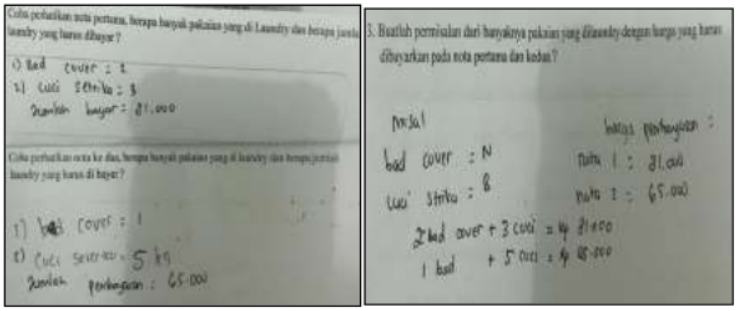

Figure 1. Students' answers in activities 1.

Based on Figure 1, it can be seen that students can identify problems by writing information on many blankets and clothes washing irons at a price to be paid and students can also make examples of this information using mathematical variables. The second activity is that students make mathematical models of the examples that have been made and can make completion of these mathematical models. As seen in Figure 2 below students can make a mathematical model from the example of the previous activity:

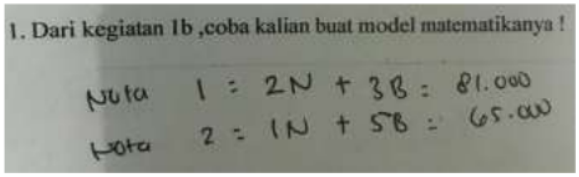

Figure 2. Students' answers in activities 2.

Based on Figure 2, it can be seen that students can make mathematical models, by changing the blankets example using variable N and clothes washing irons using variable B into a linear equation of two variables. As shown in Figure 3 below students can complete the mathematical model from Figure 2.

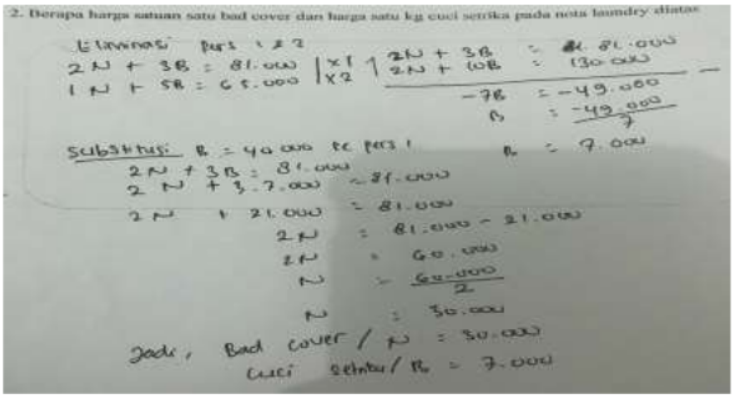

Figure 3. Students' answers in activities 2.

Based on Figure 3, it can be seen that students can solve the linear system with two variables well; students can determine the price of 1 blanket and 1 kg of clothes washing iron using the combined elimination and substitution method.

This third activity has three questions which are the types of questions C4 and C5. The teacher will direct and guide students to solve these problems using the knowledge they have learned before, as shown in Figure 4.

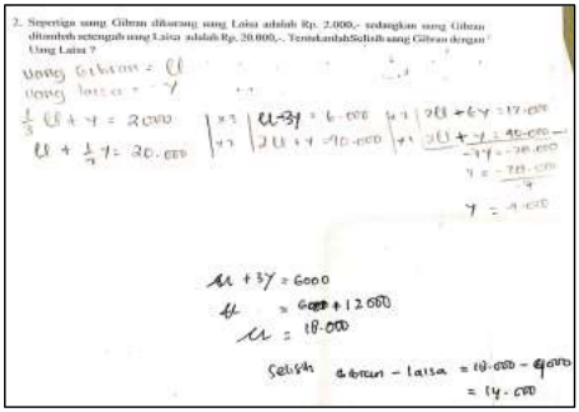

Figure 4. Students' answer in activity 3.

In Figure 4 above it can be seen that students can solve linear system with two variables problems in daily life, the questions used are HOTS type C5. PMRI approach can improve students' spatial mathematical ability one of the stages is identifying contextual problems and solving contextual problems with the group [23].The three steps of activities carried out using the train structure context can help students in understanding linear system with two variables material [9]. The three steps of the activity are identifying information and making examples, make a mathematical model and its completion, resolve the linear system with two variables problem. The three steps of activities that have been carried out in this teaching experiment can answer how the learning trajectory can help students understand linear system with two variables material using the HOTS-based PMRI approach. Learning through realistic mathematical approaches can arouse student interest in learning so that learning activities become effective [24].

Based on the conjecture that was designed in this study was in accordance with the thinking ability of students. The findings in this study are part of the development of local instructional theory (LIT) in learning HOTS-based linear system with two variables material using the PMRI approach. The learning trajectory of linear system with two variables material using the context of laundry notes can help students understand the linear system with two variables material.

4. Conclusion

Nowadays, HOTs learning is an important learning by using context. The teachers need to designs HOTS-oriented learning scenarios by applying innovative and varied learning so that students can use the new skills they have acquired. This study has developed the learning trajectories consisting of 3 activities namely identifying problems and making examples, making mathematical models, and being able to solve problems in daily life.

5. Acknowledgments

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