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DIDACTICAL DESIGN DEVELOPMENT OF LINEAR EQUATION IN TWO VARIABLES BASED LEARNING OBSTACLE AND HYPOTHETICAL LEARNING TRAJECTORY

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Abstract

Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 81A Year 2013 explains that the learning activities need to use the principle of learning which focus on students centered. However, this time not all students are able to uncover their ideas. In addition, learning obstacles experienced by students, especially in studying the mathematical concept of Linear Equations in Two Variabels. In fact, this material was very important to be understood by the students as a basis to study mathematics at the next level. Therefore, researcher conducted the study to develop of didactictal based on the analysis of learning obstacles and hypothetical learning trajectory in studying the mathematical concept of linear equations in two variabels. This study used qualitative methods through Didactical Design Research (DDR) with three stages: analysis of a didactical situation, analysis metapedadidaktis, and analysis retrosfektif. The subject of this research was students in 8th grade from SMP Bandung. Based on the results the didactictal design that has been made, could minimize the learning obstacles experienced. But the didactical design still needs improvement to correct the deficiencies found during the learning process. So, researcher made a didactical design revisions to these improvements

Keywords: Didactical Design Research, Didactical Design, Learning Obstacle, Hypothetical Learning Trajectory, Linear Equation in Two Variables

Abstrak

Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 81A Tahun 2013 menjelaskan bahwa kegiatan pembelajaran perlu menggunakan prinsip pembelajaran diantaranya berpusat pada peserta didik. Namun, saat ini tidak semua siswa mampu mengungkap ide. Terdapat beberapa learning obstacle yang dialami siswa, khususnya dalam mempelajari konsep Persamaan Linear Dua Variabel. Padahal, materi ini sangat penting untuk dipahami oleh siswa sebagai dasar mempelajari matematika di tingkat selanjutnya. Oleh karena itu, peneliti melakukan penelitian yaitu dengan mengembangkan desain didaktis berdasarkan analisis terhadap learning obstacle dan hypothetical learning trajectory. Penelitian ini menggunakan metode kualitatif melalui Didactical Design Research (DDR) dengan tiga tahapan yaitu analisis situasi didaktis, analisis metapedadidaktik, dan analisis retrosfektif. Adapun yang menjadi subjek penelitian ini adalah siswa kelas VIII di SMP Bandung. Berdasarkan hasil analisis desain didaktis yang dikembangkan mampu meminimalisir kesulitan belajar yang dialami oleh siswa. Namun, selama proses pembelajaran desain didaktis yang dikembangkan masih perlu perbaikan. Oleh karena itu, peneliti membuat desain didaktis revisi melalui perbaikan perintah soal, penambahan prediksi respon siswa, dan alokasi waktu sehingga hasil pembelajaran selanjutnya dapat lebih optimal.

Kata Kunci: Didactical Design Research, Desain Didaktis, Learning Obstacle, Hypothetical Learning Trajectory, Persamaan Linear Dua Variabel

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INTRODUCTION

Purnami research (2018) provides information that teachers have an important role in the learning system for students, especially understanding concepts. Mathematical material or ideas / concepts at the previous level are related to understanding mathematical concepts at a later level. Hayati and Setyaningrum (2019) in their research stated that the learning process of students must be trained to understand concepts well, not only to memorize material. This is also in accordance with the opinion of Hamda (2018) which states that learning good concepts results an appropriate problem solution. Therefore, learning will be effective if students understand the mathematical concepts being learned.

Two Variable Linear Equation is one of the material about algebra that can train students to think productively (Van De Walle, 2008). Based on research conducted by Wati, Fitriana, and Mardiyana (2018) found learning difficulties in learning linear equations. Generally, some learning difficulties experienced by students in learning linear equation, namely in the making of mathematical models, algebraic operations, and difficulties in understanding problems. Brown (2008) states that there are three obstacles that occur in students, namely ontogenis obstacles, didactical obstacles, and epistemological obstacles. However, based on the findings from the results of preliminary studies found, learning difficulties are included in the epistemological obstacles.

Epistemological obstacles found are when students cannot translate problems into mathematical models, miscalculate and also cannot provide an explanation of the answers obtained (Bakar, Suryadi, Darhim, 2019). Therefore, teachers need to minimize learning difficulties so that the learning process can be optimal. Learning must be designed as a whole to improve learning and must be in accordance with student learning needs. Thus, the substance of the reflection must be able to encourage and support learning activities. The didactical design arranged needs to consider the study of learning difficulties, hypothical learning trajectory, and the acquisition of mathematical concepts.

According to Clements and Sarama (2009), there are three important components in learning trajectory, namely learning goals, learning trajectory that are in accordance with the development of students 'mindset, and learning activities in the form of teaching materials that are able to improve students' thinking abilities to a higher level. In addition, Slavin (2011) explains that information can last a long time in memory if paying attention to time and important attention to the information. Figure 1. states the sequence of processing information that enters long-term and short-term memory (Slavin, 2011).

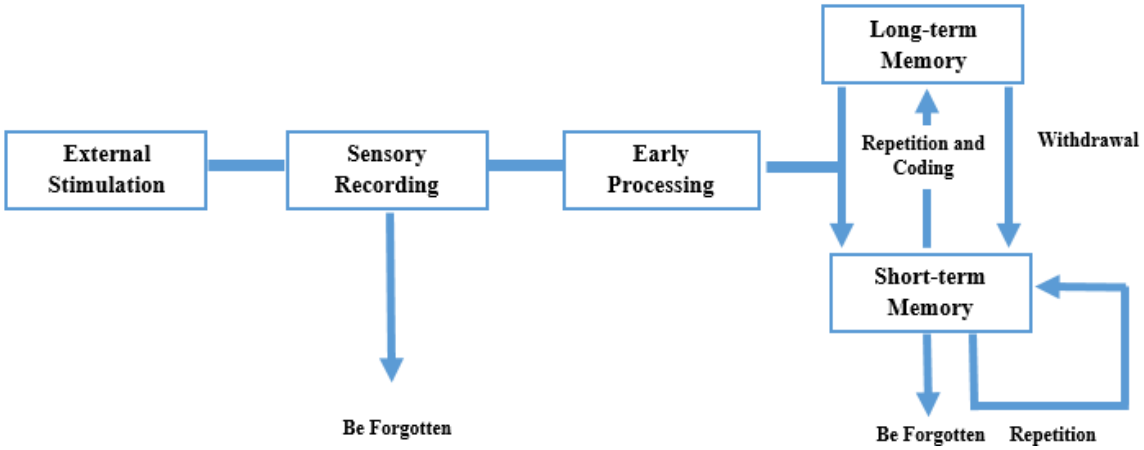

Figure 1. Order of Information Processing

Figure 1. explain that information that is remembered by a person is first given attention and transferred to short-term memory. Then, processed and transferred to long-term memory through certain activities that have been planned by the teacher. The teacher must know how information is received, processed, and stored in students' memories. To that end, the teacher helps students connect new information with what they know, solve it in other contexts, and help students to be able to find out for themselves how to solve problems related to the material provided. With these considerations, the information or knowledge obtained can last long in students' memories.

METHOD

This research used a qualitative method through Didactical Design Research (DDR) with three stages, namely didactic situation analysis, methadactic analysis, and retrosfective analysis. The research subjects are students of SMP Bandung, class VIII, who get the material of linear equations in two variabels using Curriculum 2013. The number of research subjects was 39 students consisting of 18 men and 21 women.

Basically, research answers problems with certain methods through the collection, processing, and drawing conclusions from data that has been obtained. Sugiyono (2014) argues that when Authors conduct data collection by triangulation, the Authors actually collect data which at the same time tests the credibility of the data. Therefore, this study uses triangulation techniques, namely documentation, interviews, and participatory observation.

RESULTS AND DISCUSSION

Results

Before doing didactical design development, Authors analyzed learning obstacles, recontextualization, and repersonalization. Next, the researcher divided the learning trajectory into four didactical designs (lesson design) which were carried out in four meetings. This is adjusted to the 2013 curriculum, which is 1 week consisting of 2 meetings with a duration of 2 x 40 minutes and 3 x 40 minutes. So that the total duration of learning is 10 x 40 minutes. Lesson design arranged in the form of a worksheet that contains the problems in the exercise questions and systematic steps so that students are able to find their own concepts of linear equations in two variables. There are five worksheets presented to students. The worksheet is a student worksheet created as an alternative to reducing the emergence of identified learning obstacles for students.

The researcher made lesson design related to the four identified learning obstacles, namely the low ability of students to make mathematical models, low understanding of students, lack of student understanding of prerequisite material, and students who were accustomed to obtaining material from teachers without a thorough understanding, so the learning process in learning less meaningful concept. Therefore, learning obstacles that have been identified will be taken into consideration when developing didactic designs used by Authors to develop didactical designs that will be implemented.

Next, the hypotheses of the learning trajectory compiled by the researcher are systematically arranged as follows:

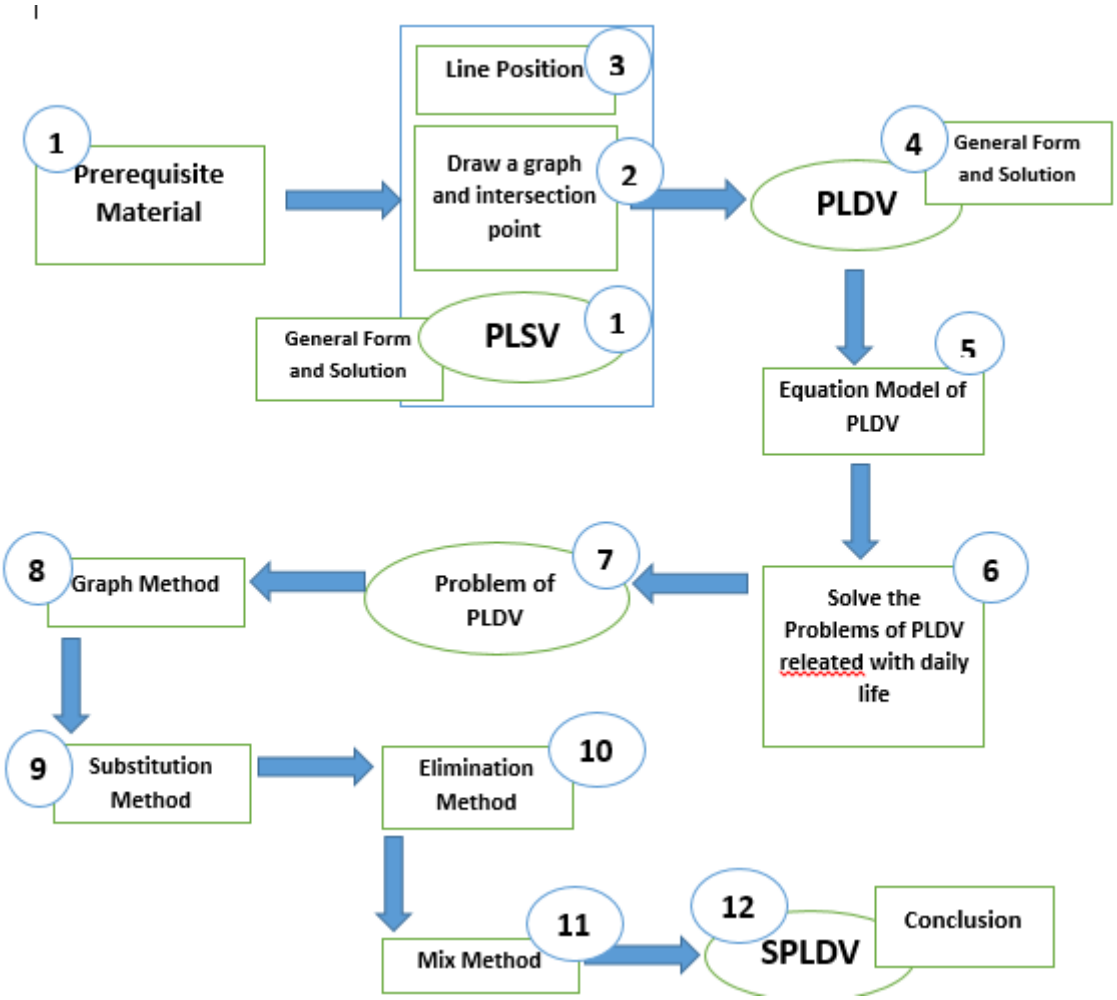

Figure 2. Learning Trajectory of Linear Equation in Two Variabels Concept

The didactical design that was compiled was then implemented in mathematics learning in schools. It was applied to students of class VIII. In the learning process in class, the application of didactical design was divided into 4 meetings. At the first meeting the indicators that must be achieved by students are modeling the problem into the form of linear equation in two variables, concluding the general form of linear equation in two variables, and distinguishing linear equation in two variables from other equations. The concept was constructed by students themselves through the presentation of problems that require students to distinguish the general form of linear equation in two variables with other equations.

In the first indicator, some students still have difficulty in making mathematical models. Authors provide assistance that two different variables give different meanings. At the second meeting, the indicators that must be achieved are making a graph of the problem model and determining the solution by graphical. Authors provide problems in the form of story questions in contextual problems that must be made in mathematical models first so that students are accustomed to making mathematical models. The following are examples of the answers of students who made mistakes in drawing graphics and intersection points on the given questions.

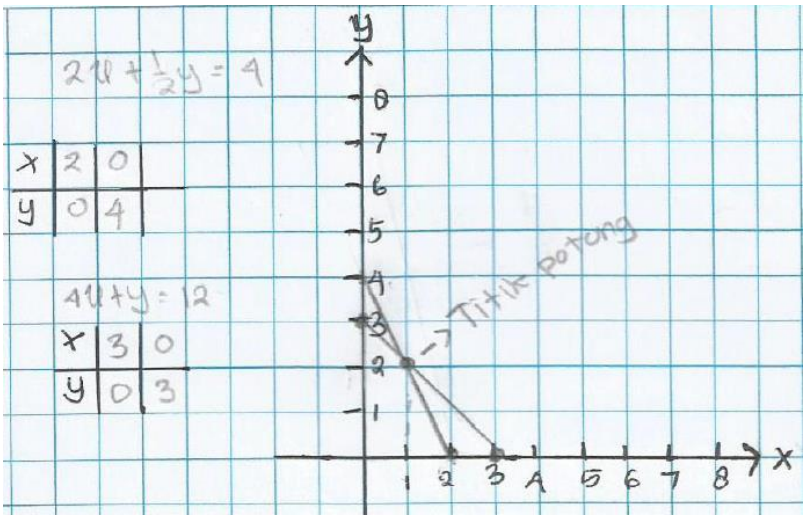

Figure 3. Incorrect Group Answers in Drawing Graphs

Based on the Figure 3. obtained information that students are still not able to draw equations $2x + 12y = 4$ and $4x + y = 12$. This shown from the answers in the worksheet 2. The student mistakenly determines the point that intersects the axis y, therefore the value $x = 0$ is chosen and substituted into the equation, but the answer yag is obtained incorrectly, $y = 4$.

At the third meeting, the indicators that must be achieved was determining the solution by substitution and elimination methods. The fourth meeting was the last meeting with indicators that must be achieved namely determining the resolution. At this meeting problems were given to further strengthen students' understanding of solving problems related to the linear equations in two variables in daily life.

Discussion

In general, the learning obstacles were students having difficulty connecting between previously learned concepts and the concepts to be learned. For this reason, the teacher helps students connect new information with what they know, solve it in other contexts, and help students to be able to find out for themselves how to solve problems related to the material provided. Slavin (2011) suggests that the involvement of students in using knowledge and the ability to produce their own products can create meaningful information and can be remembered well. One way that information can be stored in long-term memory is by repetition. According to Anderson (in Slavin, 2011), repetition is carried out in the initial and final activities. The teacher must also consider, understand, and organize lessons to convey new concepts. New concepts are placed at the beginning of the lesson, and then the lesson concludes at the end of the lesson.

At each meeting, with the help of Authors and groupmates, generally students could to solve any problems in the worksheets provided. This activity was in accordance with the theory of Brunner (Putra, 2013) that when someone is assisted by a teacher or other people who have more ability to solve problems, these students can exceed the limits of their development. Problems given in each worksheet were problems in the story problems. Putra (2013) explains that by providing problems in real life can improve critical thinking skills. In addition, Vygotsky (in Budiningsih, 2005) explained that to help children develop truly meaningful knowledge by integrating concepts and procedures through demonstration and practice. Authors invite students to work on these problems both individually or with their peers. This was based on the ability of different children. Vygotsky (in Huda, 2011) explains the zone of proxima development between the distance of actual ability and potential ability. Interaction between students will increase learning achievement.

Slavin (2011) explain that the involvement of students in using knowledge and the ability to produce their own products can create meaningful information and can be remembered well. Piaget (in Santrock, 2011) revealed that as the child seeks to construct an understanding of the world, the developing bra creates schemas. These are actions or mental representations that organize knowledge. With the scheme, individuals can understand, receive and respond to information. The scheme can develop as a result of the interaction and adaptation of individuals to the environment. Therefore, students in groups discuss worksheets with the aim of constructing their own understanding of the general form of linear equation in two variables.

In the learning process based on Piaget's cognitive theory, Trianto (2007) explains that the teacher introduces information by involving students to find ideas using normal thinking patterns so that they can use concepts to problems. Difficulties of students who are accustomed to working on algebraic contexts alone, are overcome by presenting didactic designs that contain problems in various contexts. Authors provide an explanation again about the prerequisite material that is a linear equation in one variable, drawing a graph, and the position of two lines to provide assistance or make it easier for students to understand concepts at completion using the graphical method.

Based on the implementation of a didactical design, a revised didactic design was arranged to correct the deficiencies that have been discovered. In general, didactical designs that have been made can be maintained. However, there are some things that need to be considered, namely instructions in the given problem, predictions of student responses, teacher assistance, apperception activities, classroom conditioning, and appropriate time allocation.

CONCLUSION

Didactical design of the concept of linear equation in two variables prepared by Authors was developed based on learning obstacles and hypothetical learning trajectory. Based on the results of the didactical design analysis developed can minimize the obstacles of student learning difficulties. In general, didactical designs implemented need to be maintained. However, the researcher recommends the existence of a research on the development of the didactical design of the concept of linear equation in two variables with various improvements, both in terms of deeper concepts, presentation, and predictions of student responses. In addition, a review is needed to overcome the difficulties students have in drawing graphs and the meanings of the intersection points of the two lines.

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REFERENCES

Bakar, M.T., Suryadi, D., and Darhim, D.. (2019). Learning obstacles on linear equations concept in junior high school students: analysis of intellectual need of DNR-based instructions. Journal of Physics: Conference Series. 1157 (3): https://doi.org/10.1088/1742-6596/1157/3/032104

Budiningsih, C.Asri. (2005). Belajar dan pembelajaran. Jakarta: PT Rineka Cipta.

Brown, S.A. (2008). Exploring Epistemological Obstacles to the Development of Mathematics Induction. Proceedings of the 11th Conference for Research on Undergraduate Mathematics Education, San Diego.

Clements, D.H. and Sarama, J. (2009). Learning and Teaching Early Math (The Learning Trajectory Approach). New York: Routledge.

Hamda. (2019). Mathematical Problem Solving Strategy based on Conceptual Thinking. Journal of Physics. 10282(1): 1-9, http://dx.doi.org/10.1088/1742-6596/1028/1/012163

Hayati, R, and Setyaningrum W. (2019). Identification of Misconceptions in Middle SchoolMathematics Utilizing Certainty of Response Index. Journal of Physics. 1320(1): 1-9, http://dx.doi.org/10.1088/1742-6596/1320/1/012041

Huda, Miftahul. (2011). Cooperative Learning (Metode, Teknik, Struktur, dan Model Terapan). Yogyakarta: Pustaka Pelajar.

Purnami, Agustina Sri., et al. (2018). The effect of team accelerated instruction on students' mathematics achievement and learning motivation. Journal of Physics. 812(1): 1-6, http://dx.doi.org/10.1088/1742-6596/812/1/012026.

Putra, Sitiatava Rizema. (2013). Desain Belajar Mengajar Kreatif Berbasis Sains. Yogyakarta: Diva Press.

Santrock, J.W. (2011). Educational psychology fifth edition. New York: McGraw-Hill.

Slavin, Robert E. (2011). Psikologi pendidikan (teori dan praktek). Indonesia: PT Indeks.

Sugiyono. (2014). Metode penelitian pendidikan: pendekatan kuantitatif, kualitatif, dan R&D. Bandung: Alfabeta.

Trianto. (2007). Model-model pembelajaran inovatif berorientasi konstuktivisme. Jakarta: Prestasi Pustaka Publisher.

Van De Walle, John A. (2008). Matematika Sekolah Dasar dan Menengah Jilid 2. Jakarta: Erlangga.

Wati, S., Fitriana, L., and Mardiyana. (2018). Students' difficulties in solving linear equation problems. Journal of Physics. 983(1): 1-7, http://dx.doi.org/10.1088/1742-6596/983/1/012137

Wati, S., Fitriana, L., and Mardiyana. (2018). Technological pedagogical content knowledge of junior high school mathematics teachers in teaching linear equation. Journal of Physics. 1008(1): 1-8, http://dx.doi.org/10.1088/1742-6596/1008/1/012067