Research Article

Lesson Design of Table and Diagram Modeling to Develop Algebraic Thinking Ability of Elementary Schools Students

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ABSTRACT

This research is motivated by the learning osbtacles findings regarding algebraic thinking caused by students have not received formal algebra learning in elementary school. On the other hand, previous research states that algebraic thinking can be accustomed since elementary school age. This habituation can be done by choosing elementary school mathematics material that has the potential to be used as a learning precondition for algebra or called algebraic thinking. Thus the need for a learning plan that can improve the algebraic thinking ability of elementary school student. This research uses the Didactical Design Research (DDR) research method. The stages of this research method consisted of prospective analysis, methadactic analysis and retrospective analysis. After an analysis of learning obstacles is carried out, field findings are triangulated into learning trajectories. The process of analysis and triangulation produces alternative didactic situations that can overcome obstacles in algebra thinking. The alternative didactic situation is used as the basis for developing lesson designs that will be implemented. This research produced lesson design in algebra thinking class V in elementary school. Based on field studies that think algebra in the curriculum in primary schools is not explicitly stated, it is necessary to develop lesson design to facilitate students in developing algebraic thinking.

Keywords: algebraic thinking, lesson design, elementary school students, tables and diagrams

INTRODUCTION

There are a close relationship between algebra resolution and algebraic thinking terms. The definition of algebra according to Lew (2004) is a way of thinking, which contains six mathematical thinking abilities consisting of generalization, abstraction, analytical thinking, dynamic thinking, modeling, organization. One of the ability to think mathematically in algebra is modeling. Modeling activities in mathematics are fully translated using symbols. While algebra thinking is analogous to a bridge between concrete thinking and abstract thinking that cannot be separated from mathematical modeling. Thus, succeeding students in mathematical modeling activities also proves that students are able to think algebra.

Algebraic thinking is defined as the ability to think using appropriate language, concrete models and symbols, and begins to use a balance strategy to find that doesn't know or unknown (Waren, et al, 2009, p. 10). The balance strategy in mathematics is better known as being symbolized by "=" (equal to). Symbol used as an equalizer between quantitative left and right segments. The concept of pulling left and right segments that will be used to find something that have not known through mathematical modeling or modeling. The strategy of meaningful balance is the basis for developing more complex algebraic thinking skills.

Research result of Booker & Windsor's (2010) occur representation activities and solve problems with students' own solutions in various steps in preparing for algebraic thinking in schools. Another way to develop algebraic thinking is by making generalizations from the solutions obtained. Mestre & Oliviera's research (2012) shows that elementary school students already have the ability to do algebraic thinking. In addition, Radford's research (2010; 2011; 2012a; 2012b) found that non-symbolic algebraic thinking begin to notice students at the age of seven to eight years. The development of algebraic thinking begins with expressing generalizations of numerical relations in various representations.

Previous research has found that not all primary schools contain algebra material explicitly (Pratiwi, Herman and Lidinillah, 2017). The National Council of Mathematics Teachers (NCTM) conducted a study to find ways to explore algebraic reasoning at the pre-school level until K-12 (NCTM, 2000, p. 37). The research produced indicators of algebraic thinking that students must master in learning mathematics from pre-school to K-12. Then the indicator is reduced to the item. The item was tested on elementary school students and produced several findings. There are several obstacles in thinking algebra in elementary school students, namely ontogenical obstacle, didactical obstacle, and epistemological obstacle (Brousseau, 2002). These three types of obstacles occur in elementary school students (Pratiwi, Herman and Suryadi, 2019)

On the other hand, didactical obetacles can also be caused by learning that does not pay attention to wrinkles in terms of the appropriate stages of thinking (Pratiwi, Farokhah and Abidin, 2019). Obstacles that occur can be minimized by implementing lesson design that is designed in accordance with the learning path and the right didactic anticipation. Then there needs to be a didactical design development in the form of lesson design that can minimize oblstacles that occur and can develop the algebraic thinking skills of elementary school students.

RESEARCH METHODS

The research method used was didactical design research or also known as didactic design research which has more specific scope of design research. Suryadi (2010) explains that there are three stages in didactic research as follows, including prospective analysis including didactic situation analysis prior to learning in the form of a didactic hypothesis design, methachactic analysis, when implementing learning by taking into account the relationship of the Kansanen triangle, and retrospective analysis. The Kansanen Triangle is a reciprocal relationship between teacher, student and material in the learning process. Retrosfective analysis is an analysis that links the results of the didactic hypothesis of a situation analysis with the results of a tachycathic analysis.

This research was conducted in elementary schools in the city of Bandung and Garut regency. The participants in this study consisted of students from class V Elementary Schools. Students were involved as participants in the development of didactic designs designed by 35 students and those involved in the preliminary study were 50 students. The instrument used in this study was the human instrument, the researcher himself. According to Sugiyono (2012) researchers as human instruments, serves to determine the focus of research, choose informants as sources of data, interpret data, and make conclusions on their findings. Equipped with supporting instruments such as observation sheets, questionnaire interview sheets, student responses to conduct observations, interviews and find out student responses after the design test.

FINDINGS AND DISCUSSION

Based on the results of the preliminary study analysis, the discovery of learning obstacles happens to students in algebraic thinking. Therefore, to minimize the difficulties faced by students designed lesson design. Development of lesson design includes mathematical modeling activities, changing mathematical situations or mathematical problems using tables, diagram drawings, bar charts to line diagrams. The design was designed by considering learning obstacles and learning trajectory.

Learning trajectories are designed based on the interdependence of material. After knowing the material wrinkles, then determined some of the material that is raised and dug deeper to bring up learning situations that can develop the ability to think algebra. In addition, the material of tables and diagrams is designed from the most concrete to the most abstract so that students can interpret gradually based on the conditions of thinking of elementary school students (Pratiwi, Nurkaeti and Putri, 2019). Paying attention to various aspects in compiling the learning trajectory is expected to be developed into a didactic design of algebraic thinking that can be used in general is like figure 1.

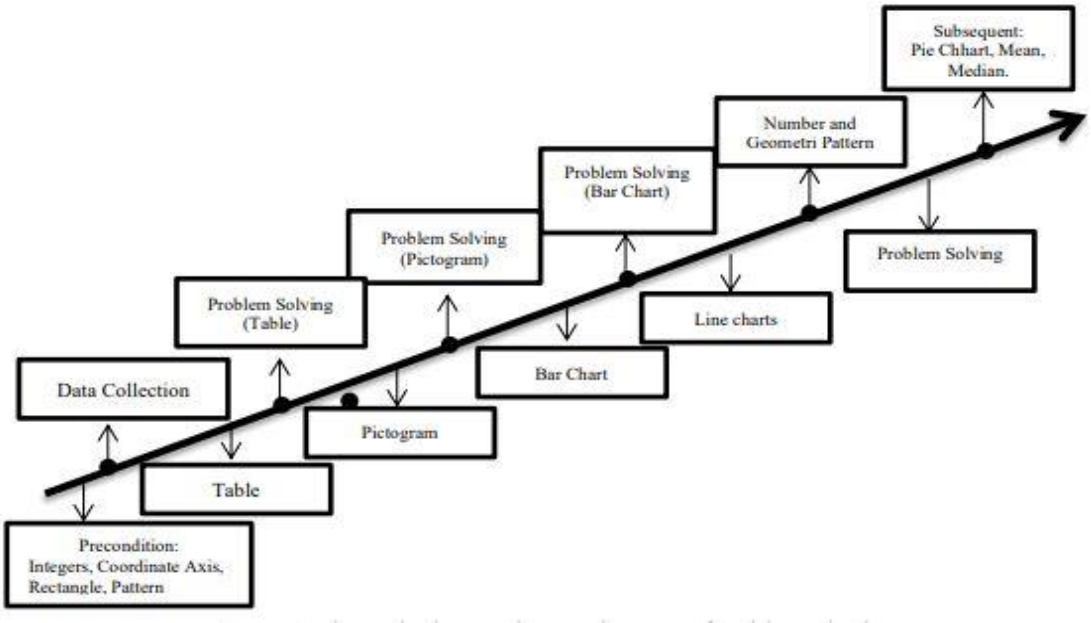
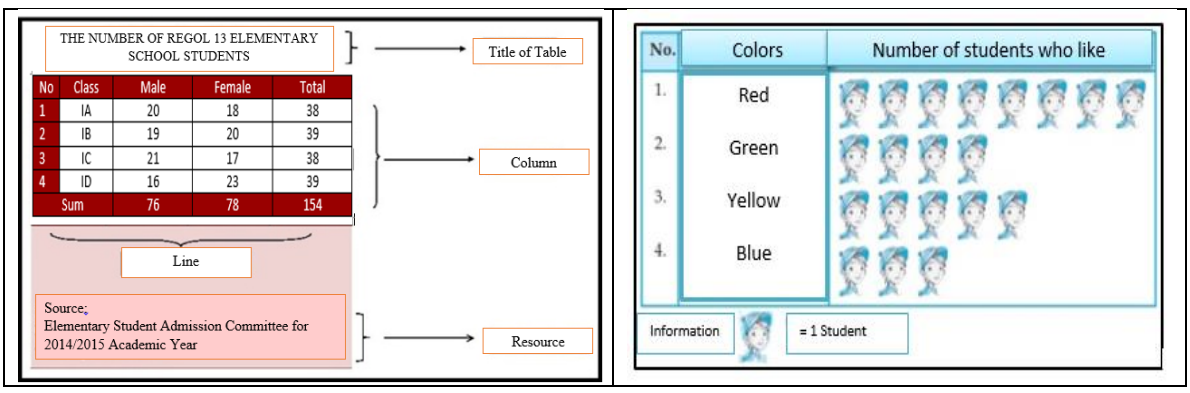


Figure 1. Algebraic Learning trajectories (Pratiwi et al. 2020)

Based on Figure 1 above, visible sequence material to develop algebraic thinking skills. Material that is a prerequisite is the concept of integers and line numbers, the concept of vertical and horizontal lines, and the concept of rectangular flat shapes, and patterns. The prerequisite material must be mastered by students before lesson design is implemented. The core material for developing algebraic thinking skills in table and diagram material is the representation of data using tables, diagram drawings, bar charts, and line diagrams. The flow of thinking that is built is the ability of students to model problem situations in tabular form. At the beginning of modeling, students move data from the form of stories into tabular form. Table representation is the beginning of a simple equality way of thinking. Students create other forms of existing data without reducing the amount of quantity in a more effective form. This way of thinking occurs when students draw pictures, bar charts, and line charts. In addition, representation is made from the semi-abstract form of the table, then into the form of a diagram of an image that begins modeling in the form of images, then modeling the shape of the bar to form a line diagram.

Didactic Design of Algebra Thinking

Lessons design consists of didactic situations, prediction of student responses, didactic anticipation and assessment processes. Lesson design is designed in four meetings, the duration of each meeting is 2 x 35 minutes. The complete lesson design can be seen in the appendix. The main purpose of designing a didactic design is to provide algebraic thinking experience by modeling problem situations using tables and diagrams. Lesson designs are designed to pay attention to the modeling process from the most concrete to the abstract. General illustration as in Figure 2.



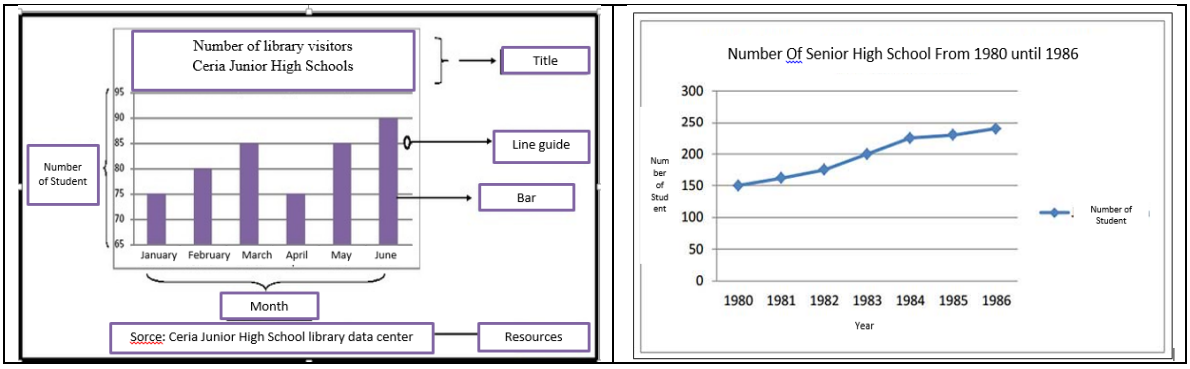


Figure 2. General description of lesson design

In Figure 2, mathematical modeling begins with the process of changing mathematical situations or mathematical problems using tables, then using diagrams picture, bar charts to line charts. In the first lesson design, learning objectives are designed so that students can collect data and present it in tabular form. In addition, students are expected to be able to deduce the contents of the table. The didactic situation then presents the data and looks for other ways to present data with the same contents. In this situation, the other way is directed to the modeling using the diagram.

Second Lesson Design Students do one picture modeling to represent several real objects or people. After the ability to model using a table is built and connected with modeling using picture diagrams the students have understood. The lesson closes by concluding together all the activities that have been carried out. The first didactic situation was to build students' interest in mastering the diagram of the picture.

In third lesson design, a didactic situation was developed regarding a bar chart. the parts contained in the bar chart along with their functions. students recognize vertical and horizontal bar charts. This section is important given to students, because it is found students who have difficulty interpreting that information on the vertical and horizontal lines determine the contents of the bar chart. Students connect between learning about bar charts with learning about line charts. Actually a bar chart can also show a decrease or increase, but it is far more effective when using a line chart.

The fourth design lesson regarding line diagrams aims to enable students to model problem situations using line diagrams. When compared with the learning in the previous diagram, line diagram is the most abstract diagram modeling. Therefore, in this case the fourth lesson design is the culmination in a series of learning to develop algebraic thinking skills. In addition, there is an additional didactic situation in which students' activities explore patterns through geometric fields and work on problem solving related to line diagrams and geometric patterns.

DISCUSSION

Material tables and diagrams are the right choice for developing algebraic thinking skills of elementary school students. Based on the results of research Pratiwi, et al (2020) shows that the achievement of algebraic thinking skills of students who learn by using diagram and table modeling is better than students who learn to use conventional approaches. That is because in the material of tables and diagrams, there is a process of abstraction and symbolization from the most concrete things to the most abstract things.

Basically the development of lesson designs to one to four has the same pattern. It's just that the emphasis didactic situation based on obstacles that occur. In the first lesson design, the emphasis of learning activities is on collecting data and representing it in tabular form. The activity of making tables is the culmination of other activities aimed at building students' knowledge in making tables. The activities carried out are reading tables, interpreting tables, getting to know the parts of tables, and describing their functions and formulating steps to make tables.

In the second lesson design, learning is focused on the activity of making a picture diagram. The process of representing data in the form of a diagram of an image is an activity of modeling a problem in a problem in the form of a relevant picture. The ability of representation is built by

analyzing the simplest diagram forms to complex representations. Through the activity of drawing diagram analysis gradually can facilitate students to build the concept of bar charts.

The activities contained in the third lesson design, students can represent data in the form of bar charts. When applying a didactic situation of distinguishing vertical and horizontal diagrams, it is likely that students will understand the meaning of vertical and horizontal bar charts. In addition to being more abstract, it also trains students to understand comprehensively the data representation in various forms of data presentation.

Pressing in the fourth lesson design, the activity of making line charts based on data that has regular changes (patterned). Data representation using line charts is the most abstract form of data presentation among the previous diagrams. In addition, problem solving activities in a pattern are also abstract activities that can be resolved in various ways. Lesson design is coherently designed from concrete to abstract. The process of transferring between materials must be experienced by students flowing and there is a connection. Thus, students will feel that the knowledge gained during the learning process is a unified knowledge that is useful and useful in daily life so that students' algebraic thinking skills can be honed well.

CONCLUSION

Lesson design consists of some didactic situations including introductory didactic situations, formulation of steps, open ended questions or problem solving and closing activities in the form of connecting with the next material. Each lesson design begins with a didactic situation that aims to motivate students and gain experience about tables and diagrams in daily life. For elementary school age students this is very important. Given the psychological condition of elementary school students. Readiness to learn and accept lessons depends on how interested students are in the material. In addition, in each lesson design there are also activities in the formulation of steps for making both tables and diagrams. Formulation is the culmination of the stages of learning in the theory of didactical situation that aims so that students can master certain concepts. Students discover their own concepts that are formulated by mutually agreed upon after going through the discussion process. Other didactic situations that exist in every lesson design are working on open ended problems or problem solving. That is because algebraic thinking one of the indicators is modeling, while modeling the problem situation through tables and diagrams can be explored through open ended problems and problem solving.

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