The Impact Of RME-Based Design Instructional On Students' Mathematical Communication Ability

Lily Andriani, Ahmad Fauzan

Abstract: This study aims to produce effectiveness from the development of learning design through statistical concepts using the Realistic Mathematics Education (RME) approach to mathematical communication skills implemented in HLT (Hypothetical Learning Trajectory), teacher and students book which valid and practical. The method used is a combination of the Plomp design research model and the Gravemeijer & Cobb model, which consists of 3 phases, namely the preliminary research phase (preliminary research / preparing for the experiment), the development phase (development or prototyping phase / design experiment) and the assessment phase (assessment phase / retrospective analysis). The subjects of this research were students of class VIII junior high school. Data collection techniques that will be used were posttest tests from two classes, namely the experimental class and the control class. Data analysis technique was using the Independent-Sample T Test. The analysis shows that p-value = 0,000 <0.05 means that there are significant differences between the two classes. So, the development of learning design based on Realistic Mathematics Education has a positive impact on students' mathematical communication skills on statistical material.

Index Terms: Learning design, Realistic Mathematics Education, Mathematical Communication.

1. INTRODUCTION

Statistics is the study of how to plan, collect, analyzes, interpret, and present data. Statistics is not only used in mathematics but also in every field and discipline of science, both the natural sciences, social sciences, as well as in the fields of business, economics, and industry [1, 2]. Some research results show that statistics are one of the subjects that are less liked and considered difficult by students. From the results of research conducted by Batanero, et al [3-6] shows that students experience difficulties in statistical concepts, student's initial knowledge, and methods or approaches used by teachers in teaching and difficult to overcome misunderstandings caused by several representations facing the basis of the production of variations and data. Sukestiyarno and Muslikah's research [7] found the problem that students were still confused in distinguishing between single and group data types so that students found it difficult to apply the problem solving especially in the form of real context. In addition, based on observations made by Nugroho [8] students have difficulty in distinguishing the usefulness of the mean, mode, and median concepts especially when related to the application of different formulas that students must use to work on existing problems. In this case statistics material is difficult material for students. One of the factors influencing students' learning difficulties is the process of learning and teaching mathematics that has not yet been linked to the real world. Gil & BenZvi [9] claim that to know and understand statistics there needs to be a real context in playing an important role as student performance.

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However, the textbooks used by using a contextual approach in the presentation of mathematics material in some schools are still limited. If we look at the process of learning in the teaching material, it does not contribute to the development of student learning where the presentation of the material starts from giving a definition and continues to decrease the formulas and sample questions. There is no information about the benefits of statistical material in daily life so that it does not motivate students to learn. The material in teaching materials is presented directly on the concept without the process of student involvement in building the concepts or knowledge learned. The sentences used to describe the material are felt to be insufficient to help students construct their understanding independently of the completion of statistics, and there is no process that involves students finding their own concepts. In addition, available textbooks generally encourage teachers to teach mathematics "mechanistically" and "algorithmically" [10-13]. One of the skills that must be possessed by students is the mathematical communication skills of students, with the existence of these mathematical communication skills students are expected to communicate ideas with symbols, tables, diagrams or other media to clarify the situation or problem. However, the thing that happens in learning mathematics in general is that most students are still confused about understanding the problem or the data that is in the problem, so that it will have difficulty in expressing it in mathematical form. In the end they are not able to determine what concepts or principles should be used to solve problems. This is supported by the results of Ranti's research [14] which states that students still experience confusion when having to read or interpret data presented in the form of images, graphs, diagrams or other mathematical symbols. So, it can be said that the ability of students in doing math, especially in conducting mathematical communication is still low. To improve the quality of mathematics learning, teachers need to design learning designs that emphasize the connection of concepts with everyday experiences. Learning design is known as HLT (Hypothetical Learning Trajectory). This term was first put forward by Simon [15], he said that hypothetical learning tools were defined by researchersdevelopers as goals for meaningful learning, a set of tasks to accomplish those goals, and a hypothesis about student "thinking and learning". While Chuang Yin-Chen [16] said the hypothetical learning trajectory consists of learning objectives learning activities and hypotheses of the learning process. Thus, HLT is a learning consisting of learning objectives for meaningful learning, learning activities, and hypotheses about how students learn and think. HLT provides instructions for teachers to determine and formulate learning objectives to be achieved, make decisions about the steps to be taken in learning to arouse student motivation in learning [17]. Therefore, it is designed a teaching material such as teacher's book and student's book to complement the shortcomings that exist in the existing textbooks. One approach that can optimize student learning from environmental objects that aims to motivate students to understand mathematical concepts by linking concepts to everyday problems is the Realistic Mathematic Education (RME) approach. Realistic Mathematics Education (RME) is an approach where mathematics is seen as a human activity [18-21]. Human activities and mathematics can be linked in the context of everyday life as a source of development and application through mathematical processes from both horizontal and vertical [22]. Horizontal mathematics processes from the real world into mathematical symbols while vertical mathematics is a process that occurs in the mathematical system itself such as the discovery of strategies in solving problems, connecting mathematical concepts and using formulas [23]. According to Freudenthal [24] there are three RME principles that can be used as a reference. These three principles are guided discoveries through mathematical, educational phenomena and students' own models. Five characteristics of RME according to Traffers [25] are using contextual problems, using models, valuing a variety of answers and student contributions, interactivity and integrating with other learning topics. The purpose of this study is to examine the effectiveness of learning design based on Realistic Mathematics Education on statistical material on students' mathematical communication skills.

2. METHODOLOGY

This research is a type of development research. This development model combines two types of design research, namely Plomp [26] and Gravemeijer & Cobb [27] model designs, to implement learning trajectory, teacher and student books are designed using Plomp research design, beside of the development of the learning, designed using Gravemeijer & Cobb design research. The results of the merger of the two models consisted of: the first phase or initial investigation phase carried out needs analysis, curriculum analysis, analysis of student characteristics, concept analysis and literature review. The second phase or the phase of making Prototype is carried out formative evaluation, design and evaluation activities. Formative evaluation steps start from self-evaluation, expert review, one-on-one evaluation, small group evaluation and field test. The instruments used in this study include a list of interview questions, check lists, validation sheets, observation sheets, questionnaires, before being used, each instrument was validated by expert experts and carried out practicality tests to see the ease of use of teaching materials. The third phase or assessment phase is carried out in the form of a test of students' mathematical communication skills. At this stage, it is carried out to determine the effectiveness of the RME-based learning design. Data collection techniques that will be used were posttest tests from two classes, namely the experimental class and the control class. The subjects of this study were eighth grade students of SMP Negeri 1 Batang Tuaka. The effectiveness of RME-based learning design is defined as an increase in students' mathematical communication skills. In addition, the effectiveness of the RME learning design can be seen from indicators of students' mathematical communication skills.

3. RESULTS AND DISCUSSION

The assessment phase is carried out to determine the effectiveness of the learning design through teacher books and student books. The potential impact of learning design is measured through the posttest of the two classes for comparison, for the experimental class using the RME-based learning design and the control class using regular learning. This purpose is to see the development of students' mathematical communication skills in different classes of statistical material. Furthermore, the value is processed using descriptive statistics; the results can be seen in Table 1.

Table 1. *Descriptive Statistics of Experimental Classes and Control Classes*

	n	$\bar{x}$	*Std. deviation*	*max*	*min*
Experiment	*21*	*83,33*	*9,457*	*100*	*61,11*
Control	*20*	*63,10*	*12,933*	*88,89*	*50*

The results of the descriptive statistical analysis in Table 1 show that the average posttest results of the experimental class are higher than the control class. The average difference in the posttest results of the experimental class and the control class was 20,35. This shows that the results of the mathematical communication skills of the experimental class students are better in the control class. Based on the normality test using the Kolmogorov Smirnov test, obtained significance values for the experimental class and the control class > 0.05, then Ha is accepted meaning that the data is normally distributed. Both samples have normal distribution; the next step is to test the variance homogeneity. This homogeneity test uses the Independent Sample T test, obtained the significance value of Levene's Test for Equality of Variance for the mathematical communication ability variable of 0.051, because the significance value > 0.05, it can be said that the data variance of mathematical communication skills of students from two groups is the same (homogeneous). After obtaining that the results of the analysis of both homogeneous variances t-test was performed. From the data show that the significance of 0,000 <0.05. It can be concluded that there is a significant difference between the two experimental and control classes when the test of the students' mathematical communication skills is done. Furthermore, the results of the analysis of the percentage value of each indicator of mathematical communication skills using RME-based learning design on statistical topics, as in Table 2 below.

***Table 2**. Percentage of Value of Every Indicator of Mathematical Communication Capability of Experiment class*

and Control class.

Test	*Test Percentage Value of each Indicator (%)*			
	1	*2*	*3*	*Average*
Experiment	*91,27*	*78,57*	*80,16*	*83,33*
Control	*66,66*	*53,97*	*59,52*	*60,05*

Table 2 shows that the percentage value of each indicator of the mathematical communication ability of the experimental class and the control class has met the criteria for a success rate of more than ≥ 50%, meaning that it is effectively used in improving students' mathematical communication skills on statistical topics. Based on the results of tests of mathematical communication skills, the following is a description and analysis of student answers that are associated with indicators of mathematical communication skills.

Indicator 1: Ability to present problems using descriptions, terms, notations, mathematical models / formulas, diagrams, graphs or tables.

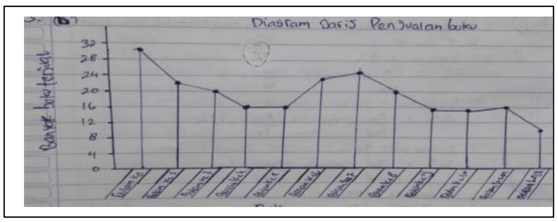

Figure 1. *Results of Experiment class students' answers*

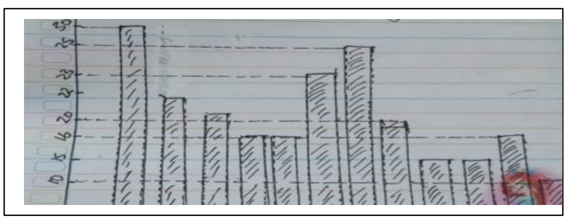

Figure 2. *Results of Control class students' answers*

In the questions students are asked to present the right data to see the development of notebook sales every month. The results of the answers in the experimental class show students have been able to represent or present data appropriately using line charts, because this diagram is easier to see the ups and downs of the development of notebook sales every month, so students have understood the purpose of the problem. In contrast to the results of the answers in the control class, students present the data in the form of bar charts; in this case the students are less precise in representing the data.

Indicator 2: Ability to give a reason or explanation for a statement

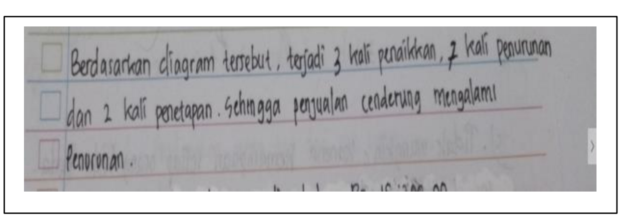

Figure 3. *Results of Experiment class students' answers*

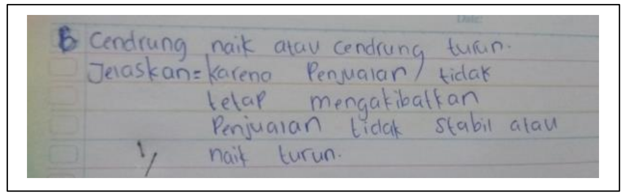

Figure 4. *Results of Control class students' answers*

In this problem students are asked to provide an explanation of the diagram from the previous answer by seeing whether sales are always going up, down, tend to go up, or tend to go down. Based on the answers of students in the experimental class, students give reasons that have been right with their own language and with sentences that are easily understood, students also have understood the purpose of the problem. As with the answers from the control class, students have been able to provide reasons or explanations in their own sentences and are easy to understand but the reasons given are less precise. Students only see changes in sales each month without seeing changes in overall sales

Indicator 3: Ability to explain ideas / strategies that are owned clearly and precisely

Students are asked to be able to explain or write ideas or steps to solve the problem given. In the question students are asked to look for the average profit of each notebook that is sold by being given the average profit gained each month. The students' answers in the experimental class showed that the students were able to write the answers correctly as well. Student's first look for an average of many books sold each month. After the results are obtained students look for an average profit in each book by dividing the average profit each month divided by the number of books sold each month, so that the profit is obtained from each book sold. For the results of students' answers in the control class, students write the wrong way. Students are able to find an average of books sold every month, but to determine the average profit of each book a student experiences a mistake, where students multiply the average profit gained every month by many months and then the results are divided by the average book results which sells every month. Thereby produces the wrong answer. Based on the description and analysis of the results of students 'answers from the two classes, the experimental class tends can be better at seeing the development of students' mathematical communication skills. The results of the students' answers above only represent some students. Therefore, the development of RME-based learning design conducted in the experimental class can improve students' mathematical communication skills. So based on the three results of this effectiveness test analysis, it can be concluded that the design of RME-based learning has a positive impact on students' mathematical communication skills on the topic of statistics.

4. CONCLUSION

Based on data obtained from the results of the posttest conducted in two groups, namely the experimental class as a class using the RME-based learning design and the control class with conventional treatment, it can be concluded that the development of the RME-based learning design has a positive impact on students' mathematical communication skills.

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