

The Development of statistics learning design based on realistic mathematics education for grade VIII junior high school

N Yuliasari^{1*}, Yerizon¹ and I M Arnawa²

¹Department of Mathematics Educations, Universitas Negeri Padang, Indonesia

²Department of Mathematics, Universitas Andalas Padang, Indonesia

*Corresponding author: yachannova@gmail.com

Abstract. The results of the preliminary study indicated that there are problems in learning Statistics at grade VIII SMP/MTs. The students tend to be introduced to the use of formulas without involving the discovery of the concept itself and learning apart from the students' daily experience. This underlies the design of the learning trajectory for Statistics topic and links them to activities based on students' experience (experience-based activities). The purpose of this study was to design a learning trajectory of Statistics topic for grade VIII SMP/MTs based on the Realistic Mathematics Education (RME) approach, that equipped with a teachers' and students' books. This study was a design research that combines the Plomp model with the Gravemeijer & Cobb model. The subjects of this study were the students grade viii MTs Negeri Bangko. This study revealed a Statistics topic-learning design based on RME approach with the learning trajectory that were finding the mean concept, finding the mode concept, finding the median concept, and finding the five series statistical concept. The learning trajectories were implemented through the teachers' book and students' book. The results of conducting experiments showed that the context contained in a students' book that can stimulate the students to develop their knowledge in finding statistical concepts. All strategies was found and discussed by students, show how the construction or contribution of students in finding the statistical concepts from informal to formal level. The results showed that the learning design of Statistics topic basd on RME approach was valid and practical. It was valid in terms of content and language and it was practical in terms of implementation, convenience and time required.

1. The first section in your paper

Mathematics has an important role for the development of science and technology. Many problems and activities in life are always related to mathematics such as measuring, calculating, and so forth. Until now mathematics is one of the sciences that has an important influence on its application to various sciences and technologies used to facilitate human activities. But unfortunately, Indonesian students' mathematical abilities are still low [1-12]. One of the topics of mathematics at Grade VIII is Statistics. Statistics is one of the topics in a subject studied in a school in which this topic has many benefits in everyday life. According to Bakker [1] Statistics is the study of how to plan, collect, analyze, interpret, and present data. Statistics is widely applied in various scientific disciplines, both natural sciences (e.g Astronomy and Biology as well as social sciences (including Sociology and Psychology), as well as in business, economics, and industry. Statistics in a curriculum in a country is



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taught at different levels. In America, students learn mean, median, and mode at grade 4 or 5, when the students are 9 or 10 years old [2].

Based on the mathematics teachers' argument, in SMP Negeri 1 Merangin and MTs Negeri Bangko, in learning Statistics at grade viii, the teachers said that the learning began by explaining a set of data, calculating the concentration and spreading the data with formulas accompanied by several examples of questions, then the students doing the exercises according to the example. The teachers used the textbooks without designing for him how the Statistics topic should be taught. Based on the analysis of the textbooks in school, the Statistics topic presented has not helped students construct their own knowledge. Statistics was presented by providing the concepts and examples of problems without the discovery of these concepts. In addition, the questions presented were only intended to practice numeracy skills and skills using formulas.

The results of learning about Statistics material taken from the observed schools, namely SMP Negeri 1 Merangin and MTs Negeri Bangko obtained that the students have not reached the mastery learning classically above 65%, where the mean of the percentage of the students who completed the Statistic topic at grade viii in 2018/2019 in SMP Negeri 1 Merangin was 40.86% of all the students and in MTs Nagari Bangko it was 40.66% of all the students. Based on this, it is necessary to design a learning that provides opportunities and guides students in learning to reinvent concepts learned in their own way.

Learning design is an overall process undertaken to analyze the needs and objectives of learning and the development of a system of delivering learning material to achieve these goals [3] and emphasizes more on the connection of concepts with daily experiences through various activities. This is related to the opinion of Freudenthal who said that if children are separated from their daily experiences, then they will quickly forget and cannot apply mathematics [4]. Learning design based on learning trajectory is known as Hypothetical Learning Trajectory (HLT). HLT is a series of activities carried out by students based on the contextual problems to find learning goals. Learning trajectory consists of learning objectives, learning activities, and hypotheses of the learning process to predict how the mind and understanding of students will develop in the context of learning activities by Simon [5]. The learning trajectory provides instructions for the teacher to determine and formulate learning goals to be achieved. Designing learning related to how students' thinking and understanding will develop in learning activities. It is very suitable to use the Realistic Mathematic Education (RME) approach. RME is an approach with a paradigm that mathematics is a human activity and learning mathematics means working with mathematics (doing mathematics) [6]. The learning design in this study through RME-based learning trajectory on the Statistics topic (RME-LTS) is expected to improve the quality of learning. This learning trajectory will direct students' thinking in solving mathematical problems with various predictions that have been designed by the teacher and their anticipation. This learning design is expected to provide the ease of use in learning Statistics topic by the teachers and students.

2. Materials and Methods

This study was a development research by combining the Plomp model and the Gravemeijer & Cobb model. The Gravemeijer and Cobb model consists of three phases: preparing for the experience, conducting the experiment and retrospective analysis [7]. The Plomp model consists of 3 phases, namely the preliminary research phase, the prototyping stage and the assessment stage [8]. Based on the results of the analysis in the preliminary research phase, a RME-LTS was designed. Then, for the operations the students' book and teacher' Book were designed.

In the prototyping phase, the prototypes that have been made were assessed through a formative evaluation. The RME-LTS learning design that has been designed was self-evaluation and validated by the expert. After a valid RME-LTS was produced, a one-to-one evaluation was done/cycle 1 was conducting the experiment, evaluating a small group, and conducting the experiment to see practicality.

3. Results and Discussion

Based on the needs analysis, it was found that in statistical learning so far the students have not constructed their own abilities in finding concepts. They were given the formulas then completed the examples using the formulas given and continued with exercises. Based on the curriculum analysis, it was found that indicators to be studied were about finding the concepts of mean and its characteristics, finding the concept of mode, finding the concept of median and its characteristics, and finding the five series Statistical concept. The results of the concept analysis showed that the prerequisite material that the students must master was the presentation of data and integers. Then, based on the student analysis in MTs Negeri Bangko dan SMP Negeri 1 Merangin, it was found that the students learned based on the explanation by the teacher. Based on the preliminary analysis, a RME-LTS for the students grade viii SMP/MTs was designed.

3.1. Prototype Design

The Hypothetical Learning Trajectory (HLT) was designed. Four HLTs were designed, First, it was finding the concept of mean through 3 contexts. The first context was through the fair distribution of marbles which aims to enable the students to construct their understanding of finding mean informally. Macross & Russel in [1] stated that mean as fair share and balance so that as to find the mean concept informally the students could divide equitably. Furthermore, the second context was through the diagram-shaped blocks of fried banana sales results whose results were divided equally so that the students could find the mean concept formally by finding the same high diagram form, and the third context was about the results of the test if added, subtracted, multiplied and divided in order that the students found the properties of the mean.

Second, in finding the concept of mode through the first context regarding the taste of students' favorite candy. This context was aimed at making the students find that the favorite flavor was the one that has the most interest. The second context was regarding the size of the students' shoes. The students would be asked questions about the number of shoes the most used by their friends that aims the students observed that the most frequently occurring mode. Then, the third context was the presentation of the data using diagrams. The students could find that the mode was the diagram that had the greatest frequency.

Third, in finding the median concept through the first activity of determining the holding company office. The selection of the parent company office can stimulate the students to find the median concept as data in the middle and has the smallest total deviation. Next, the second activity found the concept of a median using the order of the birth of children so that the students could find that the median was the data that was at the center after being sorted.

Fourth, regarding the statistics of the five series through activities determining students who take part in scout competitions. This problem was presented with the aim of stimulating the students to find the smallest data concepts, lower quartile, middle quartile, and upper quartile.

Formative evaluation was carried out to assess the quality of the product design developed. To assess the quality of HLT design results, teacher's book, and student book used formative evaluations developed by Tessmer consisting of expert validation, one-to-one interviews, small group or micro evaluation, and field tests [8]. After the self-evaluation of the RME-LTS has been designed, the further improvements were made.

3.2. Learning Design Validation Results

The learning design was validated by 5 validators. In the HLT, the aspects observed were the content and language aspects. The overall validity result of the HLT was 3.36 with a very valid category. Thus, it can be concluded that the HLT component aspects of the RME-LTS were valid. The results of the HLT, teacher's book, and student's book validation each are stated in Table 1, 2 and 3

Table 1. The results of validation HLT by validator

Presentation aspects	Overall Validity	Category
Content	3.33	Very valid
Linguistic	3.41	Very valid
Validity result of the HLT	3.36	Very valid

Table 2. The results of validation teacher's book by validator

Presentation aspects	Overall Validity	Category
Content	3.33	Very valid
Didactic	3.27	Very valid
Linguistic	3.38	Very valid
Graphic	3.21	Very valid
Validity result of the Teacher Book	3.29	Very valid

From Table 2, the overall results of the Teacher Book, the RME-based Teacher Book that was designed was valid. From Table 3, the RME-based student's book that was designed was valid.

Table 3. The results of validation Student's Book by validator

Presentation aspects	Overall Validity	Category
Content	3.26	Very valid
Didactic	3.25	Very valid
Linguistic	3.38	Very valid
Graphic	3.25	Very valid
Validity result of the Teacher Book	3.28	Very valid

3.3. The Results of Practicality of the Learning Design

One-to-one evaluation was carried out with two teacher and three students at MTsN Bangko. Based on interviewing with the students, generally the students could understand the contextual problems presented in contextual problems that served as starting points in finding each concept.

Meanwhile, based on interviews with teachers, it was known that the design was already practically used for the next stage. At the end of the teacher and student meeting the practicality questionnaire was given regarding the ease of use of the students and teacher Book. The results of questionnaire practicality by teachers and students each was presented in Table 4 and 5.

Table 4. The results of practicality by teacher *one to one evaluation* Stage

The Aspect assessed	The overall practicality (%)	Category
Ease of use	84.1	Practical
Time Efficiency	87.5	Very Practical
attractiveness	89.6	Very Practical
Process of use	87.5	Very Practical
The result of practicality	87,2	Very Practical

Table 5. The results of practicality by students *one to one evaluation* Stage

The Aspect assessed	The overall practicality (%)	Kategori
attractiveness	82.8	Practical
Process of use	82	Practical
Ease of use	87.5	Very Practical
Time Efficiency	91.7	Very Practical
The result of practicality	86	Very Practical

Evaluation of small group was carried out on 6 students. This learning begins with a class discussion, the students sit in groups of 3. The learning design of this RME-LTS can already be used for statistical learning. After conducting 6 small groups of meetings the researcher then gave an observer the practicality questionnaire to the teachers and students. The results of the questionnaire practicality analysis by the teacher and student each were presented in table 6 and 7.

Table 6. The results analysis of practicality by teacher stage Small Group

The aspect assessed	Overall practicality (%)	Category
Interesting	83.30	Practical
Process of use	86.67	Very Practical
Easy to use	83.30	Practical
Efficiency	80.00	Practical
Equivalency	91.70	Very Practical
The result of practicality	85.00	Very Practical

It can be concluded that the teachers consider the design of RME-LTS learning design to be practically used in Statistics for the students grade viii SMP/MTs. The practicality result of RME-LTS learning design was in Table 7.

Table 7. The results analysis of practicality by students stage Small Group

The aspect assessed	Overall practicality (%)	Category
Interesting	84.7	Practical
Process of use	90.0	Very Practical
Easy to use	85.3	Very Practical
Efficiency	83	Practical
The result of practicality	85.75	Very Practical

4. Conclusion

The learning design of RME-based Statistics topic for Grade VIII SMP / MTs has been designed to be valid and practical to use. The learning design of RME in Statistics topic for Grade VIII SMP / MTs can be used as a guide for teachers and students.

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