# Development of Learning Devices Based on Realistic Mathematic Education to Improve Mathematical Communication of Students at Senior High School

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***Abstract*--This research is intended to describe: 1) validity, practically and effectivity of devices which is developed by using Realistic Mathematic Education; 2) Enhancement of student's mathematical communication which used teaching and learning devices developed. It used 4-D model which consists of four stages: defining, designing, development and disseminate. The subjectis gradeXIof Senior High School 1 Barumun Tengah. The result of test I and test II showed that (1) Teaching and learning tools developed is valid both in terms of content and construct; (2) Teaching and learning Devices developed was easily used seen by students'dan teacher's response; (3) Teaching and learning Devices developed is effective, seen by student'smathematical communication; (4) an increase of student'smathematical communication in test I is 76,91 raised into 82,16 in test II.**

***Keywords: Learning Devices, Realistic Mathematic Education, Communication***

## I. INTRODUCTION

Education is very important and cannot be separated from life. The importance of education, so that it becomes a benchmark for the progress of a nation. A developed nation is a nation that has quality human resources, both in terms of spirituality, intelligence and skill. So that with quality human resources a nation will be able and proactively answer the challenges of an ever-changing era. To develop quality human resources, quality education is needed too. One way that can be done to achieve these goals is continuous reform in the field of education, especially mathematics.

Mathematic is one of science that's basically developes community's life and really needed in the development of science and technology. [1] There arefive reasons mathematic is important to learn is: (1) thinking medium‟s clear and logic; (2) the madium to solve daily life problem; (3) the mediu to know the relation forms and experience generalization; (4) the medium to develop the creativity; and (5) the medium to improve the awareness to the culture development.

[2]Helping students succeed in mathematics is a very important national goal to be achieved. But despite a lot of research in mathematics learning, there are shortcomings in the form of breadth and reliability and the lack of information obtained from these studies as a guide to improving math skills at school.

Given the importance of mathematics, students must also feel the importance of mathematics in themselves. To achieve this, students need to experience the benefits of mathematics directly. This can be achieved if students are given learning activities that enable students to learn actively so they can do doing math to find and build mathematics in themselves which is certainly facilitated by the teacher in learning activities.

One part of mathematics is mathematical communication. [3] For students grades 9-11 states that: *Changes in the workplace increasingly demand teamwork, collaboration, and communication. Similarly, college-level mathematics courses are increasingly emphasizing the ability to convey ideas clearly, both orally and in writing. To be prepared for the future, high school students must be able to exchange mathematical ideas effectively with others. However, there are more-immediate reasons for emphasizing mathematical communication in high school mathematics. Interacting with others offers opportunities for exchanging and reflecting on ideas; hence, communication is a fundamental element of mathematics learning. For that reason, it plays a central role in all the classroom episodes*

From the explanation above, it appears that mathematical communication skills are abilities that students really need to have. Furthermore [4] at least two important reasons why communication in mathematics needs to be developed among students. First, mathematics as language, meaning that mathematics is not just a tool to aid thinking, a tool to find patterns, solve problems or draw conclusions, but mathematics is also a valuable tool for communicating ideas clearly, precisely and carefully. Second, mathematics learning as social activity, meaning as a social activity in learning mathematics, mathematics is also a vehicle for interaction

between students, as well as communication between teachers and students.

The above explanation shows that many problems or information are conveyed in mathematical language, for example presenting problems or problems into mathematical models that can be diagrams, mathematical equations, graphs, or tables. Communicating ideas with mathematical language is actually more practical, systematic and efficient. The importance of mathematical language as communication so that mathematical language is part of the language used in society.

[4] Evaluation standards for measuring communication skills are: (1) the ability to express mathematical ideas through oral, written, demonstrating and visualizing; (2) the ability to understand, interpret and evaluate mathematical ideas both verbally, in writing and in other visual forms; (3) the ability to use terms, mathematical notation and its structures to present ideas, describes relationships with situations models. Based on the explanation above, it can be concluded that mathematical communication indicators are able to write mathematical ideas in the form of images, able to connect images into mathematical ideas and be able to write mathematical ideas into mathematical models and solve problems.

Based on the granting of mathematical communication questions to 23 students of class XI SMA at Barumun Tengah on October 30, 2017, the results showed that students who had a score of more than 65 for indicators were able to write mathematical ideas in the form of 30.4% (7 students), indicators are able to connect images to mathematical ideas of 43.5% (10 students), and indicators are able to write mathematical ideas into mathematical models and solve problems by 26.1% (6 students). From the results of the percentage, it can be seen that students' communication skills are still low.

If this condition continues to be allowed, it is feared that students will find it increasingly difficult to understand mathematics since mathematics is a tiered science. If the first material of the student is not complete, then in the next material the students will be more difficult. This situation will be like a snowball roll that is getting bigger and bigger until it forms an opinion in the mind of students that math subjects are difficult, uninteresting, and difficult.

[2] To achieve the main goals in the learning process of mathematics, it is necessary to change some components of mathematics education in schools. Especially about learning tools, learning materials, assessment, teacher education and professional development and socializing the education system carried out together to ensure the participation of all students in learning mathematics from elementary and secondary education. So that it can be concluded to improve the quality of learning, we need a learning tool that supports these abilities.

A good learning tool must meet certain quality criteria. [5] The quality criteria of a device are validity, practicality, and effectiveness. So that it can be stated that a quality device that fulfills all three aspects. [6] Validity obtained from the validation of devices by experts and peers contained content, construct and language validation. Furthermore practicality means that learning devices can be applied by the teacher in accordance with planned and easily understood by students. While effectiveness is seen from the results of authentic assessment which includes an assessment of the learning process and learning outcomes.

## II. MATHEMATICAL COMMUNICATION

According to Suriansyah (2014) [7] communication is an activity that is always carried out by everyone wherever he is, because communication is one of the needs of humans as social beings. Furthermore Greenes and Schulman [4] explain mathematical communication is: ability (1) express mathematical ideas through speech, writing, demonstration, and visualize them in different types, (2) understand, interpret, and assess ideas presented in writing, oral, or in visual form, (3) constructing, interpreting and linking various representations of ideas and their relationships. From the expert opinion above, it can be concluded that communication is a process or way of delivering ideas, views, thoughts or explaining understanding between fellow persons, namely communicators with communicants.

Mathematical communication skills in this study are students' ability to connect real objects, images, and diagrams into mathematical ideas, explain ideas, situations and mathematical relations both orally and in writing in the form of images or graphics; explain and make questions about mathematics learned from a given situation. The indicators that show mathematical communication skills in this study are: (1) Writing mathematical ideas in pictures, (2) Linking images to mathematical ideas or connecting mathematical ideas into images, and (3) Writing mathematical ideas into mathematical models and solve the problem.

## III. REALISTIC MATHEMATICS EDUCATION

Realistic mathematic education (RME) approach come from contextual issues, in this situastion student a should has the active role in learning activities, while teacher plays as facilitator. Teacher and student has a different role. Students can express and communicate the ideas to each other and teacher will help and support to compare the idea and also to make a decision. Which idea are the best among other. With those kind of characteristics, Indonesian realistic mathematic approach has a good prospect to applayed. It is good among structureal is, empiric, or mechanical approach. So, that expectation that RME is the answer to the problem of mathematic approach in Indonesia.

Realistic mathematics education is a education approach has developed more than 40 years in the fild of sciences and mathematics. Activities from a unit to develop student understanding of logarithms are used to exemplify the RME design principle of progressive formalization. Starting from contexts that elicit students' informal reasoning, a series of

representations and key questions were used to build connections between informal, pre-formal and formal representations of mathematics. RME offers more than a way to support student transition from the concrete to the abstract. RME instructional sequences are conceived as "learning lines" in which problem contexts are used as starting points to elicit students' informal reasoning. That is, the context is a source for new mathematics."

Explanation aboce describe that RME is competent to improve the understanding of mathematic, computantion ability, and communication ability. Characteristic of RME according to Gravameijer (2010) [9] like:

1. Guided discovery through a progresive process of mathematic:

Guided discovery Ahmadi (2011) [10] is a learning activity that involve whole students capacity of thinking to locate and investigate something systematically, critically, logically, and analitically. And finally students able to formulate their discovery with fully of confident.

2. Using a didactic phenomenon:

Didactical phenomenom concept Suprijono (2009) [11] is a phenomenom / concept that helping teachers to associate between theory an real world situation that encourage students to build the assosiation between knowledge they had and the application in their real life as a family member or a society member

Papakadis, Kalogiannakis, and Zaranis. (2017) [12] found that "*Holistically, our results suggest that teaching of realistic mathematics is a didactic approach with a positive effect, on the development of mathematical competence in kindergarten*".

Noviani, Syahputra, and Murad (2017) [13] found that "*improving students' spatial skills taught with Realistic Mathematics Education is better than conventional learning*"

From a number of previous studies, it has been shown that researchers have carried out studies on the development of learning devices, using realistic approaches to improve mathematical abilities. From the results of this relevant study it was concluded that the development of devices based on realistic mathematical approaches to improve communication skills was not an impossible thing to do.

## IV. RESEARCH METHOD

The research method is the development research to the teaching material through 4-D model by Thiagarajan, Semmel and Semmel. The researcher had developed the teaching devices in statistic. The learning tools developed in this research is teaching devices through RME model. The developed model which is stated by.Thiagarajan, Dorothy S. Semmel, dan Melvyn I. Semmel (1974) [14] include of four step called *define step,design step, develope step and the disseminate step*. The teaching material development can be seen int thisfollowing picture:

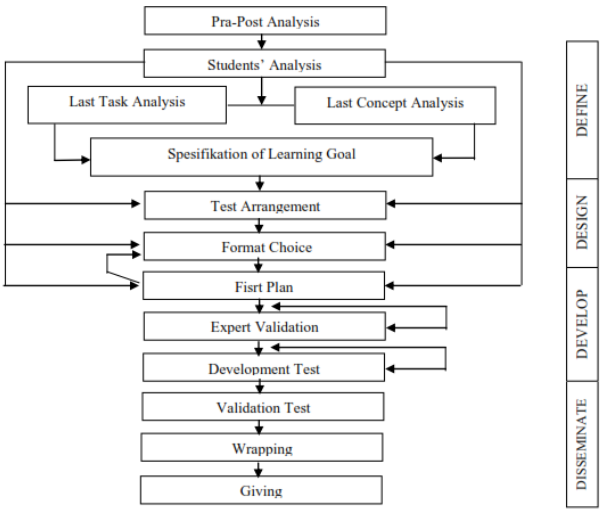


Fig -1: Development procedure of 4-D Model
(Source: Adapted from Thiagarajan 1974: 6-9) [14]

## V. RESULTS AND DISCUSSION

The results of the research that show that the devices developed have met the criteria of valid practical and effective. The results of the validity seen from the results of expert validation are used as a basis for revising and improving the learning device. Experts who carry out validation are called validators, amounting to 5 people consisting of 3 UNIMED lecturers and 2 high school math teachers. The validator performs validation which includes the format, content and language of the learning device.

Validation is done by assessing learning devices on a scale of 1-5. The results of expert validation indicate that the average validation of RPP, student books and LKS sequentially is 4.03; 4,11; 4.13. These results indicate that the assessment of all learning devices is in the valid category.

Furthermore, the validator also adds notes in the form of improvements to the RPP, students' books and LKS around the time, repairing images, illustrations and typing. This note is an improvement material to improve the learning device developed. Then a trial is carried out by applying learning devices directly to classes outside the research location. With the trial obtained a valid and reliable test. In addition, problems will also be obtained in unexpected learning.

The results of the practicality of trials I and II showed that student's responses to the device were more than 80% and the learning tools developed made the teacher interested and motivated in teaching. This shows that learning devices developed practically for teacher use in the learning process. Previously the practical criteria by student's had also been fulfilled. The conclusion from the results of practicality of trial II is that the learning devices developed have met practical criteria.

Based on the results of tests of mathematical communication skills in trials I and II, the results showed that in the first trial conducted in class XI IPA-1 Barumun Tengah

1 Senior High School the average score of students was 76.91 and the percentage of classical learning completeness was 81.82%. Then in the second trial in class XI IPA-2 Barumun Tengah 1 High School, the average score of students was 82.15 and the percentage of classical learning completeness was 93.3%.it showed that the learning tools was effective.

Based on the average value and percentage of classical completeness in the two trials, it shows that student's mastery of mathematical communication skills increased from trial I to trial II. The increase in the average value of students is 5.24 points and an increase in the percentage of classical learning completeness of students is 10.49%. This result is in accordance with the study Papakadis, Kalogiannakis, and Zaranis. (2017) [12] also concluded the results of his research that in general teaching with RME had a positive effect on the development of early childhood mathematical competencies. The two studies above show that RME affects the cognitive abilities of students even students who are introduced to mathematics from an early age.

Furthermore, the research of Saleh, Prahmana, Isa and Murni (2018) [15] concluded that achievement and improvement of student's reasoning abilities using RME were better than conventional learning. This is in line with the results of research by Noviani, Syahputra, and Murad (2017) [13] which states that the spatial ability of student's with RME is better than ordinary learning. From the results of the above research, it appears that RME contributes to improving student's cognitive, in this case mathematical communication skills.

## VI. CONCLUSION

Based on this research we can conclude that relevant to this research

1. Increased mathematical communication skills of trial I to trial II of 5.25, namely from 76.91 to 82.16.
2. The effectiveness of learning devices developed on mathematical communication skills is seen from the fulfillment of effective criteria in trial II which shows that 93.3% of student's have mathematical communication skills with a minimum score of 65. These results indicate that learning devices are developed effectively to improve mathematical communication skills.

## VII. SUGGESTIONS

Based on the results of the research and the conclusions above, several things can be suggested as follows:

1. The teachers can use RME-based learning tools as an alternative to learning mathematics in statistical material in the classroom.
2. The RME-based learning tool developed can be used as a reference to make a learning device with other materials to develop students' mathematical abilities, both the same and different levels of education.
3. For other researchers who want to conduct research using the same learning model with this study, it is recommended to examine other abilities in mathematics such as connection, and representation

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