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E-Module Based on RME Approach in Improving the Mathematical Communication Skills of Elementary Students

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ABSTRAK

Rendahnya hasil belajar matematika disebabkan karena belum efektifnya pembelajaran yang dilakukan oleh guru. Diperlukan sebuah inovasi sejalan dengan perkembangan teknologi komunikasi. Salah satu inovasinya adalah pengembangan bahan ajar berupa e-modul yang dikontekstualisasikan dengan kehidupan sehari-hari siswa. Penelitian ini bertujuan untuk menguji efektivitas e-modul matematika yang sudah dikembangkan dengan pendekatan Realistic Mathematic Education (RME) untuk sekolah dasar. Penelitian ini merupakan tindak lanjut dari hasil uji validitas dan uji praktikalitas e-modul yang sudah dikembangkan tersebut. Pengembangan e-modul menggunakan model 4Ds. Pada penelitian sebelumnya, validitas e-modul yang sudah dikembangkan diuji melalui expert judgement, dan praktikalitasnya diuji melalui uji coba individu, kelompok kecil, dan kelompok besar. Efektivitas e-modul diuji melalui pretest-posttest control group design menggunakan tes esai; dengan 26 siswa pada kelas eksperimen dan 24 siswa pada kelas kontrol. Data dianalisis menggunakan uji-t dan skor N-gain. Hasil penelitian diperoleh nilai t hitung sebesar 3,706; dan nilai N-gain adalah 63,81% untuk kelas eksperimen, dan 58,85% untuk kelas kontrol. Hasil tersebut menunjukkan bahwa penggunaan e-modul yang dikembangkan berbasis pendekatan RME dapat meningkatkan kemampuan komunikasi matematis siswa. Dengan demikian, dapat disimpulkan bahwa e-modul berbasis pendekatan RME yang dikembangkan efektif untuk meningkatkan kemampuan komunikasi matematis siswa SD.

ABSTRACT

The low learning outcomes of mathematics are caused by the ineffectiveness of learning carried out by teachers. Innovation is needed that is in line with the development of communication technology. One of the innovations in the development of teaching materials in the form of e-modules that are contextualized with students' daily lives. The purpose of this study is to ditermined the effectiveness of the developed mathematics e-modules using the Realistic Mathematic Education (RME) approach in improving the mathematics communication skills of the elementary students. This study is a follow-up to the results of the validity and practicality tests of the e-module that has been developed. The development of e-modules using 4Ds models. In the previous studies, the validity of the developed e-module was tested through expert judgement, and the practicality was tested through individuals, small and large group trials. The effectiveness of the developed e-module was tested through pretest-posttest control group design using essay test; with 26 students at the experimental class and 24 students at the control class. Data were analyzed using t-test and N-gain score. The research found that the t score is 3,706; and the N-gain score is 63.81% for experimental class, and 58,85% for control class. These results indicate that the use of developed e-modules based on the RME approach can improves student mathematical communication skills. Thus, it can be concluded that the developed e-module-based on RME approach is effective to improve the mathematical communication skills of the elementary students.

1. INTRODUCTION

Learning mathematics is very important for students at every level of schooling. Many studies have proven that mathematics learning has a significant relationship with various students' thinking abilities (Fasha et al., 2018; Meilantifa & Budiarto, 2018; Putri et al., 2019). Various thinking abilities of students, such as critical, logical, and analytical thinking can be improved and developed through mathematics

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learning (Brito et al., 2019; Fitria et al., 2018; Turgut & Turgut, 2020). There is almost no doubt that these critical, logical, and analytical thinking skills are very important for students in their daily live, and also for their future lives. Students who have critical, logical, and analytical thinking skills will find it easier to make arguments, make decisions, solve problems, and adapting (Ridlo, 2020; Saprudin et al., 2020; Yamin et al., 2020). Furthermore, Hermana (2018) said that these thinking skills are indispensable abilities in the Industrial Era 4.0. In addition, learning mathematics can also develop students' ability in communication ((Atikah et al., 2020; Sukardjo & Salam, 2020). Although thinking skills are very important and necessary for students' daily lives and also for their future live; but mathematics remains a subject that is less favored by most students. This disliking of students towards mathematics is happening in all over the world (Olivares et al., 2020; Prahmana & D'Ambrosio, 2020; Uchida & Mori, 2015); especially in Indonesia ((Agustyaningrum et al., 2020; Dewanti et al., 2020; Kismiantini et al., 2021)). Moreover, for the case of Indonesia, students' dislike of mathematics can be seen from the results of PISA assessment. The results of the PISA assessment show that Indonesia is always at the lowest 6th place for mathematics learning outcomes (Abdiyani et al., 2019). For example, in 2012, in the field of mathematics, Indonesia was ranked 64th with a value of 375 out of 65 countries. In 2015, Indonesia's position increased to 63 out of 69 countries with a score of 386. However, in 2018, Indonesia's ranking continued to decline, being at 73rd out of 79; even the math score was lower than the previous year, which was 379.

The low of mathematics learning outcomes of students are supported by the results of the documentary study of the first semester mathematical exam at the 2019-2020 school year, from several elementary schools in Bengkulu and Padang. This documentary study shows that more than half of the students could not achieve the minimum standard of learning mathematics that had been determined by the school. Base on this situation, large efforts should be made to improve students' mathematical ability, so they can be able to compete internationally in order to achieve international standards. There are many factors cause low students learning outcomes in mathematics. One of the factor is the ineffective learning carried out by the teacher. Teachers more often teach students with the lecture method (Aziz et al., 2020; Muna et al., 2017; Purnomo, 2016). From the observations in several elementary school in Bengkulu City and in Padang City found that the mathematics learning process have not fully involved all students to participate in communicating the mathematics material being studied. Submission of material is still informative, meaning that the teacher is more dominant in telling students the subject matter. The teacher has not created a mathematics community in the classroom. There were lack of interaction between students in the classroom during the learning process. As a result, there were many students having proplems in understanding mathematical ideas or concepts because they learn things that are less meaningful and abstract. Most students only memorize the concepts taught by the teacher. Learning mathematics mechanistically, without involving students to participate in communicating the mathematics material being tought, will not make students understand what they learn, and their mathematics communication skills will not develop (Helsa et al., 2021; Hoyles et al., 2013; Meltzer, 2002).

Mathematics communication skill is very important for students to be succed in learning mathematics (Hobri et al., 2018; Hung et al., 2014; Muhtadi et al., 2018). By having mathematics communication skills, students will be able to find concepts and put them in the form of symbols or mathematical language. Students' mathematical communication skills are the ability of student to explain ideas, language, symbols, graphics or images (Chilmi et al., 2020; Kurani & Syarifuddin, 2020). Thus, students' mathematical communication skills are not only verbal, but also include the ability to use symbols, pictures, and graphics. There are two reasons why communication in mathematics needs to be developed for students. Firstly, mathematics is not only a tool for thinking in solving problems and drawing conclusions; but mathematics also has unlimited value for expressing ideas clearly, thoroughly, and precisely (Pratama & Retnawati, 2018; Selvianiresa & Prabawanto, 2017). Secondly, mathematics and mathematics learning have a function as a forum for student interaction and communication between teachers and students (Cheung & Yin, 2021; Mullis et al., 2012). Students' success in mathematical communication skills at elementary school will allow them to also succeed in learning mathematics at the next level of education. Given the importance of having skills in mathematics, including mathematical communication, by learners; math teachers at all levels of education, need to take their math teaching and learning process seriously. In order for students to be able to develop skills in mathematical communication, teachers should prepare their teaching mathematics as well as possible, which allows students to achieve their learning goals.

Mathematics is an abstract learning. Thus, students, especially at the elemantery school, need real objects in learning mathematics. By using real objects in learning mathematics, can help elementary students more easier to understand what they learn, because the material learned can be captured by all their five senses (Das, 2020; Saputra et al., 2020; Sari et al., 2020). This is because elementary school students are still at the phase of concrete operational development (Kurnia et al., 2019; Muslihatun et al.,

2019; Nugraheni, 2017). In this phase, students really need media or teaching aids in learning, especially in learning mathematics. Therefore, teachers at elementary school must use media or teaching aids that can help clarify what will be conveyed so that mathematics learning will be more easily understood by students (Purwandari & Wahyuningtyas, 2017; S. Rahayu & Hidayati, 2018). One of the interesting forms of mathematics learning media for students today is an electonic module or commonly known as e-module. E-modules is a learning media in which materials, methods, and evaluations are presented in an attractive and systematic way to achieve learning objectives that is displayed electronically using hard disks, CDs, flash drives or other book-reading tools (Darmaji et al., 2019; Nisa et al., 2020; Susanti et al., 2020).

This e-module is interesting because it takes advantage of advance communication technology. There are many benefits that can be taken by using e-modules in learning, including: first, helping students to learn independently, and enabling students to solve problems in their own way. Second, helping students to build their own knowledge so that their learning becomes meaningful. Third, helping students to solve learning problem when it has to be implemented online. Fourth, can be used or accessed by students anywhere and anytime (Asrial et al., 2021; I. Rahayu & Sukardi, 2020; Silalahi, 2020). In addition, the advantages of e-modules, namely: (1) clarifying and facilitating teaching material so that it is not too verbal; (2) increasing students' learning motivation; (3) students can learn according to their wishes, needs, and abilities; and (4) students can measure their abilities through the evaluation contained in the e-module (Aufa et al., 2021; Istuningsih et al., 2018; Mulyadi et al., 2020). Furthermore, learning mathematics for elementary schools does not only require interesting media or teaching aids; but also requires the use of the real world, namely the world that is close to the lives of everyday students. The approach to learning mathematics that uses the real world is known as the Realistic Mathematics Education (RME) approach. The Realistic Mathematics Education (RME) approach places reality and experience as the starting point during the learning process so that learning becomes more meaningful for students (Laurens et al., 2018; Purwitaningrum & Prahmana, 2021; Trimahesri & Hardini, 2019). The RME approach in learning makes students understand everyday situations or reality so that learning materials are easy to understand and meaningful (Kowiyah et al., 2019; Sumirattana et al., 2017). Thus, it can be concluded that the RME approach is a learning approach that uses the surrounding environment as a learning resource to make learning more relevant to students' daily lives so that learning becomes fun, easy, and meaningful. The findings of previous studies also state that e-modules make it easier for students to understand learning materials (Irwansyah et al., 2017; Lumbantobing et al., 2019; Matsun et al., 2019). Other research findings also state that e-modules can help students in independent learning (Asmi et al., 2018; Astalini et al., 2019; Subarkah et al., 2021).

Based on the description above, the purpose of this study is to develop a mathematics learning media in the form of an e-module for elementary school students that is able to improve students' mathematical communication skills. The e-module has interesting characteristics, namely: (1) it takes advantage of advances in communication technology so that it can be used or accessed anywhere and anytime; and (2) it uses a real mathematics learning approach, which is close to students' lives, so that the material is easily understood by students. Therefore, the researchers have developed a mathematics e-module based on RME approach to improve mathematical communication skills of elementary students. This study is a follow-up to previous research on the development of an elementary school mathematics e-module based on the RME approach to improve mathematical communication skills. Previous research was conducted to examined the validity and practicality of the developed e-module. This research was conducted to determined the effectiveness of the developed mathematics e-model. The proposed hypothesis is: the mathematical communication ability of students who use e-modules is better than students who use ordinary textbooks.

2. METHOD

This research is a follow-up to the results of the validity and practicality tests of mathematics e-modules that have been developed using the RME approach to improve the mathematical communication skills of elementary students. The development model used was the 4Ds model. There are four stages of a 4D development model, namely define, design, develop, and disseminate (Herayanti et al., 2017). At the previous study, the validity of the e-module was examined through expert judgment, and the practicality of the e-module was tested through individual, small and large group trials. This research examine the effectiveness of the e-module that has been developed. The study used a pretest-posttest control group design, and was carried out at two elementary schools in West Padang Regency. Students in the experimental class used the developed e-module, while students in the control class used an ordinary textbook. The number of samples was 50 students at fourth grade, consisting of 26 students at experimental

class and 24 students at control class. The two group of sample have equal abilities. The instruments used was an essay test that has been tested its validity and reliability. The question grid can be seen in Table 1.

Table 1. Mathematical Communication Ability Question Grid

Indicator of Mathematical Communication Ability	Question Indicator	Cognitive Level	Question Number
Expressing mathematical situations or everyday events in the form of mathematical models and solving them	Presented story problems in various forms of fractions, students can determine the fraction of the father obtained.	C4	1
	Presented story questions about percent, students can provide arguments about the statement.	C5	3
Expressing mathematical models (pictures) in plain language	Presented pictures of 10 books with 2 yellow books and 8 grey books, students can determine the yellow book fractions and their reasons.	C4	12
Give an explanation of the mathematical model and or pattern	Presented in the form of mixed fractions, students can describe mixed fractions.	C6	8
	Presented in the form of common fractions, students can determine the form of mixed fractions	C4	9
Prepare questions for the given situation with reasons	Presented decimal fraction data, students can make a story problem and the reason.	C6	4
	Presented story questions related to decimal fractions, students can provide arguments about the statements presented.	C5	5

Collected data were analyzed using t-test (comparing two averages score) and N-gain scores (to see the effectiveness of the developed mathematics e-module). The normality and homogenity of the data were examined first, before the data analysis was carried out.

3. RESULT AND DISCUSSION

Result

This study examines the effectiveness of the developed mathematics e-module based on the RME approach to improve the mathematical communication skills of elementary school students. The examination was carried out through the experimental pre-test post-test control group design. The hypotheses tested were: The mathematical communication skills of students who used e-modules based on the RME approach were better than students who used regular textbooks. Before the hypothesis is tested, the data were tested for homogeneity and normality first, and the results show that the data were homogen and normally distributed. The results of data analysis can be seen in Table 2.

Tabel 2. The Result of Data Analysis

	Pre-test		Sig	Post-test		Sig
	Experiment Class	Control Class		Experiment Class	Control Class	
Highest Score	61	53		95	88	
Lowest Score	40	42		70	67	
Mean	46.23	46.88		80.54	78.20	
Standart Deviation	4.063	3.002		5.722	5.959	
t-test Score	**-0.592**		**0.2**	**3.706**		**0.01**

Table 2 shows that in the pre-test, there is no significantly difference between the average score of the control class and the experimental class. In the pre-test, the average scores of the experimental class and the control class were 46.23 and 46.83, respectively. However, in the post-test, there was a significantly difference between the average score of the experimental class and the control class. The average scores of

the experimental class and the control class were 80.54 and 78.20 respectively. It means that there is a significantly difference in mathematical communication skills between students at the experimental class that used mathematical e-modul as teaching materials compare to students at the control class that used ordinary textbook. To see how effectively the developed mathematics e-module can be used during the learning process in grade IV, the researchers measured it using the N-gain value. The N-gain value is calculated based on the difference between the average pretest and posttest scores. In the experimental class, the score increased by 63.81%. The percentage increase in score at the class experiment is greater than the control class which only increased by 58.85%. Based on this result, it can be said that the learning mathematics carried out at the experimental class and at the control class ran smoothly and successfully, but the percentage increase in learning using mathematical e-module developed based on the RME approach was higher than using the ordinary textbooks.

Discussion

Based on the results of this study as well as previous studies, it was proven that the developed mathematics e-module is valid as an e-module based on the RME approach, practical for teachers and students to use, and effective in developing elementary school students' mathematical communication skills. The findings of previous studies also developed an innovative material and teaching approach using technology communication in learning of mathematics, such as e-module and video material for e-learning based on communication mathematics (Andini et al., 2018; Tse et al., 2019; Uyen et al., 2019). In their research, they concluded that the online materials they developed were effective in improving students' communication skills in mathematics. In addition, this study is also in line with the study found that learning mathematics based on the RME approach were effective in improving sdudents' mathematical communication skills (Faidah et al., 2019; Hidayat et al., 2020; Istikomah et al., 2020). The effectiveness of the developed mathematics e-module based on the RME approach in developing students' mathematical communication skills is very possible, because the material presented in the e-module is packaged in an attractive way, and explained using real-world examples. Learning mathematics using real examples is effective in developing mathematical thinking, reasoning, and communication skills of the students (Dewi & Izzati, 2020; Kowiyah et al., 2019; Paroqi et al., 2021). This makes students more active in learning and easier to understand the material presented (Buchori & Rahmawati, 2017; Hoyles et al., 2013). Especially the fractional material contained in the e-module. As Student learning becomes interesting and meaningful; students are motivated to learn it because students know what the use of the material they learn, and can apply it in everyday life (Darmaji et al., 2019; Ediyanto et al., 2020; Nisa et al., 2020).

In addition, the development of mathematics e-module based on the RME approach is in electronic form. This allows the material to be accessed or downloaded over the internet using a computer, or laptop, or smartphone; so that students can learn it anytime and anywhere repeatedly (Fonda & Sumargiyani, 2018; Ilmi et al., 2021; Seruni et al., 2020). Furthermore, mathematics e-modules based on the RME approach are an innovation in learning, and can be a solution for teachers in delivering subject matter online through existing applications, such as Google Classroom, Zoom Meting, and Google Meet (Istuningsih et al., 2018; Triwahyuningtyas et al., 2020). As it is known that during the current Covid-19 pandemic, students must study at home, so teachers need learning tools that are interactive, interesting, and easy for students to learn. The developed mathematics e-module is able to create interactive, fun, and meaningful learning (Hadiyanti et al., 2021). It can help students learn independently, without reducing the essence of the subject matter being taught, even though it must be done online. The findings of this study provide several potentially significant implications. Through the implemetation of e-modules based on the RME approach, it has provided skills to teachers in planning, organizing, and implementing online learning to improve students' communication skills in mathematics. Using e-module for teaching and learning can improve teachers competencies, especially teachers' techno- pedagogical skills (Buchori & Rahmawati, 2017; Fisnani et al., 2020; Sadimin Sadimin et al., 2017). In addition, through learning using e-modules based on the RME approach, it allows students to practice independent learning, as well as practicing specialized communication skills, such as solving complex problems, making comparisons, and logical explanations of mathematical concepts.

Although there are some advantages derived from using RME-based e-modules in developing students' mathematical communication skills; this research has some limitations. These limitations include: (1) the developed e-module based on RME approah is only focused on developing mathematical communication skills for fourth grade elementary school students through the topic of fractions with two basic competencies. For this reason, this e-module needs to be developed further with broader topics and basic competencies; (2) trials conducted to examine the effectiveness of this e-module are still very limited. E-module only implemented at two schools in two sub-districts in Padang City. For further ensure the effectiveness of this e-module, a wider trial is needed with different socio-cultural contexts. Based on these

implications and limitations, it is recommended for teachers to use a mathematics e-module based on the RME approach as teaching materials. This mathematics e-module has been proven to improve students learning outcomes, especially improving students' mathematical communication skills. In addition, it is recommended for other researchers to develop mathematics e-modules based on the RME approach with different topics, broder basic competencies, and for other grades or levels of educational.

4. CONCLUSION

The mathematics e-module developed based on the RME approach is effective for improving the communication skills of the elementary students. Students who are taught using e-modules based on the RME approach have better mathematical communication skills than those taught using regular textbooks. Thus, it is recommended for elementary school teachers to use mathematics e-module based on the RME approach that has been developed in learning fraction (both online and offline), especially for Grade IV elementary school students. Since there are some limitations of this study, it is also recommended for other researchers to develop mathematics e-modules based on the RME approach for different topics, grades, and levels of education.

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