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Development of Learning Devices Based on Contextual Teaching and Learning Models to Improve Mathematical Communication Ability and Self-Efficacy of Students of SMP Negeri 1 Medan

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Abstract
This study aims to: (1) analyze how the validity, practicality and effectiveness of mathematics learning tools developed using contextual-based learning were developed to improve students' mathematical communication skills and self-efficacy; (2) analyzing the improvement of students' mathematical communication skills using contextual-based learning tools that have been developed; and (3) analyzing the increase in students' self-efficacy using contextual-based learning tools that have been developed. This study uses a 4-D development model (define, design, develop, and disseminate) Thiagarajan, Semmel and Semmel (1974) by developing a learning device with a problem-based learning model. The research involved the subject of class VII students of SMP Negeri 1 Medan in the 2021/2022 academic year. While the object in this study is a learning device using the Contextual Teaching and Learning (CTL) model. The results showed that: (1) The learning tools based on the contextual teaching and learning model that were developed were declared valid, practical and effective; (2) in the first trial there was an increase in students' mathematical communication skills with the "moderate" criteria with a score of 0.41 (g 0.3) and in the second trial there was an increase in the score with the "medium" criteria with a score of 0.59 (0 ,3 < N-Gain 0.7). So it can be concluded that the learning tools based on the developed contextual teaching and learning model can improve students' mathematical communication skills; (3) the results of the students' self-efficacy questionnaire analysis in the first and first trials showed that there was an increase in students' self-efficacy abilities. In the first trial it showed that the average student self-efficacy was 81.36 with a standard deviation of 8.08, then in the second trial it showed that the student's average self-efficacy was 101.47 with a standard deviation of 9.28 . So it can be concluded that the learning tools based on the contextual teaching and learning model developed can improve students' self-efficacy abilities.
Kata Kunci: Mathematical Communication, Self Efficacy, Contextual Approach (Contextual Teaching and Learning)
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INTRODUCTION

As stated in the National Council of Teachers of Mathematics (NCTM, 2000) it is explained that communication is an essential part of mathematics education. This opinion implies that it is very important for students to have communication skills in mathematics and must be further improved, because mathematics has a role as a symbolic language that allows accurate and precise communication to be realized. The importance of communication in mathematics learning was proposed by NCTM (2000:63) which stated that school mathematics learning programs should provide opportunities for students to (1) compose and relate their mathematical thinking through communication; (2) communicate their mathematical thinking logically and clearly to their friends, teachers, and others; (3) analyze and assess mathematical thinking and strategies used by others; (4) use mathematical language to express mathematical ideas correctly.

One of the life skills that need to be developed through the educational process is mathematical communication skills. With communication skills students can exchange ideas in mathematics so that learning will be more meaningful. However, the reality is that students' mathematical communication skills are still not satisfactory. As Sri Asnawati (2018) said that "low mathematical communication skills will make it difficult for students to digest the questions given, while students who have good communication skills will easily take a step to solve a problem.

However, the reality of the conditions that characterize mathematics learning today is around the low quality or quality of mathematics education, which shows that the quality of education, especially in mathematics, is still low, which is indicated by Indonesia's low ranking at the junior high school level. Based on the data from the 2003 TIMSS study, Indonesia is ranked 35th out of 46 participating countries with an average score of 411, while the international average score is 467. The results of the 2007 TIMSS study, Indonesia is ranked 36th out of 49 participating countries with an average score - an average of 397, while the international average score is 500. And the latest results, namely the results of the 2011 TIMSS study, Indonesia is ranked

38th out of 42 participating countries with an average score of 386, while the international average score is 500 (IEA, 2014).

The problem of low mathematical communication skills is also experienced by students of SMP Negeri 1 Medan. Based on the tests given, it was found that students' mathematical communication skills were still very low. The test instrument given is in the form of story questions and is structured by considering the steps according to NCTM (2000), namely: (1) Ability to express mathematical ideas orally, and demonstrate and describe them visually; (2) The ability to understand, interpret, and evaluate mathematical ideas either orally, in writing, or in other visual forms; (3) The ability to use terms, mathematical notations and their structures to present ideas, describe relationships with situational models. Students' ability in writing is measured by students' ability to make alternative solutions. The test instrument was intended to see students' ability to measure mathematical communication skills. Students are expected to communicate by writing down the steps starting from drawing, mathematical expressions, writing.

From the test results, it was found that most of the students had not been able to solve the questions well. At this stage it is difficult to separate information into smaller and more detailed parts, students do not understand what the question wants so that students do not answer correctly. Students also have difficulty in understanding and making contextual models of the problem, students still cannot formulate mathematical ideas into mathematical models.

Overall, of the 36 students who worked on the questions above, only two students (5.56%) were able to complete the mathematical communication ability test well. Eleven students (30.55%) were not able to work on the problem at all on the grounds that they did not know how to solve it. Fourteen students (38.88%) were only able to make a sketch beforehand so they could determine the circumference in order to make a mathematical model. Nine (25%) chose a suitable strategy to interpret/read information from pictures based on ideas, thoughts and knowledge clearly and precisely. The researcher also conducted interviews with the students concerned about these difficulties, the result was that the difficulties felt by students were caused by several things, namely: (1) the material being tested had been passed so that students did not remember much of the material; (2) from the beginning the material was presented, not many students understood the material so it continued until the student went to grade. From the causes above, it causes students who are working on the questions to try to remember the steps to find the answer in question. Based on the analysis of the mathematical communication ability test and interviews with the students concerned, it can be concluded that learning so far has only explained the steps for simply counting without helping students to express ideas/ideas in oral and written form. In addition, students are still always focused on numbers, so that when a mathematical problem is presented in the form of a problem in the form of symbols or in-depth analysis, students are unable to solve it. So in this case students' mathematical communication skills still really need to be improved, or in other words mathematical communication skills are really needed.

In addition to seeing the importance of students' mathematical communication skills in learning, another aspect that becomes a problem is students' self-efficacy. Husnun (2017) explains that self-efficacy is a person's assessment of his ability to organize and carry out a number of behaviors that are in accordance with the performance he designed. Ulpah (2019) adds that self-efficacy is a student's consideration of his or her ability to achieve the desired or determined level of performance, which will influence subsequent actions. Furthermore, Widianawati (2017) adds that Self-efficacy is a person's belief about his ability to cope with various situations that arise in his life. The purpose of efficacy is related to individual beliefs about things that can be done with the ability possessed no matter how big. Low self-efficacy can occur because a person does not know his potential and the obstacles in developing that potential.

Based on the above, this CTL model can help teachers to prepare lesson plans according to the seven principles and can be used as teaching materials that facilitate students to construct knowledge. Based on these principles, students will carry out learning activities such as searching, processing, and finding more concrete learning experiences. This means that the learning process is an important thing that the teacher will see as a form of achieving learning objectives.

According to Komalasari (2009) that "learning tools are a form of preparation made by the teacher before carrying out the learning process. Therefore, the learning device must be prepared by the teacher before carrying out learning activities. This is supported by Trianto (2011) the success of a teacher in carrying out learning depends on his insight, knowledge, understanding, and level of creativity in managing learning tools. Good learning tools have valid, practical, and effective criteria. According to Nieveen (2007:26) there are criteria in determining the quality of learning device development results, namely: (1) validity (valid); (2) practically (practically) and (3) effectiveness (effective). So it can be stated that a quality learning device is one that meets these three aspects. The government, through Regulation of the Minister of Education and Culture Number 22 of 2016 concerning Standards for Primary and Secondary Education Processes, asks teachers to design lessons by preparing lesson plans, preparing learning media and resources, and learning assessment tools. Without learning tools it will be difficult for teachers to improve learning effectiveness. Likewise with students, without learning

tools students will have difficulty adjusting to learning. Learning devices are arranged to facilitate the learning process in order to achieve the competencies that must be mastered by students. According to Sutarti and Irawan (2017:4), they define development research as an attempt to develop an effective product for use in schools, and not to test theory.

METHOD

Research Pattern

Based on the formulation of the problem and the research objectives that have been set, this research is categorized into the type of development research. This study uses a 4-D development model (define, design, develop, and disseminate) Thiagarajan, Semmel and Semmel (1974) by developing a learning device with a problem-based learning model. This development is carried out to produce learning tools using the Contextual Teaching and Learning (CTL) model which will then be tested in the classroom using The One-Class Pretest-Posttest Design, by not using a comparison class but already using an initial test so that the magnitude of the increase in mathematical communication skills and student self-efficacy can be known with certainty.

Subject

The research involved the subject of class VII students of SMP Negeri 1 Medan in the 2021/2022 academic year. While the object in this study is a learning device using the Contextual Teaching and Learning (CTL) model.

Data Analysis

Instrument Validity Data Analysis

Before assessing the quality of the process and the quality of students' learning abilities in learning, the observation instruments and test instruments for students' mathematical communication skills that will be used are analyzed for reliability and test validity.

Analysis of the Validity of Questions and Questionnaires

Validity relates to the accuracy of the measuring instrument against the mastery of the concept being measured so that it actually measures what it is supposed to measure. The formula used to calculate validity is the product moment correlation formula, namely:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}}$$

(Arikunto, 2014: 213)

If $r_{hitung} > r_{tabel}$, it means that the correlation is significant, otherwise, the correlation is not significant. Then a test item is said to be valid if it meets the following criteria: $r_{hitung} > r_{tabel}$.

Data Analysis of Practicality of Learning Devices

Practicality of Learning Devices is measured based on the results of the observer's assessment to state whether or not the device can be implemented in the classroom using the provided learning tools (Intended-Operational or IO). The instrument used is an observation sheet on the implementation of learning devices that have been developed.

Analisis Data Keefektifan Perangkat Pembelajaran

- **Data Analysis of Mathematical Communication Ability Achievement**

The value of learning completeness per class or the percentage of classical completeness (PKK) is obtained by calculating the percentage of the number of students who complete individually. A class is said to have completed its learning, if the PKK is 80% (Trianto, 2011: 241). The percentage can be calculated by the formula:

$$\text{PKK} = \frac{Jumlah\ siswa\ yang\ telah\ tuntas\ belajar}{Jumlah\ seluruh\ siswa} \text{ x } 100\ \%$$

The criteria which state that students have mathematical problem solving skills if more or equal to 80% of students have mathematical communication skills with a minimum score of 75.

- **Analysis of Achievement of Learning Objectives**

To achieve the learning objectives used the formula:

$$\text{T} = \frac{Jumlah\ skor\ siswa\ untuk\ butir\ ke{-}i}{Jumlah\ skor\ maksimum\ butir\ ke{-}i}\ x\ 100\%$$ (Fauzi, 2002)

The criteria are:

$0\% \leq T < 75\%$: learning objectives have not been achieved

$75\% \leq T \leq 100\%$: learning goals achieved

The achievement of complete learning objectives is at least 75% of the learning objectives achieved by students.

- **Time Achievement Data Analysis**

This data is obtained by looking at the achievement of the time used in the learning process. If the achievement of time used during the learning process is efficient or does not exceed ordinary learning, then the achievement of time is said to be good.

Data from observations of student activities during learning activities were analyzed based on percentages. The percentage of student activity is the frequency of each aspect of observation divided by the total frequency of all aspects of observation multiplied by 100%.

- **Analisis Data Respon Siswa**

The data from the student response questionnaires were analyzed by presenting the students' positive and negative responses in filling out the student response questionnaire sheets which were calculated by the formula :

$$PRS = \frac{\sum A}{\sum B} \text{ x } 100\% \text{.....(Trianto, 2011 :243)}$$

Data Analysis to Analyze Students' Mathematical Communication Ability Improvement

The amount of increase before and after learning is calculated by the N-gain formula from Hake (1999) as follows:

$$Indeks\ Gain\ Ternormalisasi = \frac{Skor\ postest - Skor\ Pretest}{Skor\ Ideal - Pretest} \text{ (Hake, 1999)}$$

With the gain index criteria as shown in table 1. below:

Table 1. Normalized Gain Score Criteria

Score N-Gain	Interpretation
$g > 0{,}7$	Tall
$0{,}3 < g \leq 0{,}7$	Currently
$g \leq 0{,}3$	Low

Sumber: (Hake, 1999)

Data Analysis Techniques To Analyze Self-Efficacy Improvement

Data analysis to find out how students' self-efficacy before and after learning using learning tools that have been developed can be obtained from the data from the results of giving student self-efficacy questionnaires which then determine the average score, standard deviation and determine grouping (high, medium and low).

Data Collection Instruments and Techniques

The learning device validation sheet is used to obtain data about the quality of the learning device based on the assessment of the experts. All validation sheets in this study were developed and adapted to the contextual-based learning tool development model to improve mathematical communication skills and self-efficacy.

Validation carried out by several experts on the learning device was carried out before the device was used. There will be at least 5 (five) people who have the competence to act as validators in this study. The 5 (five) validators will assess and provide input and suggestions for the learning tools that are prepared. Validation sheet for the Learning Implementation Plan, Teacher's Manual, Student Book and Student Activity Sheet.

To obtain data on students' mathematical communication skills, a test is given after learning takes place using a mathematical communication ability test. This Student Self-Efficacy Ability Instrument is useful for capturing student self-efficacy data. The form of this instrument is a questionnaire consisting of 30 questions. The scoring technique for this instrument uses a Likert scale. There are grids and scoring techniques for students' self-efficacy. Student response questionnaire is the percentage of student responses to the components and tools of learning mathematics developed. These student responses were netted with a student response questionnaire sheet by placing a check (√) mark in the column provided for each question posed. This questionnaire was used to obtain data about the level of readability of students' books and student responses.

RESULT

Description of the Validity of Learning-Based Devices (Contextual Teaching and Learning)

Learning devices are said to be valid if from the expert's/practitioner's assessment the learning tools developed meet the valid criteria and have a percentage of the feasibility of learning tools of 60%. In the following, it will be explained how the analysis of the validity of learning tools based on the Contextual teaching and learning model that was developed will be explained.

The analysis of the validity of learning tools based on the Contextual teaching and learning learning model developed in terms of the assessment of the learning device experts/practitioners shows the results with valid criteria. The expert's assessment has been explained previously at the development stage regarding the validation results from the validators, where the results show that the learning tools developed are declared valid with an average value of 4.3 "valid" categories. Based on this analysis, it can be said that the learning tools developed

are valid and ready to be used in learning.

Description of Practicality of Learning Devices Based on Contextual Teaching and Learning Models

Based on the results of the assessment of the experts (validators), all validators stated that the learning tools developed were suitable for use with minor revisions. This is supported by the opinion of Akker (2007: 66) which states that the criteria for the practicality of learning tools are said to be practical if the validator assesses that what is developed can be applied. This is in line with the research of Annisa, Putra, and Dharmono (2020: 78) which states that the practicality of learning devices is important to know because one of the requirements for learning devices is that they are easy to use by users.

Then, through the observation sheet on the implementation of learning using interactive learning tools based on the developed contextual teaching and learning learning model which was given to two observers at each trial meeting I and II, in the first trial it was found that the score for observing the implementation of learning did not meet the practical criteria. namely with a score of 2.75 with the category of being carried out less well. Furthermore, in the second trial, a score of 3.86 was obtained with the category carried out well. This is supported by the opinion of Akker (2007: 66) which states that the criteria for the practicality of learning devices are said to be practical if the results of observations of learning devices in the classroom are included in the good or very good category.

Description of the Effectiveness of Learning Tools Based on Contextual Teaching and Learning Models

Student Mathematical Communication Ability Test Achievement

Based on the results of the test analysis in the first and second trials, it was found that the students' mathematical communication skills had met the classical completeness criteria. This is due to the materials and problems that exist in the learning devices developed in accordance with the conditions of the student learning environment. By using this learning tool, students will more easily understand the material of flat shapes (squares and rectangles). The achievement of the final test of students' mathematical communication skills in the first trial was 61% with a total of 20 students who were declared complete. So, it can be concluded that in the first trial the application of learning tools based on the contextual teaching and learning model developed did not meet the criteria for achieving classical completeness (>80%). However, in the second trial, the achievement of the final test of students' mathematical communication skills had met the specified criteria, namely 88% with a total of 30 students who were declared complete. Thus, it can be said that the learning tools based on the contextual teaching and learning model have met the effectiveness criteria in terms of achieving students' mathematical communication skills.

This is supported by the research of Sonda, Alimuddin, and Asdar (2016) which states that the learning effectiveness criteria in terms of N-gain scores are in the medium category and classical student completeness is more than 80%. With the application of learning tools developed by teachers in the early stages of learning and as long as they complete their assignments, students will be more active in handling their learning tasks which results in more effective learning carried out and has an impact on classical student learning completeness. Based on the results of the research, and the results of previous studies above, it can be concluded that the learning tools based on the contextual teaching and learning model developed have met the indicators of effectiveness in terms of student learning completeness from the achievement of students' mathematical communication skills tests.

Deal Time Achievement

Based on the analysis of the results of observation of student activity in the first trial, the average percentage of student activity deal time achievement for the three meetings in the trial was 20.63%, 19.59%, 19.93%, 23.43%, 7.34 % and 9.09%. Meanwhile, in the second trial, the average percentage of student activity deal time achievement for the three meetings was 22.57%, 18.40%, 23.26%, 23.26%, 7.29% and 5.21%. Based on these data, it can be concluded that all student activities in the second trial meet the specified deal time percentage.

Increased student activity during learning occurs because of the application of learning tools based on the contextual teaching and learning model, Sanjaya (2014) explains that contextual teaching and learning is learning that emphasizes the process of full student involvement to be able to find the material being studied and relate it to the situation. real life so as to encourage students to be able to apply it in their lives. The contextual learning approach places students as learning subjects, students who play an active role in the learning process by finding and exploring their own understanding of the subject matter. This is in line with research conducted by Munawir (2017) that in the application of the contextual teaching and learning learning model, student activities are in the very good category.

Student Response

Based on the analysis of the results of student responses that have been described previously, it was found that in

the first trial and trial, students were interested in the learning tools developed. This can be seen from the average score of student responses showing interest in learning with the learning tools developed. Judging from the student response questionnaire scores in the first trial of 80% and in the second trial of 91%. So it can be concluded that from student responses to interactive learning tools based on the effective developed contextual teaching and learning learning model. According to Ismail, Abrar, Nur, Suharti and Halimah (2021) the application of learning tools based on the contextual teaching and learning model received a positive response from students. Furthermore, the results of research by Nuraeni Indrayanti and Sukmaningthias (2021) that student responses to the application of learning tools based on contextual teaching and learning obtained an average score of 3.29 or in the positive category.

From the description of all aspects of the effectiveness of the learning tools above, it can be concluded that the learning tools based on the contextual teaching and learning model that were developed are effective for use in learning on flat (square and rectangular) materials to improve students' mathematical communication skills.

Improving Students' Mathematical Communication Ability

Based on the results of the analysis of students' mathematical communication ability tests in the first and second trials, it showed that there was an increase in students' mathematical communication skills. Based on the average normalized gain, it was found that in the first trial there was an increase in students' mathematical communication skills with the "medium" criteria with a score of 0.41 ($0.3 < g \leq 0.7$) and in the second trial there was an increase in the score with the criteria “medium” with a score of 0.59 (0.3 < N-Gain 0.7). So it can be concluded that the learning tools based on the developed contextual teaching and learning model can improve students' mathematical communication skills.

The results of this study are strengthened by several previous studies, namely the research conducted by Nurmala, Hidayat and Hendriana (2018) in a study to improve students' mathematical communication skills through the CTL approach and obtain results: this study aims to examine the results of the effect of the CTL approach on increasing mathematical communication skills. student. From the results of the study, both from the results of data analysis and hypothesis testing, it can be concluded that the increase in mathematical communication skills of students who learn using the CTL approach is better than those who use conventional learning.

Improving Student Self-Efficacy

Based on the results of the students' self-efficacy questionnaire analysis in the first and second trials, it showed that there was an increase in students' self-efficacy abilities. The trial showed that the average student self-efficacy was 81.36 with a standard deviation of 8.08, then the second trial showed that the student's average self-efficacy was 101.47 with a standard deviation of 9.28. The results of this study are strengthened by the results of previous studies, namely the research of Amir and Mulyani (2019), that the contextual teaching and learning learning model has an effect on students' self-efficacy. So it can be concluded that the development of learning tools based on contextual teaching and learning models can improve students' self-efficacy abilities.

CONCLUSION

The learning device based on the contextual teaching and learning model developed was declared valid in terms of the validity results by the expert who stated that the learning device consisted of: (1) the average validation result of the learning implementation plan was 4.3, (2) the average validation result of the Student's Book is 4.3, (3) the validation result of the average Teacher's Book is 4.27, (4) the validation result of the average Student Worksheet is 4.27, (4) the average validation result The average mathematical communication ability test and self-efficacy questionnaire can be used with minor revisions.

Learning devices based on the contextual teaching and learning model that were developed meet the criteria for the practicality of learning devices in terms of the analysis of the results of observing the implementation of learning. The score obtained in the first trial was 2.75 (category "poorly implemented") and did not meet the criteria for research success. However, after making several revisions, in the second trial the learning implementation observation score increased to 3.86 (category "Well implemented"). So that the learning tools developed successfully meet the criteria of practicality.

The learning tools based on the developed contextual teaching and learning learning model have met the effectiveness criteria in terms of: (1) In the second trial it was 88% (30 students); (2) the learning time used does not exceed the usual learning time set by the school. (3) student responses in the first trial were 94%;

Based on the normalized gain index, it was found that in the first trial there was an increase in students' mathematical communication skills with the "moderate" criteria with a score of 0.41 (g 0.3) and in the second trial there was an increase in the score with the "medium" criteria with a score of 0. .59 (0.3 < N-Gain 0.7). So it can be concluded that the learning tools based on the developed contextual teaching and learning model can improve students' mathematical communication skills.

Based on the results of the student self-efficacy questionnaire analysis in the first trial and the first trial, it showed that there was an increase in students' self-efficacy abilities. In the first trial it showed that the average student self-efficacy was 81.36 with a standard deviation of 8.08, then in the second trial it showed that the student's average self-efficacy was 101.47 with a standard deviation of 9.28 . So it can be concluded that the learning tools based on the contextual teaching and learning model developed can improve students' self-efficacy abilities.

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