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DEVELOPMENT OF TEACHING MATERIALS BASED ON GUIDED INQUIRY LEARNING MODEL TO IMPROVE STUDENT'S MATHEMATIC COMMUNICATION ABILITY

Winanda Marito[1], Nova Riani[2]
[1,2] Universitas Pembinaan Masyarakat Indonesia
Email : ndha62@gmail.com[1], novarianiharahap@gmail.com[2]

ABSTRACT
The product of this research is a teaching material that meets the valid and effective criteria in the form of Student Worksheets (LKS), and Mathematical Communication Ability tests which are designed based on the Guided Inquiry learning model to improve students' mathematical communication skills. The development model used is a 4-D model consisting of four stages, namely defining, designing, developing and distributing. This research was conducted in SMP Karya Bhakti Medan. The population of this study were all students of SMP Karya Bhakti Medan which consisted of 156 people spread over 7 parallel classes.
Keywords: Development of teaching materials, guided inquiry, mathematical communication skills

1. Introduction

Entering the 21st century paradigm, the world of education has experienced a shift marked by differences in learning orientation. If in the previous century learning emphasized reading, writing, and mathematical literacy, in the 21st century these three became the basic capital for developing new literacy, namely human, data, and technological literacy which are very important to face the current and future globalization era. Muhali 2019). To be able to face these challenges, the government and all aspects involved in education continue to make changes to improve the quality of education in Indonesia. The teacher as a professional and who plays an important role in the learning process must continue to innovate in improving the quality of the learning process in the classroom.

Teaching materials as learning resources need to be considered in the activities of the teaching and learning process. Teaching materials are the most important components that can determine the success of learning in the classroom which must be prepared by the teacher before carrying out learning activities in the classroom. According to Pannen Teaching materials are materials or subject matter that are systematically arranged that are used by teachers and students in the learning process (Magdalena et al. 2020). Teaching materials must have a systematic structure and sequence, explain the instructional objectives to be achieved, motivate students to learn, anticipate learning difficulties, provide training opportunities for students, are generally oriented to individual students (learner oriented), and teaching materials independent.

Designing teaching materials is an ability that must be possessed by teachers, in order to be able to create a quality learning process so that varied and meaningful learning can be created for students. However, the facts in the field are based on observations made at the Karya Bakti Middle School in Medan and the Al-Washliyah Middle School in Medan Ampera, the teaching materials used by the teacher are teaching materials in the form of ordinary mathematics textbooks containing routine questions, and Student Worksheets (LKS) which have been provided in the field. schools, so that teachers are not accustomed to making or designing their own teaching materials which include Teacher's Books (BG), Student Books (BS), Student Worksheets (LKS), as well as learning designs that raise problems to improve students' mathematical abilities but are still interesting for students. students, so that the learning that takes place tends to be ordinary learning. The purpose of compiling teaching materials is the achievement of the objectives of a learning in this case is learning mathematics.

Mathematical communication ability according to the National Council of Teacher Mathematics (NCTM) is a basic mathematical competence that is essential for mathematics and mathematics education. Without good communication, mathematical development will be hampered (Anderha and Maskar 2020). The communication process also helps build meaning and permanence for ideas and

makes them public. When students are challenged to think and reason about mathematics, and to communicate the results of their thinking to others orally or in writing, they learn to be more convincing. Students gain insight into their thinking when presenting their methods for solving problems, when justifying what they think to a classmate, teacher, or when they formulate a question about something that is confusing.

However, in reality, based on observations made at the Karya Bakti Middle School in Medan by giving rectangular material questions using mathematical communication indicators, it was found that students' mathematical communication skills were still low from the 24 students who were given a mathematical communication ability test, there were 7 students who completed with completeness. classically 29.17% with an average value of 2.27. This means that students' mathematical communication skills are not in line with existing expectations.

The learning model is the whole series of presentations of teaching materials which includes all aspects before and after learning by the teacher as well as all related facilities that are used directly or indirectly in the teaching and learning process (Istarani 2012). What is meant must have conditions, among others, can make students able to construct knowledge, can make students independent in learning, can increase student interaction, can train students to communicate their ideas and make learning more meaningful. With these characteristics, it is hoped that the learning model will result in increasing students' mathematical communication skills.

The Guided Inquiry learning model emphasizes manipulating objects and other experiments, before arriving at generalizations in which students are actively involved in it. This means that through this learning, students are expected to be able to communicate the things that they have understood and what are in their minds to build the knowledge that will be obtained. In line with the opinion (Hakiqi Erintias, Rini, and Djalil 2016) which states that the Guided inquiry learning model is one of the teaching models designed to teach communication and relationships between communications. When using this learning model, the teacher presents examples to students, guides them as they try to find patterns in the examples, and provides a kind of closing when students have been able to describe the ideas taught by the teacher. In this guided inquiry learning model, the teacher has provided instructions regarding the material to be taught to students as necessary. These instructions can be in the form of questions so that students are able to find or seek information on their own about the question or the actions given by the teacher that must be taken to solve the problem. This teaching can be done independently or in groups (Lestari and Irawati 2020). The syntax of the guided inquiry learning model according to Kuhlthau is: (1) Problem Submission; (2) Formulating Hypotheses; (3) Designing Experiments; (4) Collecting Data; (5) Testing the Hypothesis; (6) Making Conclusions; (7) Submission of Results; (8) Reflecting (Trisianawati and Darmawan 2018).

2. Research Methods

This research is a development research using Thiagarajan 4-D development model. The population of this study were all seventh grade students of SMP Karya Bhakti Medan which consisted of 156 people spread over 5 parallel classes.

The development of learning devices in this study refers to the model of developing teaching materials according to (Thiagarajan 1974) namely the 4-D model (four D models) which consists of 4 stages, namely the defining stage, the planning stage (design), and the development stage.) and the dissemination stage. The process can be seen in the image below.

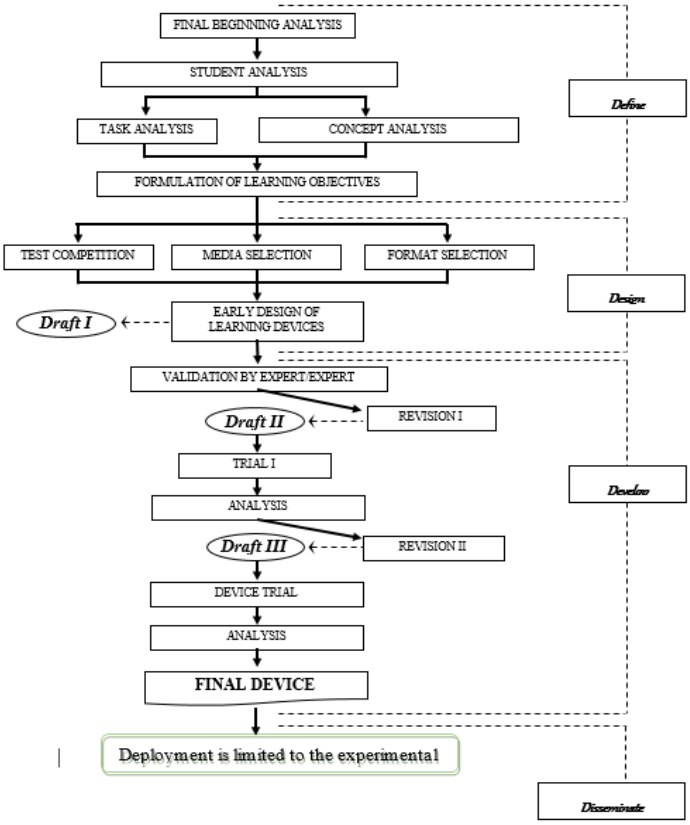

Figure 1. Teaching Material Development Process

1. Validation of Teaching Material Data

a. Student Worksheet Validation (LKS)

Content validation is based on the opinion of five (5) experts in the field of mathematics education. By using the following formula.

Average score = Total score obtained/Many aspects of observation

Information :

$1{,}00 \le x < 1{,}50$: means "Invalid"

$1{,}50 \le x < 2{,}50$: means "Invalid"

$2{,}50 \le x < 3{,}50$: means "Sufficiently Valid"

$3{,}50 \le x < 4{,}50$: means "Valid"

$4{,}50 \le x \le 5{,}00$: means "Very Valid"

b. Instrument Validation Mathematical communication ability test

Content validation is based on the results obtained by students after evaluation in the form of giving tests and rating scales. Based on the results of the student's answers, the level of validation of the test items and the assessment scale will be determined using the product moment correlation with the following formula (Arikunto 2021):

$$r_{xy} = \frac{\sum XY - \left[\left(\sum X\right) - \left(\sum Y\right)\right]}{\sqrt{n\sum X^2 - \left(\sum X\right)^2\left[n\sum Y^2 - \left(\sum Y\right)^2\right]}} \quad .....$$

with : n = number of students

X = Total score of questions
Y = total score of students

The interpretations of being divided into categories according to Guillford are presented in table 1.

Table 1. Classification of Validity Coefficients

Correlation coefficient	Interpretation
$0,90 < r_{xy} \leq 1,00$	Very High Validity
$0,70 < r_{xy} \leq 0,90$	High Validity
$0,40 < r_{xy} \leq 0,70$	Medium Validity
$0,20 < r_{xy} \leq 0,40$	Low Validity
$0,00 < r_{xy} \leq 0,20$	Very Low Validity
$r_{xy} \leq 0,00$	Invalid

Then the next step is to look at the reliability of the test using the formula (Arikunto 2021):

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum \sigma^2}{\sigma^2}\right)$$

n = number of test items
σ = total variance

To calculate the variance of the data used the formula:

$$\sigma^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{N}}{N}$$

where: X = the value of each item
N = number of students taking the test

The interpretation of the reliability coefficient of the test used is the interpretation of the degree of reliability of the instrument made by J.P Guilford as follows:

Table 2. Interpretation of the Reliability Coefficient

Reliability Coefficient	Interpretation
0.80 r11 1.00	Very high reliability
$0,60 \leq r_{11} < 0,80$	High Reliability
$0,40 \leq r_{11} < 0,60$	Medium reliability
$0,20 \leq r_{11} < 0,40$	Low reliability
$r_{11} < 0,20$	Very low reliability

1. Effectiveness of Teaching Materials

a. Mathematical Communication Ability Level

The category of mathematical ability level with reference to the communication skill level scale with the range of values in the 2013 curriculum is as follows:

Table 3 Value Range

NO.	SCORE	NILAI	KATEGORI
1	$0.00 \leq$ score $\leq 1,00$	D	**Low**
2	$1,00 <$ score $\leq 1,33$	D +	
3	$1,33 <$ score $\leq 1,66$	C -	
4	$1,66 <$ score $\leq 2,00$	C	

NO.	SCORE	NILAI	KATEGORI
5	2,00 < score ≤ 2,33	C +	
6	2,33 < score ≤ 2,66	B -	
7	**2,66 < score ≤ 3,00**	**B**	**Currently**
8	3,00 < score ≤ 3,33	B +	
9	3,33 < score ≤ 3,66	A -	**Tall**

Based on the data in the table above, the level of students' mathematical communication skills is low if 0.00 < 2.66, if categorized as moderate 2.66 Tes < 3.33, if categorized as high 3.33 Tes < 4 ,00, where the score of individual students is the number of scores obtained by students divided by the maximum score and multiplied by 4. Furthermore, classically, that a lesson is considered complete, 80% of students who take the test have achieved a minimum score of 2.66

b. Student Active Activities

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% or,

$$Percentage\ of\ student\ activity\ = \frac{\text{Frequency of each aspect of observation}}{\text{the sum of the frequencies of all aspects of observation}} \text{ x } 100\ \%$$

Determination of the criteria for the effectiveness of student activities based on the achievement of the ideal time specified in the preparation of lesson plans for a problem-based learning approach, as shown in table 4 below:

Table 4. Percentage of Ideal Time for Student Activities

Category Aspect	Ideal Time	PWI Tolerance Interval	Ideal Criteria
a. aListening/paying attention to teacher/friend explanations	25 % dari WT	20 % ≤ PWI ≤ 30 %	Three of a, b, c, d, e are satisfied and c, d must be satisfied
b. Reading student books and worksheets	15 % dari WT	10 % ≤ PWI ≤ 20 %	
c. Take notes from teacher explanations, take notes from books or from friends, solve problems on worksheets, summarize group work	30 % dari WT	25 % ≤ PWI ≤ 35 %	
d. Discuss/ask between students and their friends, and between students and teachers, draw conclusions about a procedure or concept	30 % dari WT	25 % ≤ PWI ≤ 35 %	
e. Doing something that is	0 % dari	0 % ≤ PWI ≤ 5 %	

Category Aspect	**Ideal Time**	**PWI Tolerance Interval**	**Ideal Criteria**
not relevant to learning	WT		

Source: Modified from (Sinaga and Nababan 2008)

Information:
PWI : ideal time percentage
WT : time available at each meeting

The criteria for achieving the effectiveness of student activities in learning are the average percentage of student activities from all meetings for the six indicators that meet the criteria for achieving tolerance limits for time effectiveness. With a note that indicator 3 may be less than the tolerance limit criteria for achieving time effectiveness, but it should not be more than the tolerance limit criteria for achieving time effectiveness.

c. Teacher's Ability to Manage Learning

The activities carried out to analyze the data on the teacher's ability to manage learning are as follows (Sinaga and Nababan 2008):

$$NK_j = \frac{\sum_{i=1}^{n} NRK_{ij}}{n}$$

Information:
NK_j is the value of the jth category.
NRK_{ij} is the average value of the i-th criteria, j-th and aspects
n is the number of criteria in the jth aspect

The results obtained are then written in the appropriate column in the table. Finding the average category value with the formula (Sinaga and Nababan 2008):

$$NKG = \frac{\sum_{i=1}^{m} NK_i}{m}$$

Information:
NKG : teacher ability score (mean category score)
NKj : jth category value.
m : the number of aspects of the assessment

Furthermore, the average category value (NKG) is referred to at the interval determining the level of teacher ability to manage learning with teaching materials developed based on the Guided Inquiry model as follows.

1 NKG < 2 not good
2 NKG < 3 not good
3 NKG < 4 quite good
4 NKG = 4 good

Information:
NKG: the teacher's ability score

The criteria stating that the teacher is able to manage learning with teaching materials developed based on the Guided Inquiry learning model is the level of achievement of the teacher's ability to manage learning at least quite well.

d. Descriptive Analysis of Student Response Data

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

$$\text{Respond to each aspect} = \frac{\text{the number of students responding to certain aspects}}{\text{total number of students}} \times 100\%$$

At least 80% of the many trial samples (in each trial) gave a positive response to the components and learning activities

3. Results and Discussion

The teaching materials based on the guided inquiry learning model have been valid and effective and are feasible to use. The discussion of the following research results will describe the description and interpretation of the validity and effectiveness of the teaching materials developed, mathematical communication skills, active student activities, teacher's ability to manage learning, and student responses. The factors involved in the research are development factors, learning factors and students' mathematical ability factors.

1. Validity and Effectiveness of Developed Teaching Materials

a. Validity of Developed Teaching Materials

The teaching materials developed in this study were Student Worksheets (LKS) and students' mathematical communication skills tests. All teaching materials have gone through a validation process by the validator. The total average validation value for LKS is 4.5 and is in the valid category. Although the teaching materials developed have met the criteria for validity, there are several things that must be corrected according to the notes provided by the validator including content, language and constructs, and linkages with the phases of the guided inquiry learning model with the teaching materials developed. So, based on the results of the notes from the validators of this teaching material, it has met the criteria for validity in the "valid" category with a slight revision note. Furthermore, revisions were made to the teaching materials according to suggestions from the validator.

While the results of the validation by the validator for the mathematical communication ability test showed that this test met the criteria for content validity. The mathematical communication ability test consists of 9 test items. Furthermore, statistical validation was carried out in trial 1 in the form of giving tests to students to see the validity of the test items. From the results of statistical validation, it was obtained that 5 pretest items and 6 posttest items met the valid criteria. Furthermore, the pretest and posttest questions were selected, each with 5 questions to be used in trial 2.

The fulfillment of the validity aspect is in line with Akker's opinion which states that validity refers to the extent to which the design of the device is based on the latest state of technology, art, or science ('content validity') and the various components of the device are consistently related to each other ('construct validity'). '). Giving teaching materials to validators is part of content validation while field trials are part of construct validation (Marito 2015).

b. Effectiveness of Teaching Materials

1) Achievement of Students' Mathematical Communication Ability Level

Based on the results of the data analysis of trials 1 and 2 regarding the achievement of the level of mathematical communication skills, the results showed that in the posttest trial 1 there were 15 students in the medium value category and 8 students in the high score category, so that the percentage of students who obtained more or the same with a value of 2.67 which is 76.67%. The results of this posttest did not meet the established effective criteria, therefore trial 2 was carried out as a process of improving learning tools and reflecting on learning practices. While in the posttest trial 2 there were 5 students who were in the medium value category and 21 students who were in the high category, so that the percentage of the number of students who were more or equal to getting a score of 2.67 was 86.67%. In this case, the level of students' mathematical communication skills has met the specified criteria. So it is concluded that the teaching materials developed have met the effective criteria.

2) Student activities

Based on the results of the data analysis of trials 1 and 2 about student activities, it was found that in trial 1 there were 4 categories of activities that had met the specified criteria and there was 1 category of activities that did not meet, namely the category of student reading activities and worksheets. However, trial 1 still met the effective criteria, because the category of student reading activities and student worksheets were not included in the ideal criteria. While in trial 2, the category of student activity in reading student books and student worksheets has increased even though it is still less than the lower limit of the ideal time. However, this 2nd trial has met the effective criteria, so it can be concluded that the teaching materials developed have met the effective criteria.

3) Teacher's Ability to Manage Learning

The overall average ability of teachers to manage learning in trial 1 is in the "good enough" category, this category has reached the minimum criteria of the average teacher's ability to manage learning. This means that in the first trial the teacher's ability has been effective. However, in trial 2, the average teacher's ability to manage learning was in the "good" category. So that the overall average has reached the minimum criteria set and the teacher's ability to manage learning can be said to be effective

4) Student response

This criterion is met if 80% of students give a positive response to teaching materials and learning activities. Based on the results of the data analysis of trials 1 and 2 regarding student responses, it was found that the average percentage of students' total positive responses in trial 1 was 94.60%. So it can be concluded that the student's response to the components and learning activities using teaching materials based on the guided inquiry learning model has been effective. However, because the effective criteria have not been met in trial 1, trial 2.

The results obtained about student responses are the average percentage of students' total positive responses in trial 2 of 97.60%. If the results of this analysis are referred to the criteria set out in Chapter III, it can be concluded that students' responses to the components and learning activities based on the guided inquiry learning model have met the effective criteria.

4.Conclusions

Based on the results described above, the teaching materials developed were valid and effective and could be distributed. In this study, the dissemination phase was carried out on a small scale at the Karya Bhkati Middle School in Medan. These teaching materials are expected to be able to contribute to the school and can motivate teachers to further develop their own teaching materials according to the needs of students at school.

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