Design Student Worksheets Based on Problem- Learning to Enhance Mathematical Communication

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DOI: https://doi.org/10.37134/ajatel.vol9.no2.2.2019

Published: 18 August 2019

Abstract

Mathematical communication ability is one of the abilities that must be possessed by students in 21st century learning. Worksheets of students who have not yet integrated mathematical abilities will hinder the achievement of learning objectives. Problem based learning is a model that can improve mathematical communication skills. This study aims to design mathematics student worksheets of problem-based learning models to improve mathematical communication skills. This research is a type of development research with the ADDIE model. This research focused on the design stage of ADDIE model. The subject of this study consisted of teachers and students of MTs Class VIII, Seleman, Indonesia. The instrument of data collection consists of observation guidelines, interview guidelines and documentation sheets. Observation guidelines are used for the characteristics of students' mathematical communication. The interview guide used to retrieve student characteristics data from the teacher's perspective during the learning process. The documentation sheet manual used to view curriculum implementation data that apply in the school. The data were analyzed by using quantitative data with the provisions of the Likert scale. Producing design products in the form of student worksheets as learning media, the quality of the design is "very good" with a score of 4.36. An average score of 4.08 by filling in the LKS design, 4.33 LKS design languages and 4.5 technical aspects. This study resulted in the design of student worksheets of problem-based learning models according to the needs of students. Student worksheets are designed to improve students' mathematical communication skills.The results of the study show that the quality of the design products produced based on the validity and the student worksheets met the criteria well. This research can be expanded at the stage of developing, implementing and evaluating.

Keywords: *Design of student worksheets, mathematical communication, problem-based learning*

INTRODUCTION

Mathematical communication is a way of sharing ideas and clarification of Understanding (NCTM. 2000). Accurate communication is vital to enable students to understand the processes, discussions, and decisions made (Viseu & Oliveira. 2017). Written precise communication is the intellectual activity that requires students to express their mathematical ideas or thoughts in writing (Pantaleon et al., 2018). Mathematical communication skills both oral and written can bring students to a deep understanding of mathematics. 21st-century skills consist of four main domains namely digital age literacy, inventive thinking, effective communication and high productivity (Turiman et al., 2012). The results of the study (Osman & Marimuthu, 2010) the skills found in the 21st century is one of them. Namely mathematical communication is critical and relevant to ensure that students are ready for a better future.

The National Mathematics Teachers Council (NCTM) states that learning programs in kindergarten to high school must give students the opportunity to: Organize and consolidate mathematical ideas and ideas by communicating them; Communicate their accurate thoughts logically and clearly to their friends, teachers, and others; Mathematical analysis and evaluation of other people's mathematical views; and using precise language to express the right idea (NCTM, 1989). The results of

the study (Lim & Chew, 2007) the importance of accurate communication in learning and learning mathematics.

But it is unfortunate, even though mathematical communication skills are, but there are still few students who have these abilities. Based on the results obtained by Indonesian students at the TIMSS event, it was seen that Indonesian students were still weak concerning mathematical communication, as happened with students' answers to one of the questions about reading data in a pie chart and presenting it in the form of bar charts (TIMSS, 2007).

Mathematical communication can be interpreted as the ability of students to convey something that they know through an event of dialogue or reciprocal relations that occur in a classroom environment, where there is a transfer of messages. Deleted messages contain mathematical material that studies, concepts, formulas, or problem-solving strategies (Rahmi et al., 2017). Communication mathematics is a dimension that is indispensable in teaching mathematics (Kaya, & Aydin. 2016). One effort that can be done by educators to develop students 'mathematical communication skills is by designing student-centered learning activities so that students' mathematical communication skills, both verbally and in writing, can be facilitated well. This is in line with the opinion (Lee, 2006) which states that to develop mathematical communication skills, what educators can do is change the way students interact with their work and other students. The first step we must take is to choose a learning model or strategy that is suitable for the goals to be achieved.

Problem Based Learning is student-centered learning (Bergstrom et al., 2016). Problem-based learning not only fosters the development of content knowledge, but also various skills, such as communication and collaboration skills, problem-solving, decision making, critical thinking, and independent learning (Wilder, 2015).

Student worksheets are guides used by students to carry out learning activities (Inan & Erkus. 2017). Student worksheets are created to help students connect problems with subject matter with everyday life (Yaden. 2017).

Learning with student worksheets allows students to learn more quickly to complete one basic competency (KD) or more, because students can learn it first, and student worksheets developed contain material and are rich in practice questions that will guide students in finding concepts, so that the student worksheets provided can direct students to solve mathematical problems related to real life.

Student worksheets are used because they are shorter, more comfortable and summarize the material along with questions to be able to help students in mathematical communication skills (Ruri et al., 2018). Student worksheets have not been widely used by teachers in most secondary schools in Pekanbaru (Murni & Anggraini. 2018).

Based on the identification of the problems above, the formulation in this study is the design of student worksheets with PBL models for class VIII MTS students on statistical material. Based on the wording of the problem, the purpose of this study is to improve students' mathematical communication.

METHODS

This research is design development research, developing student worksheets based on the problem-based learning method. The model used in this study is ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The ADDIE model can be seen in **Figure 1**.

Development procedures include analyzing, designing, developing, implementing, and evaluating. This research is limited only to the design stage to determine the design of student worksheets using the problem-based learning method to improve scientific communication. The subject of this study consisted of teachers and students of MTS Class VIII, Seleman, Indonesia. The instrument of data collection includes of observation guidelines, and documentation sheets. Observation guidelines are used for the characteristics of students' mathematical communication. Interview guidelines are used to see the need for teaching materials from teachers on PBL-based student worksheets. The documentation sheet manual is used to view data on the implementation of the curriculum, learning.

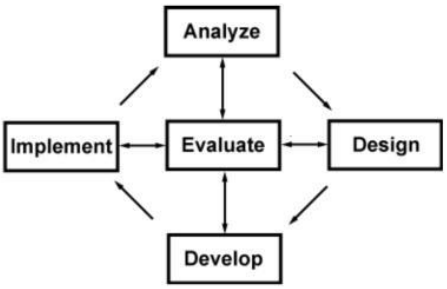

Figure 1. ADDIE model (Afifah & Suparman, 2018)

Materials and teaching materials that apply in the school. Qualitative techniques analyzed data. In this study validity data obtained from the results of the validator's assessment. The following is an explanation of data analysis techniques from the validity of student worksheets. Quantitative data with the provisions of the Likert scale.

Calculate the average score with the following formula

$$\bar{X} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Information:
$\bar{X}$: average instrument score
x_i: score on item I statement
n: lots of statement items

Convert the average score to a qualitative value according to the assessment aspect as presented in Table 1. In this assessment, the learning device is said to be valid if it meets the classification of the minimum learning device assessment either.

Table 1. Conversion score for student valuation and worksheet classification score range

Score Range	Classification
$\bar{X} > 4{,}2$	Very good
$3{,}4 < \bar{X}\ 4{,}2$	Good
$2{,}6 < \bar{X} \leq 3{,}4$	Enough
$1{,}8 < \bar{X} \leq 2{,}6$	Less
$\bar{X} \leq 1{,}8$	Very less

RESULTS AND DISCUSSION

Based on the ADDIE stage that has been explained in the research procedure, the problem-based learning based worksheet is produced as follows.

Step 1: Analysis

The analysis phase of the ADDIE model identifies performance gaps, differences between standards set in standard operating procedures (SOP) and some teacher performance. Gap performance is usually handled by learning products, namely: a collection of training and assessment materials in phase analysis in doing several stages. Methods of study can include surveys, interviews, and student observations and learning environments (Widoyoko, 2009). At this stage analysis of the needs and requirements for developing student, worksheets are carried out. Some analyzes at this stage are:

Stage 1: Analysis of curriculum, teaching materials, and learning materials. The curriculum used in the MTS cadets is the 2013 curriculum. Mathematical communication skills are one of the abilities that must be possessed by students in 21st-century learning. According to interviews with teachers at MTS Taruna, for statistical material, the teacher uses student worksheets as teaching materials and uses conventional methods.

Stage 2: Analysis of learning methods. Regarding methods, conventional learning methods are also not able to help students in understanding statistical concepts because there is no real approach to objects that are learned and impressed with everyday life. Analysis of the learning method resulted in the thought that the need for PBL-based student worksheets to facilitate students in, so students were expected to be easier to understand statistical concepts and understand the problems to solve them.

Stage 3: Analysis of student characteristics. Based on the observation of the character of MTS Taruna VIII grade students, the first is when the teacher explains the lesson, some students do not pay attention to them, for example, telling stories with their peers, and some students are busy with their activities. Students are less interested in learning mathematics, so students lack concentration in learning. The three students were less active during the learning process.

Step 2: Design

Design Determine learning objectives, explore assessment strategies and choose teaching tactics (Rowland, 1993). At this stage design activities are carried out in the form of drafting in developing problem-based learning based worksheets. This stage is done by designing the product worksheets of students according to the results of the analysis at the define stage. Student worksheets consist of components (a) cover, (b) preface, (c) table of contents, (d) instructions for using student worksheets, (e) essential competencies, (f) PBL-based student worksheets, (g) problem orientation, (e) individual tasks. The activity steps are based on the problem-based learning model. In student worksheets, there are activities carried out by students in groups and provide opportunities for students to find their concepts to learn. The results of the initial design are called draft 1.

(a) Cover

Cover student worksheets are made interesting, so students are interested in working on student worksheets. Statistics material and is used for an eighth grade is illustrated in **Figure 2**.

Figure 2: Cover

(b) Preface

The preface serves to provide the reader with the content or description contained in the student worksheet. This presentation not only thanks God and apologizes but the forward also consists of a general description of the subject and is equipped with stories that encourage others to read the student worksheet as shown in **Figure 3**.

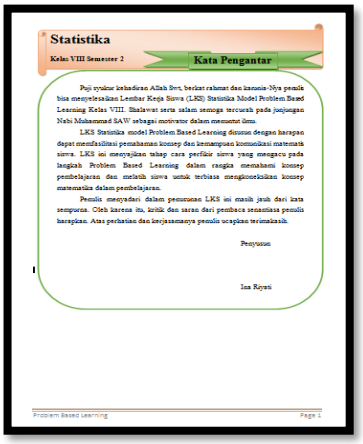
Statistika
Kelas VIII Semester 2
Kata Pengantar
Puji syukur kehadirat Allah Swt, berkat rahmat dan karunia-Nya penulis bisa menyelesaikan Lembar Kerja Siswa (LKS) Statistika Model Problem Based Learning Kelas VIII. Shalawat serta salam semoga tercurah pada junjungan Nabi Muhammad SAW sebagai motivator dalam menuntut ilmu.
LKS Statistika model Problem Based Learning disusun dengan harapan dapat memfasilitasi pemahaman konsep dan ketrampilan komunikasi matematis siswa. LKS ini menyajikan tahap cara berfikir siswa yang mengacu pada langkah Problem Based Learning dalam rangka memahami konsep pembelajaran dan melatih siswa untuk terbiasa mengkoneksikan konsep matematika dalam pembelajaran.
Penulis menyadari dalam penyusunan LKS ini masih jauh dari kata sempurna. Oleh karena itu, kritik dan saran dari pembaca senantiasa penulis harapkan. Atas perhatian dan kerjasamanya penulis ucapkan terimakasih.
Penyusun
Isa Kyai
Problem Based Learning
Page 1

Figure 3. Preface

(c) Table of Contents

The table of contents serves to make it easier to find the material you want to learn. The table of contents is arranged based on the page order on the student worksheet. The table of contents is shown in Figure 4.
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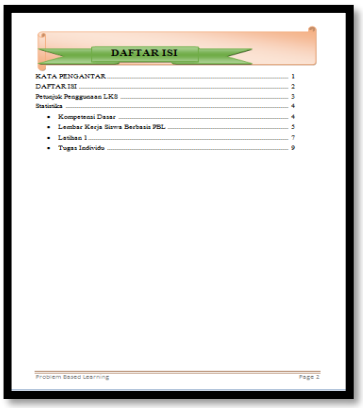
DAFTAR ISI
KATA PENGANTAR 1
DAFTAR ISI 2
Petunjuk Penggunaan LKS 3
Statistika 4
- Kompetensi Dasar 4
- Lembar Kerja Siswa Berbasis PBL 5
- Latihan 1 7
- Tugas Individu 9

Problem Based Learning
Page 2

Figure 4. Table of contents

(d) Instructions for Using Student Worksheets

Instructions for using student worksheets contain steps to use student worksheets to make it easier for students to use student worksheets as presented in **Figure 5**.

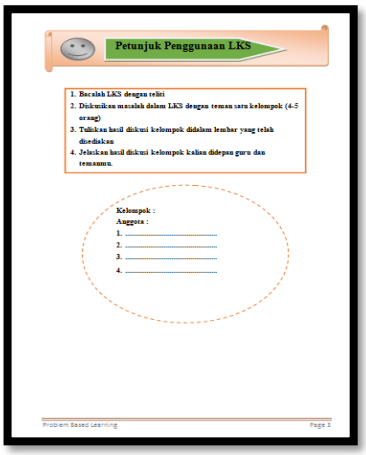

Figure 5. Instructions for use student worksheet

(d) Basic Competence

Basic competency is the result of a curriculum analysis that contains the achievement of learning outcomes that must be achieved by students as illustrated in **Figure 6**.

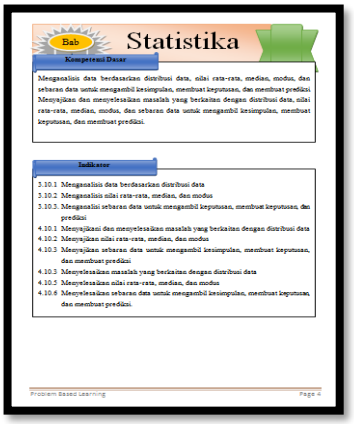

Figure 6. Basic competence

(e) PBL-based Student Worksheets

Content section, which consists of group division, chapter titles, material summaries, and exercises. Can be seen in **Figures 7** and **8**.

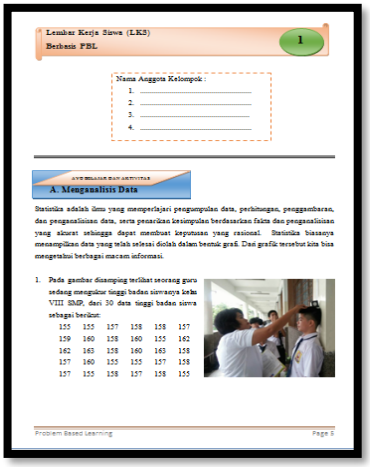

Figure 7. PBL-based student worksheets

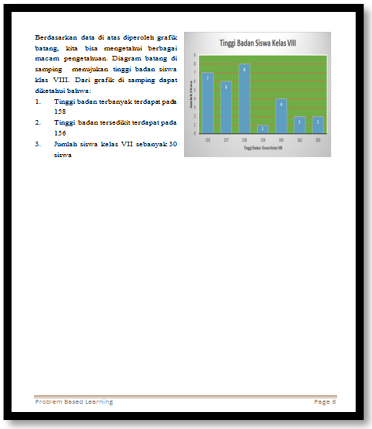

Figure 8. PBL-based student worksheets

(f) Problem Orientation

Action steps are an example of Supporting Information, is additional information that can complement teaching materials so students more easily master the knowledge that will be obtained. Supporting information contains articles on data analysis prepared to make it easier for students to understand the material. The action steps comprise several procedural steps that students must do in studying the material and problems presented. In operations activities consist of issues presented for the work of students in groups, the process steps are based on the learning stages of Problem Based Learning as presented in **Figures 9** and **10**.

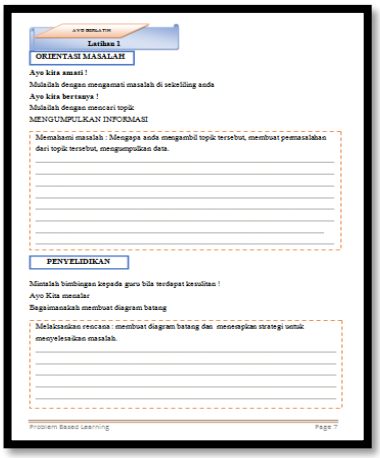

Figure 9. Problem orientation

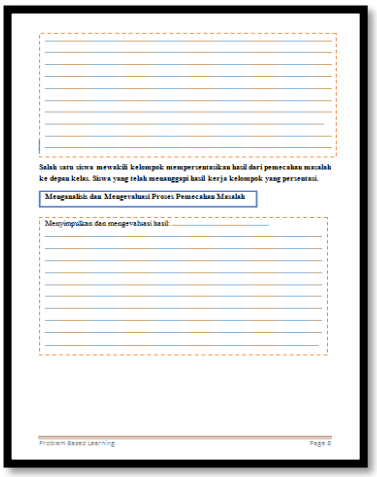

Figure 10. Problem orientation

(g) Individual Tasks

Individual assignments are forms of jobs given to students to practice skills after learning instructional materials (Hur & Suh. 2010). Questions are used to determine the level of mastery of students 'material and to measure students' problem-solving skills after following the learning process and in practice exercises have immediate problem-solving steps as illustrated in **Figure 11**.

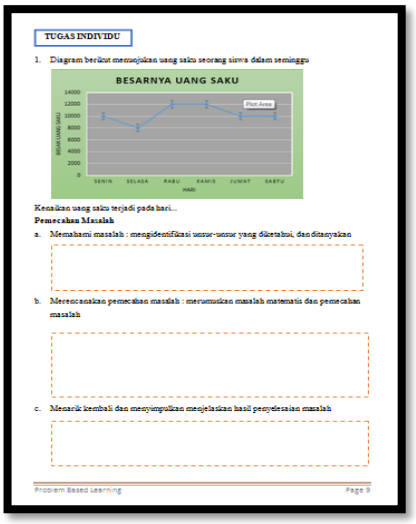

Figure 11. Individual tasks

The following are some validator input and suggestions from material experts ranked in **Table 2** and **Table 3**.

Table 2. Inputs and Suggestions from the validator 1

Suggestions and Comments	Follow-up
LKS design is equipped with KI, KD, Indicators and learning objectives	Revised
JThe title of the material on the cover was removed by "STATISTICS" only	Cover is removed from the material shelf
The questions in the design of KKS LKS foster mathematical communication skills	Revised

Table 3. Inputs and Suggestions from the validator 2

Suggestions and Comments	Follow-up
LKS design is equipped with KI, KD, Indicators and learning objectives	Revised
The word "perfikir" is changed "thinking"	Has been replaced
The word "graph" is changed "graph	Has been replaced

The validity of the design of student worksheets is brief, the results of the assessment of student worksheet design are shown in **Table 4**.

Table 4. Results of assessment of student worksheet design by experts

Assessment Aspect	Maximum score	Average Score	Information
Fill in the LKS design	5,00	4.08	Good
LKS design language	5,00	4.33	Very good
Technical aspects	5,00	4.50	Very good
Information		4.36	Very good

CONCLUSION

Student learning designed based on curriculum analysis, material, learning methods, teaching materials, student characteristics and the needs of students with problem-based learning models. Student worksheets are designed to improve students' mathematical communication skills. Designing student worksheets are part of the ADDIE development procedure. The design component of the student worksheet consists of cover, introduction, necessary competencies, action steps, problem training.

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