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Development of Mathematics Student Worksheets Based on Problem Based Learning in The Topic of Composition Function

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Abstract

Composition function material is one of the mathematics learning materials that is considered difficult, so the learning process can include problems in everyday life. One solution to overcome these difficulties is the existence of teaching materials in the form of mathematics worksheets which can help students' learning process. This research aims to determine the stages of development and to determine the validity and practicality of mathematics worksheets based on Problem Based Learning material on composition functions. This type of research is development research with the ADDIE (Analysis, Design, Development, Implementation and Evaluation) development model. The research instruments used in this study were (1) interview guide (2) validation sheet (3) student response questionnaire. The validation results from two material experts and two media experts obtained an overall average score of 3.4 and 3.8 and met the very good criteria. The practical aspect based on the student questionnaire response criteria is very good with a score of 4.4. From these data, it can be concluded that the Mathematics Student Worksheet based on Problem Based Learning (PBL) composition function material that was developed meets the valid and effective categories so it is suitable for use in the learning process

Keywords: composition function, problem based learning, worksheet

INTRODUCTION

Mathematics is the science of numbers, relationships between numbers, and operational procedures used in solving problems related to numbers. In research by (Astuti, 2021) shows that mathematics is a very important subject in the world, because mathematics can make students think logically, critically, rationally and broadly. This expression refers to national education in Law of the Republic of Indonesia Number 20 of 2003 that national education is education based on Pancasila and the 1945 Constitution of the Republic of Indonesia which is rooted in religious values, Indonesian national culture and responsive to the demands of changing times.

Indonesia's PISA (Program for International Student Assessment) results in 2022 show that Indonesia's mathematics ability category rose five positions compared to PISA 2018, but the score fell 13 points. This data means that education in Indonesia is still very low on a global scale, especially mathematics. The assessment carried out by PISA emphasizes the skills needed in the 21st century: critical thinking, creative, systematic, communicative and reflective (OECD, 2018). Based on research from Setiawan (2019), it shows that the learning

outcomes of class. The low mathematics learning outcomes are due to the lack of tools for delivering material that can be a bridge for teachers to achieve the learning objectives.

In learning mathematics, teachers are expected to be able to create a learning atmosphere that is fun, memorable, and has a variety of learning resources. The teacher's efforts to create a pleasant learning atmosphere cannot be separated from the supporting components of learning, one of which is learning resources. Learning resources are learning tools or materials that students can use to make learning easier in the form of data, methods, models and media (Samsinar, 2019; Agung et al., 2023). Learning resources relate to the preparation of learning media. Learning media is a tool to support the implementation of the learning process. With learning media, students are expected to better understand the subject matter being studied. One of the learning media that can be used in learning is Student Worksheets (Hamidah, Noer, & Caswita, 2017).

Student worksheets are printed teaching materials that make it easier for students to interact with the material provided. are able to involve student activities so that they are more active in the learning process. not only make it easier for teachers to carry out learning in class, but can also direct students to rediscover concepts. The Ministry of Education and Culture (2014) states that one of the alternatives for developing mathematics learning is constructivism-based, based on the principles: every child born on earth has potential, the way of thinking, acting and perception of each individual is influenced by culture, mathematics is a cultural product. , and mathematics is the result of the abstraction of the human mind (Yustinaningrum, 2019).

There are quite a lot of learning models that understand constructivism and are relevant to the objectives of mathematics learning, one of which is the problem-based learning model. Problem-based learning (PBL) is an innovative approach to learning that teaches many important strategies for success in the 21st century (Yustianingrum, 2019). The Problem Based Learning learning process is designed so that students can find out that mathematics can be applied in real life. PBL is able to provide opportunities for students to organize their knowledge through discussion when finding or determining a solution to a problem (Artika, Sutiarso, & Yunarti, 2016).

Apart from that, PBL-based learning tools can also provide learning experiences for students, such as in terms of investigating, problem-solving skills, especially those related to real life, so that PBL-based learning tools are considered to be able to increase students' motivation in understanding the meaning or meaning of the material they are studying (Yustianingsih, Syarifuddin, & Zon, 2017).

From the description above, the author is interested in conducting research entitled "Development of Mathematics Student Worksheets based on Problem Based Learning (PBL)" with the aim

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of knowing the stages of developing Mathematics Student Worksheets based on Problem Based Learning (PBL) and to know the validity and practicality of the mathematics Student Worksheets being developed.

The needs to be developed in this research because the Mathematics worksheets that are already circulating do not yet integrate with the problem-based learning model. PBL-based teaching materials or worksheets are expected to provide meaningful learning experiences for students, as well as facilitate students to learn actively and independently. This research aims to determine the stages of development and to determine the validity and practicality of mathematics worksheets based on Problem Based Learning material on composition functions.

METHOD

This study uses a Research and Development. The product that will be developed in this research is a learning tool in the form of a mathematics worksheet based on problem based learning on composition function material. The development model in this research uses the ADDIE development model with analysis, design, development, implementation and evaluation stages.

The population in this study were all students in class The instrument used is an interview guide adapted from (Lusia, 2022), a validation sheet that will be given to four competent validators (2 material experts and 2 media experts). The validation grid by material expert validators was adapted from (Purwati, 2017), while the media expert validation grid was adapted from (Ariani, 2020), and the student response questionnaire was adapted from (Pranata, 2022). The data analysis technique will be carried out in two stages, namely validity and practicality analysis

Validity analysis by data in the form of suggestions and comments from material experts and media experts were analyzed qualitatively, while data from assessments from material experts and media experts, media measured using a four-interval Likert scale were analyzed quantitatively. Furthermore, the aspects measured in the validity of are media and material aspects. The media aspect includes format and usefulness, while the material aspect includes the scope of the material and language. The scores that have been obtained based on expert assessments are then analyzed by calculating the average answer based on the average score of each expert's answer. The formula used was adopted from(Ferdianto & Setiyani, 2018):

$$V_{total} = \frac{\sum Vi}{n}$$

Information:
V_{total} = average validation results
$\sum Vi$ = the total score of each validator
n = number of validators

After the results are known, it is categorized into product validity criteria. The product validity criteria follows (Nesri, 2020) presented in table 1.

For practicallity analysis, data of the practicality of worksheet was obtained based on the results of student response questionnaires after using PBL-based mathematics. This data was then analyzed

Table 1. Material and Media Validity Criteria

Validity Criteria	Validity Level
3.26 - 4.00	Very good
2.51 - 3.25	Good
1.76 - 2.50	Not good
1.00 - 1.75	Very not good

qualitatively and quantitatively. Data in the form of suggestions and comments from students were analyzed qualitatively, while data from student response questionnaires which were measured using a Likert scale were analyzed quantitatively. The data collected is then calculated by the number and average using the following formula:

$$Average = \frac{Score}{Number\ of\ question}$$

After the results were known, it is categorized into product practicality criteria. The product practicality criteria adopted from (Widoyoko, 2014) in table 2.

Table 2. Student Response Questionnaire Assessment Criteria

Practicality Criteria	Practicality Level
$4.2 \leq r < 5.0$	Very good
$3.4 \leq r < 4.19$	Good
$2.6 \leq r < 3.39$	Not good
$1.8 \leq r < 2.59$	Very not good

The worksheet developed is concluded to be practical to use if the assessment results at least fall within the "Good" criteria.

RESULT AND DISCUSSION

This study is Research and Development which produces Student Worksheets based on Problem Based Learning (PBL) on composition function material which was tested on students in class XI OTKP SMK Miftahul Ulum Melirang in lessons 2022/2023. This research procedure was carried out using the ADDIE model. The development stages can be seen in detail as follows:

Analyze Steps

Before product development, the observations or needs analysis were conducted through interviews with mathematics subject teachers regarding the curriculum used, material analysis and characteristics of class XI students at Miftahul Ulum Melirang Vocational School. Based on the results of the interview, it was found that the curriculum used for the 2022/2023 school year was the 2013 curriculum.

In odd semester mathematics subjects, students have difficulty understanding the material and operating or applying formulas to composition function material, so students have difficulty solving the problems given. Apart from that, the mathematics teacher also explained that the majority of class Odd. In the learning process, the learning models that teachers often use are the direct learning and Discovery Learning models, and the teaching materials used in learning are only books that have been provided by the school. Based on the description of the analysis results above, these conditions and opportunities support researchers to develop mathematics worksheets based on Problem Based Learning in the topic of composition function.

Design Steps

The design of the contents of Problem Based Learning-based mathematics

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worksheets is described as follows: cover (title, logo, name column), identity (curriculum used, name of compiler, name of validator, and year of study), Foreword, table of contents, curriculum, competency learning achievement indicators, learning objectives, instructions for using, content information (PBL syntax), concept map, and introduction (overview of the material).

Development Steps

Following are the results of the analyze and revision (Table 3) of the validation of PBL-based mathematics worksheets on composition function material. The validation of material experts and media experts was obtained on average 3.4 and 3.8 respectively (Table 4). Based on the validity criteria in table 2, the criterion "Good" is obtained, meaning that the PBL-based mathematics worksheet on Composition function material is suitable for use.

The results of validation on media and material aspects are presented in Table 3 as follows.

Table 3 Validation Results on media and material aspects

Indicators Result on Aspects			
Media	**Score**	**Material**	**Score**
Format	3.6	Scope of material	3.2
Usefulness	4.0	Language	3.6
Average	**3.8**	**Average**	**3.4**

Based on the data in Table 4, it can be seen that in the media aspect, the format indicator obtained a validation result of 3.6, while the usability indicator obtained a result of 4.0, with the average validation result in the media aspect being 3.8. Meanwhile, in the material aspect, the material scope indicator obtained a validation result of 3.2, and the language indicator obtained a validation result of 3.6, with an average validation result in the material aspect of 3.4.

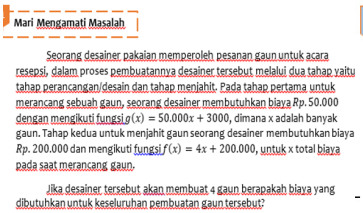
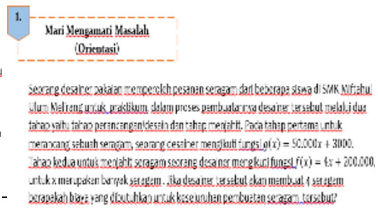
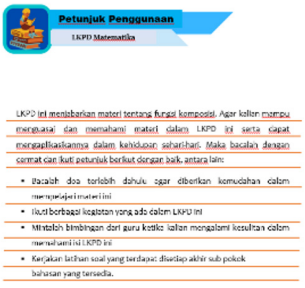
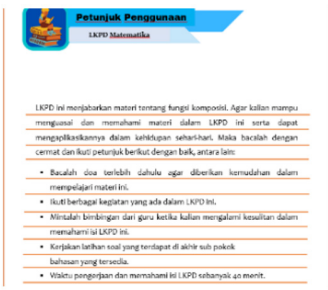
Implementation Steps

At this stage a trial is carried outusing PBL-based mathematics worksheets on composition function material, on April 9 2023 with 25 class XI OTKP students at Miftahul Ulum Melirang Vocational School. The learning process using mathematics worksheets based on Problem Based Learning composition material is carried out in accordance with the Problem Based Learning Implementation Plan that has been created. The teacher's role in learning is as a facilitator, namely providing guidance to students who experience difficulties.

After students learn using Problem Based Learning-based mathematics worksheets, an analysis of the practicality of the worksheets obtained is carried out based on the results of the student response questionnaire. the results of the questionnaire on the practicality of Problem Based Learning-based mathematics worksheets obtained a total score of 1,333 and an average score of 4.4 was obtained with the criteria "Very Good". It can be concluded that the Mathematics Problem Based Learning worksheet has met the minimum practicality criteria that have been set.

This is in accordance with Gagne's information processing theory (Agung et al., 2023) which states that external stimuli

Table 4. Validation Results on media and material aspects

Suggestion Revision	Before Ravision	After Revision
The problems presented in the "Composition Function Concept" section should direct students to the activity of determining the concept.		
The function formula used needs to be adjusted so that the results obtained do not match the actual situation.		
Some of the problems presented need to be adapted to the research location.		
The problems presented are too many		
In the instructions for using the worksheet, it is necessary to give work time and each learning stage is not numbered		
The Layout of the words " Fungsi Komposisi Berbasis Problem Based Learning" and the layout of the group name column on the worksheet cover need to be adjusted		

can encourage the emergence of students' internal conditions in the form of memories of previous learning. These results are also in accordance with Bruner's cognitivism theory (District et al., 2022) which states that students are required to be able to

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think critically about the surrounding environment in the learning process. This encourages students to be able to discover theories, concepts, rules or understanding.
Evaluation Steps

At this stage, the evaluation was carried out consisting of formative and summative evaluation. Formative evaluation is carried out in the process of developing PBL-based mathematics worksheets, while summative evaluation is carried out at the end of the stage after the learning process using the worksheet.

The results of the student response questionnaire show that Mathematics Worksheets based on Problem Based Learning material on composition functions can help students in operating equations from composition functions, and can help students understand the concept.

Based on the results of the assessment by validators of material experts and media experts, mathematics worksheets based on Problem Based Learning material on composition functions are suitable for use. Apart from that, the worksheets developed are able to help students understand the material and train students to think critically in solving the problems given. This is in accordance with research conducted by (Effendi, Herprawati, & Sutiarso, 2021) which shows that worksheets with the Problem Based Learning learning model are considered very feasible based on material experts, design experts, media and practical experts. Apart from that, it is also able to support the learning process and help students understand the material more easily (Annisa & Subiantoro, 2022).

By implementing the Problem Based Learning model, students are able to attract students to pay more attention to the material being discussed and are able to solve problems by discussing well with their group friends. This is relevant to research conducted by (Saharsa, Qaddafi, & Baharuddin, 2018) which shows that in the learning process using the Problem Based Learning model, students are brave in expressing their ideas, and are able to attract students' attention to pay more attention to the material presented. However, there is a difference, where in this research the students were more confident in presenting the results of their group discussions, whereas in the research conducted by researchers some groups were not confident in expressing their opinions when presenting the results of their group discussions. Apart from that, the results of this research focused on increasing students' understanding of concepts, whereas in the research conducted by researchers focused on students' ability to understand the material.

Based on implementation observations, it can be said that in the learning process using the Problem Based Learning model, activities at each stage can be carried out well. Researchers only change the habits of students from teachers being the center of learning information to students being the center of learning. This is in line with research conducted by (Setiawan, 2019) shows that the learning process using the Problem Based learning model uses the

majority of time according to the learning plan and the activities at each stage run well, where when the learning process takes place, the researcher plays the maximum role as a facilitator. However, there are differences in the type of research used, in this research using classroom action research and in research conducted by researchers using R&D research.

The results that have been described are in accordance with the research of Pratama et al. (2020) that the use of material in interesting and relevant teaching materials can make students more involved in teaching and learning activities, improve learning outcomes, and can add information to students through the material. These results are in accordance with research conducted by Putri et al., (2022) that learning material that is relevant to students' real-life problems can help students to be more active in learning and increase student understanding. The results that have been described are also in accordance with the research of Fadhilah et al. (2022) that good learning resources are learning resources that can be utilized optimally, are easy to understand, and can be used according to student needs.

The developed worksheet also meets the characteristics of a good because it contains all the instructions that students need, the instructions are written in simple form with short sentences and vocabulary that is appropriate to the age and abilities of the user, contains questions that must be filled in by students, integrates with innovative learning models, there is free space to write students' answers and discoveries, there is clear feedback or notes for students on what they have done, and contains simple and clear pictures (Oktasari et al., 2019; District et al., 2024).

CONCLUSION

Based on the results of the research and discussions that have been carried out, it is concluded that the Mathematics Student Worksheet (LKS) based on Problem Based Learning (PBL) composition function material that has been developed meets the valid and effective categories so it is suitable for use in the learning process.

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BRIEF PROFILE

Roisatun Nisa was born in Gresik, January 20th, 1990. Lecturer at Qomaruddin University. Had studied S1 mathematics education at PGRI Adibuana University Surabaya, graduates in 2012; Had studied S2 mathematics education at Surabaya State University graduated in 2015.

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