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Development of Mathematics Literacy Teaching Module with Problem-Based Learning (PBL) Learning Model

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Abstract

The research method used is Research and Development (R&D) with the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation. This research was tested on students of MTs Madani Alauddin and SMP Negeri 3 Sungguminasa. The validation results showed that the teaching module obtained an average score of 4.51, which was classified as valid. The teacher's response to the module was very positive, with a percentage of 93% on the small-scale trial and 94% on the large-scale. The learning implementation observation sheet showed that the module was fully implemented with an average of 1.9 in the small trial and 1.8 in the large trial, so the module was declared practical. Learners' responses were also very positive, with a percentage of 83% in the small trial and 86.6% in the large trial. Learner activities showed high involvement, with 86% in small trials and 88% in large trials. In addition, the learning test results showed the effectiveness of the module with the achievement of 85.3% in the small trial and 91.84% in the large trial. Based on the research results, this teaching module is declared valid, practical, and effective for use in learning mathematics with the PBL model on flat-sided space building material.

Keywords: Teaching Module, Math Literacy, Problem-Based Learning.

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INTRODUCTION

Mathematics has a very important role in everyday life, not only as a science that teaches calculations but also as a tool for solving various contextual problems (Hera & Sari, 2015). One of the fundamental aspects of mathematics is mathematical literacy, which is the ability of individuals to formulate, apply, and interpret mathematics in various real-life contexts (Umbara & Suryadi, 2019). This ability allows individuals to use mathematical concepts and procedures in logic and analysis-based decision-making. (Graven et al., 2023).

The importance of mathematical literacy is increasingly emphasised in various international studies, one of which is through the Programme for International Student Assessment (PISA). PISA is a global assessment that evaluates the competence of 15-year-old students in three main areas, namely reading literacy, mathematics literacy, and science literacy (Mansur, 2018). Unfortunately, PISA results show that the math literacy skills of Indonesian students are still in the low category, with a ranking that has always been among the bottom 10 countries since 2000. The latest PISA 2022 results show a slight improvement but still far from the expected standard (Kemendikburistek, 2023).

In addition to PISA, the national assessment implemented in Indonesia through the Minimum Competency Assessment (AKM) also shows similar results. AKM measures students' reading literacy and mathematical literacy (numeracy) by assessing their logical, systematic and reasoning thinking skills in solving various problems (Megawati & Sutarto,

2021). Based on the AKM results, many Indonesian students are only able to solve problems with a basic level of understanding, such as identifying information and completing routine procedures (Puslitjak, 2021).

Previous research shows that the low mathematical literacy of students in Indonesia is caused by several factors, including less innovative learning models and inadequate teaching materials (Aini et al., 2018; Fitni et al., 2023), learning methods that still focus on memorisation and mechanical procedures (Muhammad Idkhan et al., 2019), lack of experience of students in solving real problems with mathematical approaches (Kholid et al., 2022; Del Carmen et al., 2024) and lack of understanding of the importance of mathematical literacy in everyday life (Husni & Herman, 2022). Observations made at MTs Madani Alauddin show that students have difficulty in solving mathematical literacy-based problems, especially in flat-sided space-building material. Learners have difficulty identifying information contained in the problem, choosing the appropriate concept, and drawing the right conclusions. This indicates that the teaching materials and learning models applied today are still ineffective in training students' mathematical literacy skills.

One solution that can be applied to improve students' mathematical literacy skills is the development of more contextual and innovative teaching materials. Teaching modules specifically designed to develop mathematical literacy have been proven effective in improving learners' understanding (Aulia & Prahmana, 2022; Sulfayanti, 2023). A good teaching module not only presents the material theoretically but also connects mathematical concepts with real contexts so that students can understand its application in everyday life (Arvyaty et al., 2017).

In addition to the development of teaching modules, the application of learner-centred learning models is also an important aspect of improving mathematical literacy (Üzüm & Pesen, 2019). The Problem-Based Learning (PBL) learning model has been proven to improve student's critical thinking skills and mathematical literacy (Hidayat et al., 2019). The PBL model encourages learners to actively explore and solve contextual-based problems so as to improve their ability to interpret and apply mathematical concepts (Afifah et al., 2020; Ananda & Fauziah, 2022).

Previous research has shown that teaching modules based on Problem-Based Learning (PBL) can improve concept understanding, critical thinking, and student learning effectiveness. Several studies, such as those conducted by (Akbar & Razak, 2019), (Heong et al., 2020), (Mahmudah et al., 2022), (Fradila et al., 2021), serta (Sulistiyanti et al., 2021) have proven that PBL modules have high validity and provide positive results in improving students' thinking skills. However, these studies have not specifically developed modules that are oriented towards improving students' mathematical literacy.

The novelty of this research compared to previous research lies in (1) Focus on mathematical literacy; in contrast to previous studies that emphasise module validity or critical thinking improvement, this study explicitly develops PBL-based teaching modules specifically designed to improve learners' mathematical literacy; (2) Integration of PBL models in the context of mathematical literacy, although many studies have used PBL in teaching, there have not been many studies that explicitly link it to mathematical literacy as the main competency to be improved; and (3) Specific measurement of mathematical literacy, in contrast to previous studies that used more indicators of critical thinking or learning effectiveness, this study measures the improvement of students' mathematical literacy based on indicators used in PISA and AKM.

Problem-solving in this study is based on the effectiveness of the concept of the Problem-Based Learning (PBL) learning model (Chasanah & Fitrianawati, 2023; Merritt et al., 2017; Simanjuntak et al., 2021; Sari et al., 2021) as well as the benefits of using teaching modules as structured and contextual learning materials. By considering the advantages of both approaches, this research integrates PBL in the development of teaching

modules based on mathematical literacy. This development aims to improve students' ability to formulate, apply, and interpret mathematical concepts in various real-life contexts, thus providing a more effective solution for improving students' mathematical literacy.

This study aims to (1) determine the process of developing mathematics literacy teaching modules with Problem-Based Learning (PBL) learning models, (2) determine the quality of mathematics literacy teaching modules with Problem-Based Learning (PBL) learning models, and (3) determine the effectiveness of the teaching module of mathematical literacy with Problem-Based Learning (PBL) learning model. The problem formulations in this study are as follows: (1) How is the process of developing mathematics literacy teaching modules with problem-based learning (PBL) learning models? (2) What is the quality of mathematics literacy teaching modules with Problem-Based Learning (PBL) learning models? Moreover, (3) How effective are mathematics literacy teaching modules with problem-based learning (PBL) learning models?

METHODS

The type of research used in this study is research and development. The development model used is the ADDIE model. The product to be developed by researchers in this study is a mathematics literacy teaching module that is prepared by referring to the Problem-Based Learning (PBL) learning model on flat-sided space-building material. This research was conducted in two schools in the 2024/2025 academic year, namely MTs Madani Alauddin and SMP Negeri 3 Sungguminasa. Specifically, the subjects of this study were students of class IX B MTs Madani Alauddin, totalling 34 people as small-scale trial subjects. They selected using purposive techniques, namely using class criteria that have average abilities based on information from teachers. Then, the large-scale test subjects were students of class IX A, IX B, IX C, and IX D SMP Negeri 3 Sungguminasa, totalling 98 students and were selected using a cluster random sampling technique. Both trials were conducted using the One Group Pretest post-test design, which is an experiment conducted on one group only without a comparison group that begins with a Pretest and ends with a post-test after learning using the math literacy teaching module.

The process of developing the teaching module follows the steps of the ADDIE model, namely analysis, design, development, implementation, and evaluation. The analysis stage was carried out with the aim of analysing the need for the development of teaching modules for mathematical literacy. The analysis included analysing the level of students' mathematical literacy skills, analysing students' needs and characteristics, and analysing the subject matter.

The design stage is carried out with the aim of designing teaching module writing based on the results of the analysis conducted. This stage includes several planning phases, including selecting applications that will be used to compile teaching modules, collecting relevant sources for the selected material, compiling teaching module content, compiling Learning Implementation Plans (RPP), compiling Learner Worksheets (LKPD) and compiling research instruments.

The development stage is the stage to realise the conceptual teaching module for mathematics literacy that was designed in the previous stage. The math literacy teaching module was developed using Canva for Education software. Teaching modules and research instruments that have been made are validated by validators (media experts and material experts). This is done so that the teaching modules and research instruments developed can measure what is the target of this study. If there are still shortcomings, it

will be revised according to the comments or suggestions from the validator before being tested on students.

The implementation stage is the stage of testing the mathematics literacy teaching modules and research instruments that have been developed. The use of mathematics literacy teaching modules is adjusted to the chosen model, approach, and method. The trial of the mathematics literacy teaching module was conducted in class IX MTs Madani Alauddin and SMP Negeri 3 Sungguminasa.

Development products that validators have validated are then tested with small-scale trials. This trial is important because the product developed is still temporary and can undergo changes. Thus, this trial aims to evaluate the quality of the product before it is used in a more real and broad situation (Hutama, 2016). After the product is revised and refined based on the results of the small-scale trial, the next stage is a large-scale trial. This trial has similarities with the previous trial, but the difference lies in the larger number of subjects, namely 98 test subjects. The purpose of this large-scale trial is to test whether the developed product meets its performance criteria.

Finally, the evaluation stage is carried out by processing data related to the practicality and effectiveness of the teaching module. This process involves filling out questionnaires, learning implementation observation sheets and learner activity observation sheets conducted by observers during the product trial. Teachers and students filled in the questionnaire sheet to provide feedback on the use of the math literacy teaching module. In addition, the learning outcome test was also given to students after they used the module. The results of this trial will be analysed and evaluated if deficiencies are found so that the teaching module produced can meet the desired criteria. This stage includes the final revision of the teaching module based on suggestions and input from students, teachers, and observers.

Information was collected through interviews, questionnaires, and instrument tests, which included validation sheets, response questionnaires, and math literacy test sheets. The validation sheet was in the form of a questionnaire filled out by respondents to provide an assessment according to predetermined criteria. The response questionnaire was used to collect students' and teachers' responses to the developed teaching module. The mathematical literacy test sheet was used to measure the improvement of students' mathematical literacy skills.

The effectiveness of the product is measured based on (1) analysis of students' learning completeness, where students are considered complete if the proportion of correct answers achieved is at least > 76, (2) achievement of learning indicators/objectives, (3) positive responses from students, (4) students' activities, and (5) improvement in literacy skills seen from the N-Gain score.

RESULTS & DISCUSSION

Results

Description of the Mathematics Literacy Teaching Module Development Process

The process of developing a mathematics literacy teaching module with the Problem-Based Learning (PBL) learning model on flat-sided space-building material is described using the ADDIE stages as follows.

1. Analysis Stage

The analysis stage in developing this teaching module includes problem identification, learning needs, curriculum, and learning objectives. The results of

observations and interviews show that students' mathematical literacy skills are still low, especially in understanding problem information, choosing formulas, and drawing conclusions. The contributing factors include limited teaching materials that are still centred on package books and learning models that do not actively involve students. In addition, the characteristics of students in class IX MTs Madani Alauddin who are in early adolescence show that they have the potential for deductive and analytical thinking but have not been able to explore their abilities optimally because learning is still teacher-centred. Therefore, the purpose of developing this teaching module is to help students build their mathematical literacy skills through a more interactive approach. The material used focuses on flat-sided spaces, such as cubes, beams, prisms, and pyramids, with the Problem-Based Learning (PBL) learning model. The results of this analysis become the basis for designing teaching modules that are in accordance with the needs of students to be more effective and efficient in improving students' mathematical literacy.

2. Design Stage

The design stage of the Canva for Education-assisted mathematics literacy teaching module includes selecting applications, collecting sources, compiling module content, making learning activities and Learner Worksheets (LKPD), and preparing research instruments. Canva for Education was chosen because it provides free and interactive features to create attractive teaching modules with multimedia integration. Source collection was carried out through literature and online media relevant to the Merdeka Curriculum. The teaching module is arranged to include general information, core, and appendices, with flat-sided space-building material that is related to everyday life. Learning activities follow the Problem-Based Learning (PBL) model and are equipped with interactive LKPD. The research instruments include teaching module assessment sheets by material and media experts, teacher and student response questionnaires using a Likert scale, as well as observation sheets for learning implementation, student activities, and learning outcomes tests. This instrument is used to assess the validity, practicality, and effectiveness of the module before it is implemented in schools.

3. Development Stage

The development stage of the mathematics literacy teaching module with the Problem-Based Learning (PBL) model on flat-sided space building material is carried out using Canva for Education premium, including the cover, preface, table of contents, list of images, introduction, general information, core information, and attachments. Once completed, the module was downloaded in PDF format to be applied to learning. In addition, Learner Worksheets (LKPD) and PowerPoint were also made to support a more interactive learning process. The research instruments developed include practicality instruments (learning implementation observation sheet and teacher response questionnaire) and effectiveness instruments (learner activity observation sheet, learner response questionnaire, and learning outcome test). After the development was completed, the module and research instruments were validated by validators before being applied in the school trial.

4. Implementation Stage

The application stage of the mathematics literacy teaching module with the Problem-Based Learning (PBL) model on flat-sided space-building material was carried out through small-scale trials at MTs Madani Alauddin with 34 students of class IXB and large-scale trials at SMPN 3 Sungguminasa with 98 students from four randomly selected classes. The small-scale trial aimed to identify the shortcomings of the module before it was used in the large-scale trial, with improvements in the example problems and the stages of the volume formula. Each meeting in the trial discussed the elements and the calculation of the surface area and volume of spatial shapes through group discussions, presentations, and peer tutoring, which proved to improve learners' understanding. Test results showed

an increase in mathematical literacy, which was supported by positive response questionnaires from learners and teachers. The learning process used LKPD as a tool to understand the concept, using the Problem-based Learning (PBL) method, discussion, assignment, and demonstration. After each meeting, the observer filled in the observation sheet for the implementation of learning and learner activities, and the teacher filled in the response questionnaire. Findings from the large-scale trial reinforced that the teaching module developed was effective in improving students' understanding and mathematical literacy skills.

5. Evaluation Stage

Evaluation is carried out at each stage of development with direction from the supervisor. It involves material experts, media experts, teachers, and students to assess the validity, practicality, and effectiveness of the Problem-Based Learning (PBL) based mathematics literacy teaching module on flat-sided space-building material. The validation results show several aspects that need to be improved, such as improving learning methods, aligning teaching materials with problems on LKPD, adding summaries and independent exercises, and providing brief instructions in LKPD. The teacher response questionnaire needs to be focused on the teacher's experience, while the learner questionnaire must be equipped with a grid table. The module implementation observation sheet needs clarity in teacher and learner activities, while the learning outcome test needs to be adjusted to the correct context and good language. This evaluation aims to ensure that the teaching module developed is valid, practical, and effective in improving students' mathematical literacy.

Description of the Quality of the Teaching Module for Mathematical Literacy

According to Yuliastuti & Soebagyo (2021) that a good teaching module is a valid, practical, and effective teaching module. This is also in line with what was stated by Baidowi, Arjudin, Novitasari & Kertiyani (2023) that teaching modules are said to be of high quality if they meet three criteria: valid, practical, and effective. The quality assessment of the mathematics literacy teaching module with the Problem-Based Learning (PBL) learning model on flat-sided space-building material refers to three criteria, namely validity, practicality, and effectiveness.

1. Validity Analysis of Teaching Module

The validation of the quality of the Problem-Based Learning (PBL)-based mathematics literacy teaching module on flat-sided space building material was carried out by material and media experts, with the results showing that the teaching module, learning materials, lesson plans, LKPD, student and teacher response questionnaires, observation sheets, and learning outcomes tests were in the valid category. Teaching modules are considered feasible with revisions, especially in learning methods and diagnostic assessments. Learning materials need to be adjusted to the problems in the LKPD and equipped with a summary and independent exercises. RPP and LKPD are valid, with suggestions for improvement, such as providing brief instructions and the suitability of questions with the student's book. The learner and teacher response questionnaires are valid, but the teacher questionnaire needs to be adjusted to the teaching experience. Implementation and learner activity observation sheets are valid with minor revisions to clarify the roles of teachers and learners. The learning outcomes test was valid, with suggestions for improvement on context, language, and unit uniformity. Overall, the validation shows that the learning tools developed have met the validity standards to be applied to learning.

Based on the activities carried out, the results of the validation of the teaching modules developed are obtained in Table 1.

Table 1. Validation Results

Validation Type	Rata-rata	Criteria
Teaching Module Validation	4,7	Valid
Validation of Learning Materials	4,5	Valid
Validation of lesson plan	4,6	Valid
Validation of LKPD	4,4	Valid
Validation of Learner Response Questionnaire	4,8	Valid
Teacher Response Questionnaire Validation	4,4	Valid
Validation of Learning Implementation Observation Sheet	4,5	Valid
Validation of Learner Activity Observation Sheet	4,4	Valid
Validation of Learning Outcome Test	4,3	Valid

Based on the results of the validation of the mathematics literacy teaching module with the Problem-Based Learning (PBL learning model on the material of flat-sided space building developed, it meets valid qualifications if it contains an assessment based on aspects of content and purpose, instructional aspects, technical aspects, and the results of the assessment conducted by the validator. The content and purpose aspects of all components, such as learning outcomes and learning objectives, must be appropriate. This is in line with the reference from Suniasih (2019) that the teaching book developed is based on a strong theoretical foundation (content validity) and internal consistency between the components of the teaching module (construct validity). Each component of the teaching module developed is well organised and systematic so that it reaches the minimum valid criteria in the validity aspect.

The following teaching modules were developed and have been assessed for validity:

Figure 1: Teaching module developed

2. Practicality Analysis of Teaching Module

The results of the quality analysis of the mathematics literacy teaching module with the Problem-Based Learning (PBL) model on a flat-sided space-building material show that this module meets the practicality aspects based on the teacher response questionnaire and the learning implementation observation sheet. In the small-scale trial at MTs Madani Alauddin, the teacher response questionnaire obtained a total score of 63 with an average of 3.7 and a percentage of 93%, while in the large-scale trial at SMP Negeri 3 Sungguminasa, the total score was 64 with an average of 3.8 and a percentage of 94%, both of which were in the very positive category (>80%). Meanwhile, the results of observations of learning implementation by two observers showed that in the small-scale trial, the syntax

aspects and reaction principles obtained an average of 1.9. In contrast, in the large-scale trial, the two aspects obtained an average of 1.8, both of which were categorised as "fully implemented" in the interval $1.5 \leq K < 2$. Thus, this teaching module is considered practical and feasible to use in teaching mathematics in the classroom.

3. Teaching Module Effectiveness Analysis

The mathematics literacy teaching module with the Problem-Based Learning (PBL) model on flat-sided space-building material is declared effective based on three indicators: student activity observations, student response questionnaires, and learning outcomes tests. The observation results showed that students' activities were very active, with a percentage of 86% on a small-scale trial and 88% on a large scale. The learner response questionnaire also showed a very positive response, with a percentage of 83% on a small scale and 86.6% on a large scale. From the learning outcome test, the classical completeness of students reached 85.3% (small scale) and 91.84% (large scale), while the normalised gain value was in the high category with a score of 0.80 (small scale) and 0.84 (large scale). Overall, there was an increase in effectiveness from small scale to large scale, with learner activities increasing by 2%, learner responses increasing by 3.6%, classical completeness increasing by 6.54%, and normalised gain increasing by 0.04%, so this teaching module was declared effective.

Description of Effectiveness of Mathematics Literacy Teaching Module

This study examines the effectiveness of mathematics literacy teaching modules based on Problem-Based Learning (PBL) on flat-sided space-building material in improving students' activities, responses, and learning outcomes. The observation results show that the activity of students is very high, with the percentage of activeness reaching 86% in the small-scale trial and increasing to 89% on a large scale. Learners' responses were also very positive, with an average questionnaire score of 83.7% on a small scale and increased to 87% on a large scale. In terms of learning outcomes, the average pre-test score of students was still low, which was 17.9 on a small scale and 22 on a large scale, with all participants not yet reaching mastery. However, after learning using this module, the average post-test score increased to 83.7 on a small scale and 88 on a large scale, with learning completeness increasing from 85.3% to 92.86%.

Inferential statistical analysis was conducted with normality tests and various hypothesis tests using SPSS 26.0. The normality test results showed that all variables were normally distributed with a significance value of more than 0.05 (Post Test: 0.090, Response: 0.123, N-Gain: 0.2, and Activity: 0.068). Hypothesis testing of learning outcomes shows that the average learning outcome is more than 76 with a significance value of 0.000. The classical completeness of students was also more than 80%, with a significance value of 0.000. In addition, the average normalised gain value was more than 0.3, and more than 80% of learners gave a positive response to the teaching module. Students' learning activity was also more than 70%, with a significance value of 0.029. Overall, this study concluded that the PBL-based mathematical literacy teaching module was proven effective in improving students' activities, positive responses, and learning outcomes.

Discussion

The process of developing a Math Literacy Teaching Module

This study developed a Problem-Based Learning (PBL) based mathematics literacy teaching module using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

1. Analysis

This stage aims to identify the needs of learners. The results of the study show that students need teaching materials that can improve mathematical literacy, while the available package books are still limited and inadequate (Nurhaya, Hamka & Faisal , 2023; Imania & Bariah 2019). As a solution, a teaching module was developed that can be used as an independent learning guide at home (Setiyadi, Ismail & Gani (2017).

2. Design

The teaching module was designed with reference to the Merdeka Curriculum and using Canva for Education. Its components include material scripts, lesson plans, LKPD, and supporting references Ahsan, Cahyono & Prabowo., 2019). The design is made attractive with text and images to increase students' interest in learning (Dwiqi, Sudatha & Sukma, 2020).

3. Development

The teaching module was developed thoroughly with various modifications, such as appearance adjustment, image quality improvement, and feature optimisation. Additional components such as the cover, preface, table of contents, and appendices were also added. After that, the module was validated by a team of experts to ensure its accuracy and quality (Lestari, Sriyanti & Sulasteri, 2024; Satriawati, Ridwan & Kustiawati 2023).

4. Implementation

The pilot test was conducted at MTs Madani Alauddin and SMP Negeri 3 Sungguminasa in two stages:

o Small scale trial: 4 meetings at MTs Madani Alauddin

o Large-scale trial: 4 meetings at SMP Negeri 3 Sungguminasa

Data on the effectiveness of the module was collected through observations of learning implementation, learner activities, teacher and learner response questionnaires, and learning outcomes tests.

5. Evaluation

The evaluation was conducted based on the validity, practicality, and effectiveness of the teaching module, including revisions based on feedback from students, teachers, and observers. Some adjustments were made to the content of the LKPD to improve the module (Khusnah, Sulasteri, Suharti & Nur, 2020).

Overall, the development of PBL-based mathematics literacy teaching modules through the ADDIE model is proven to be able to meet the needs of students and increase the effectiveness of learning.

Quality of Mathematics Literacy Teaching Modules with Problem-Based Learning (PBL) Learning Model

1. The validity of the Mathematics Literacy Teaching Module with the Problem-Based Learning (PBL) Learning Model developed

Based on the results of the validator's assessment of the lesson plan, an average score of 4.6 was obtained with valid criteria from a maximum score of 5. This shows that the lesson plan has fulfilled the completeness of elements such as identity, competency

formulation, format, suitability of learning outcomes with learning objectives, and relevance of learning resources to teaching materials. The LKPD assessment showed an average of 4.4, which also met the valid criteria. All research instruments are considered valid because they are in the interval $4 \leq Va < 5$.

Assessment of teaching materials resulted in an average of 4.5 with valid criteria, which indicates the suitability of the material with the learning objectives and time allocation that has been determined. The teaching module developed obtained a total average score of 4.7 with valid criteria. This proves that the teaching module has relevant content and objectives to achieve the desired learning outcomes. Thus, this teaching module meets the validity standards, which means that the tools and instruments used can produce accurate data in accordance with real conditions. This finding is in line with the research of Ariawan, Utami, Herlina & Istikomah (2022), who found that the teaching module with the Problem-Based Learning model they made met the criteria for validity level. This is also in line with the research of Ladyawati & Rahayu (2022) In the development of mathematics textbooks based on literacy and numeracy as an AKM reinforcement that meets the criteria for validity level.

2. Practicality of Mathematics Literacy Teaching Module with Problem-Based Learning (PBL) Learning Model developed

The mathematics literacy teaching module with the Problem-Based Learning (PBL) learning model developed on flat-sided space-building material meets practical qualifications if it is able to provide convenience to its users. (Nesri & Kristanto, 2020). This research is based on data analysis from teacher response questionnaires and learning implementation using teaching modules. A similar practicality assessment was conducted by Rayanti (2024), who assessed the appearance of the module, curriculum suitability, and the usefulness of the teaching module to determine its practicality. The results of the teacher response questionnaire to the teaching module in the small-scale trial showed a total score of 63 with an average of 3.7, where the learning indicator using the teaching module obtained a score of 18, the presentation of the appearance and components of the teaching module obtained a score of 25, the indicator of the usefulness of the teaching module obtained a score of 12. The curriculum suitability indicator obtained a score of 8. The acquisition of this score was accumulated to get a percentage of 93%, which was in the interval $80\% \leq p < 100\%$ with very positive criteria. In the large-scale trial, the teacher response questionnaire to the teaching module obtained a total score of 64 with an average of 3.8, where the learning indicator using the teaching module obtained a score of 20, the indicator of the presentation of the appearance and components of the teaching module obtained a score of 26, the indicator of the usefulness of the teaching module components obtained a score of 10. The curriculum suitability indicator obtained a score of 8These scores were accumulated to get a percentage of 94%, which is in the interval $80\% \leq p < 100\%$ with very positive criteria.

The results of observations of the implementation of learning using the mathematical literacy teaching module with the Problem-Based Learning (PBL) learning model for flat-sided spatial figures in small-scale trials obtained an average of 1.9, which was in the interval $1.5 \leq K \leq 2$ with the criteria being fully implemented. Meanwhile, the results of observations of the implementation of learning in large-scale trials obtained an average of 1.8 in the interval $1.5 \leq K \leq 2$ with the criteria being fully implemented. This shows that during small-scale and large-scale trials, the learning process went smoothly. Thus, in general, the mathematical literacy teaching module with the Problem-Based Learning (PBL) learning model on flat-sided spatial figures meets practical qualifications. These results complement the findings of Mariska & Rahmatina (2022) namely that the teaching module created using Canva meets the practical qualifications but is only based on teacher and student response questionnaires.

3. Effectiveness of the Mathematical Literacy Teaching Module with the Problem-Based Learning (PBL) Learning Model that was developed

a. Student Activities

The results of observations of student activities in learning mathematics using mathematical literacy teaching modules with the Problem-Based Learning (PBL) learning model on flat-sided spatial geometry material show that the 10 aspects observed meet the effective criteria. In the small-scale trial, an average of 8.6 was obtained with a percentage of 86% with very active criteria. Meanwhile, in the large-scale trial, the average increased to 8.9 with a percentage of 89%, which was also in the very active category. Thus, it can be concluded that the use of mathematical literacy teaching modules with the Problem-Based Learning (PBL) learning model on flat-sided spatial geometry material can increase student activity in learning mathematics. These results are reinforced by research conducted by Maharani & Hidayah (2023) Which states that the development of mathematics learning teaching modules has proven effective in motivating students to be more active in learning. This also contributes to strengthening positive character in understanding mathematical concepts through the use of science and technology.

b. Student Response Questionnaire

The results of the descriptive analysis obtained an average response of students after using the mathematical literacy teaching module with the Problem-Based Learning (PBL) learning model of 3.5 with a response percentage of 86.6%, which is in the very positive category. Meanwhile, based on the results of the inferential analysis, it shows that H_0 is rejected and H_1 is accepted, namely the average score of student responses after being taught using the mathematical literacy teaching module with the Problem-Based Learning (PBL) learning model on the material of flat-sided solid shapes is more than 80%. Based on the results of the descriptive and inferential statistical analysis, it can be concluded that the mathematical literacy teaching module is effective in terms of student responses.

c. Student Learning Outcome Test

The student learning outcome test in the effectiveness test of the teaching module is measured through the average learning outcome, classical completeness, and normalised gain.

1. Average Learning Outcome Test

The results of the descriptive analysis obtained an average of student learning outcomes after using the mathematical literacy teaching module in a small-scale trial of 83.74 and a large-scale trial of 87.52. The results of the inferential analysis showed that the average student learning outcomes were more than 76 (H_0 was rejected, and H_1 was accepted). From the results of the descriptive and inferential analysis obtained, it can be concluded that the mathematical literacy teaching module with the Problem-Based Learning (PBL) learning model is effective in terms of achieving student learning outcomes.

2. Classical Completeness

The results of the descriptive statistical analysis, students achieved a score of ≥ 77 in the small-scale trial were 29 students or a percentage of 85.30%, while a score of≥ 77 in the large-scale trial was 90 students or a percentage of 91.84%. The results of the inferential analysis showed that classical completeness was more than 80% (H0 was rejected, and H1 was accepted). Based on the results of the descriptive and inferential analysis obtained, it can be concluded that the mathematical literacy teaching module is effective from the aspect of classical completeness.

3. Normalized Gain

The results of the descriptive statistical analysis obtained an average normalised gain value of 0.84, which is in the high category. Meanwhile, based on the results of the inferential statistical analysis, the average normalised gain is more than 0.3 (H_0 is rejected

and H_1 is accepted). Based on the results of the descriptive statistical analysis and inferential statistics, it can be concluded that the mathematical literacy teaching module with the Problem-Based Learning (PBL) learning model on the flat-sided spatial structure material is effective in terms of normalised gain.

Overall, based on descriptive and inferential analysis, the mathematical literacy teaching module with the Problem-Based Learning (PBL) learning model on the material of flat-sided spatial figures has proven to be effective in the learning process. This is reflected in the increasing activity of students, student responses, and achievement of student learning outcomes.

CONCLUSION

Based on the results of research and discussion of the development of mathematics literacy teaching modules with the Problem-Based Learning (PBL) learning model on the material of flat-sided space building, the conclusions are obtained in the form of (1) The process of developing mathematics literacy teaching modules with the Problem-Based Learning (PBL) learning model refers to the stages of the ADDIE development model, namely conducting several analysis activities to serve as a reference in designing teaching modules, designing concept papers and research instruments, making teaching modules and validation processes, testing twice, conducting data analysis, and final revision of mathematics literacy teaching modules. (2) The quality of the mathematics literacy teaching module with the Problem-Based Learning (PBL) learning model on flat-sided space building material meets the valid, practical, and effective qualifications, meaning that the teaching module is able to provide an actual data description that this teaching module is easy to use and able to improve students' understanding and mathematical literacy skills based on evidence of learning outcomes tests. Thus, the mathematics literacy teaching module with the Problem-based Learning (PBL) learning model is suitable as a learning resource. (3) The level of effectiveness of the mathematics literacy teaching module is in the effective category in terms of student activities, student responses, and mathematics learning outcomes tests, each of which has met the predetermined effectiveness criteria.

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