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DEVELOPING MATH MODULES TO IMPROVE STUDENTS' MATHEMATICAL LITERACY

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ABSTRACT

This study aims to produce a module to improve students' mathematical literacy. This study is a Research and Development (R&D) using the ADDIE model which includes: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. The subjects in this study were 20 students of class VIIIE of SMP Negeri 02 Wuluhan. The instruments used were a preliminary test, module validity and practicality questionnaire, pre-test, post-test, and pre-test post-test validity questionnaire. The results of the pre-test and post-test were tested using the paired sample t-test and n-gain. The results showed that the module achieved an average validity of 93.7% (very valid), and a practicality of 98.47% (very practical). The paired sample t-test showed a significant difference between the pre-test and post-test (sig. 0.000 <0.05) with an increase in mathematical literacy scores of 33.57. The n-gain score reached 76,72 (effective). So, it can be concluded that the module was valid, practical, and effective in improving students' mathematical literacy.

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1. INTRODUCTION

Education should be able to prepare students to face all changes and problems that may occur in the future (Triana et al., 2023). Mathematics as a part of the education system taught to students aims to practice logical, systematic, critical, analytical, procedural, and creative reasoning skills (Aini & Andreansyah, 2023). Thus, mathematics is considered a very important subject at all levels of education in all countries. The proof is, that PISA makes mathematics a basic competency that is assessed (Feriyanto & Putri, 2020).

Assessment of mathematical literacy is one of the skills that is conducted by *the Organisation for Economic Co-operation and Development* (OECD) through the *Program for International Student Assessment* (PISA) every four years for 15-year-old students worldwide. PISA was last held in 2022. Indonesia's PISA results are ranked 66th out of 81 participating countries (https://www.oecd-ilibrary.org/). Figure 1 shows that Indonesia's PISA score is still below average

(https://www.oecd.org/). PISA content includes change and relationship, space and shape, quantity, and uncertainty and data (https://pisa2022-maths.oecd.org/).

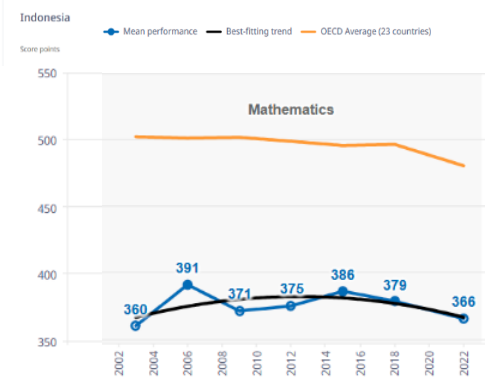


Figure 1. Results of the 2022 Indonesian PISA

Mathematical literacy skills are one of the main studies in PISA. Mathematical literacy is one aspect of literacy that is a basic skill that students must master (Feriyanto & Putri, 2020). Mathematical literacy is an individual's ability to reason, formulate, apply, and interpret mathematically to solve problems in real contexts. Mathematical literacy includes concepts, procedures, facts, and tools to describe, explain, and predict a phenomenon (https://pisa2022-maths.oecd.org/). Mathematical literacy is an individual's ability to formulate, use, and interpret in diverse contexts that include reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena (Hadiyanti et al., 2021,Susanta et al., 2022, Marsitin & Sesanti, 2023).

The main competencies of mathematical literacy are (1) communication, the process of presenting and communicating the solution to the mathematical problems faced, (2) mathematizing, the process of changing or transforming real-world situations into mathematical models, (3) representation, the use of images, lines, and diagrams to solve mathematical problems, (4) reasoning and argument, the process of reasoning and providing logical reasons through analysis of available information, (5) devising strategies for solving problems, the process of formulating strategies for solving mathematical problems, (6) using symbolic, formal, and technical language and operations, the use of symbols, language, and operations, and (7) using mathematical tools, the use of mathematical tools such as operations, measurements, and others (Masjaya et al., 2022, Ningtyas et al., 2022).

Related to the importance of mathematical literacy, it is important to practice students in it. One thing that can be done is by designing learning materials. As mathematics content taught in schools is chosen to practice reasoning, form personality, instill values, and prepare students to be skilled at solving problems (Sholihah & Aini, 2023), learning materials play an important role in supporting the learning process. Learning materials are an important factor in the learning process that can motivate students to study diligently, increase learning independence, and various student competencies (Purniawan et al., 2022). One of the learning materials that can support the learning process is a module. Previous research shows that the module is effective in improving students' mathematical literacy (Feriyanto & Putri, 2020, Hadiyanti et al., 2021,Susanta et al., 2022), mathematical reasoning skills, communication, and self-confidence (Siregar et al., 2020), numerical literacy (Purniawan et al., 2022), mathematical understanding and literacy skills (Susanta et al., 2022).

A module is a set of self-study materials designed to help students achieve learning goals. The main purpose of using learning materials is to increase the efficiency and effectiveness of learning in schools, both in terms of time, cost, facilities, and manpower to achieve goals optimally (Desy et al., 2024). Modules should be developed based on the needs and conditions of the analysis results (Yulando et al., 2019). It is necessary to know exactly what learning materials should be arranged in the form of modules, who the users are, and the resources needed and available to support the use of modules and other things that are considered important.

This R&D will develop a math module based on valid and practical mathematical literacy indicators. Through the use of this module, it is expected that students' mathematical literacy can be improved.

2. METHOD

This research is a Research and Development (R&D) type using the ADDIE model. The stages carried out are described in the following figure.

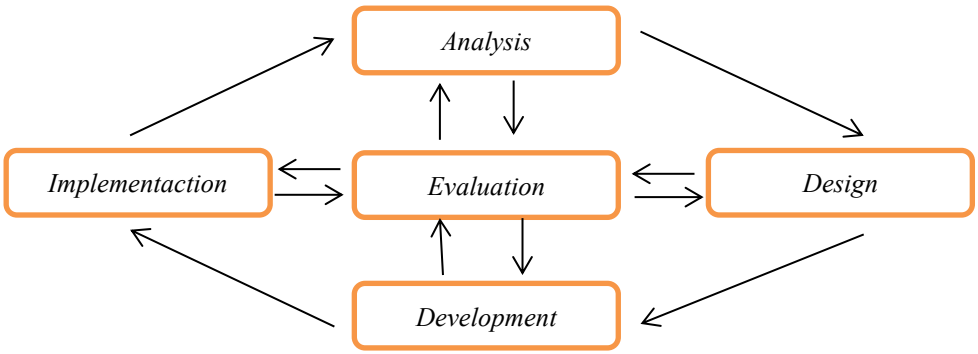


Figure 2. Model ADDIE (Widyastuti & Susiana, 2019)

Research with the ADDIE model was carried out in five stages: analysis, design, development, implementation, and evaluation. At the analysis stage, a review of mathematical content and competencies, a curriculum review, and a review of student needs were carried out. This was carried out through interviews with mathematics teachers and students, preliminary test, and analysis of the curriculum used. At the design stage, the module, the module validity and practicality test instrument, pre-test and post-test, and the pre-test and post-test validity test instrument were designed. At the development stage, the module was prepared according to the initial design and the validity test of the test instrument. At the implementation stage, a module trial was carried out in class VIII E of SMP N 2 Wuluhan Academic Year 2023/2024 with 20 students. Before learning using the module, students took a pre-test, and after learning students took a post-test. In addition, a practicality test was also carried out by providing a student response questionnaire after using the module.

The validity test was conducted by 3 math education lecturers and 1 math teacher. Validity aspects are: math content, learning materials, language and suitability of content. The validity test for pre-test and post-test was conducted by a math education lecturer. The practicality test was conducted on students and the aspects are: module design, ease of use, time efficiency, and evaluation. The validity (module, pre-test, and post-test) and practicality questionnaire use modified Likert scale namely 4 (strongly agree), 3 (agree), 2 (disagree), and 1 (strongly disagree). The scores are accumulated and then converted using a formula:

$$x = \frac{total\ score}{maximum\ score} \times 100$$

Remarks:

x: obtained score

Validity and practicality categorization (Asrizal et al., 2021) are presented in the following table.

Table 1. Validity and practicality categorization

Score	Criteria	
	Validity	Practicality
$25 \leq x \leq 39$	Not valid	Not practical
$40 < x \leq 55$	Less valid	Less practical
$56 < x \leq 65$	Quite valid	Quite practical
$66 < x \leq 80$	Valid	Practical
$80 < x \leq 100$	Very valid	Very practical

The effectiveness test was conducted using paired sample t-test and n-gain. The n-gain formula is:

$$N - gain\ (g) = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score}$$

The N-gain score test converted into categories based on Hake's formula as follows (Triyono et al., 2024):

Table 2. N-gain categorization

Average percentage (%)	Criteria
> 76	Effective
$56 - 75$	Quite effective
$40 - 55$	Less effective
< 40	Ineffective

3. RESULTS AND DISCUSSION

The following explains the development process according to ADDIE:

3.1 Analysis

Analysis was conducted on materials and competencies, curriculum, and student needs as follows. Student needs analysis is carried out based on data from interviews with mathematics teachers and students. The results presented on Table 3 below.

Table 3. Analysis results

Aspect	Analysis result(s)
Content and competency	Students still have difficulty with the material on Two-Variable Linear Equation Systems. Students are still unfamiliar with PISA model questions.
Curriculum	The curriculum used in schools is the Kurikulum Merdeka which should be student-centered learning. However, the facts are that learning is still carried out using teacher-centered learning.
Students need	Students experience obstacles in learning independently because they do not have books. Students' mathematical literacy in the preliminary test is still low.

The preliminary test contains one question on prerequisite material for a two-variable linear equation system which contains indicators of mathematical literacy. Students' mathematical literacy in the preliminary test is presented in Figure 3.

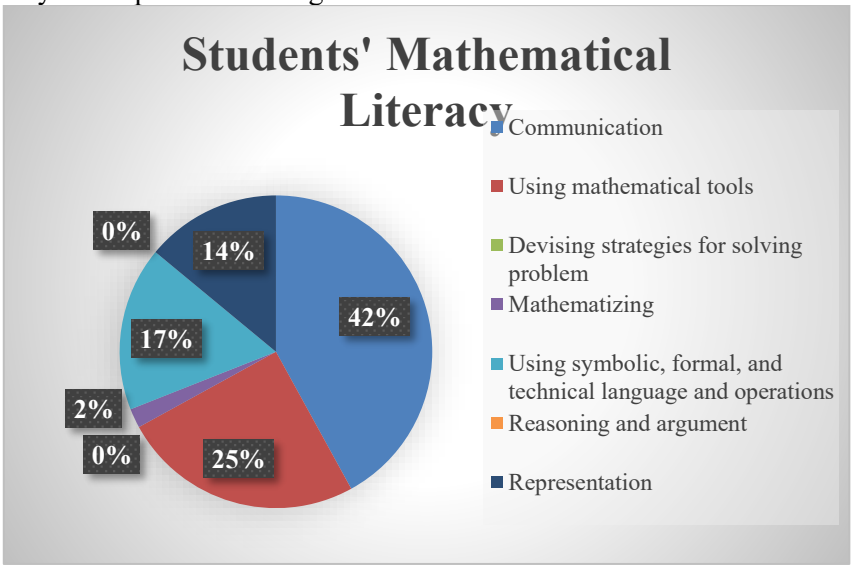


Figure 3. Students' mathematical literacy

The specifications of learning outcomes and learning objectives are formulated based on the independent curriculum in phase D for the junior high school level (https://guru.kemdikbud.go.id/kurikulum/referensi-penerapan/capaian-pembelajaran/sd-sma/matematika/fase-d/).

3.2 Design

The developed module is divided into three parts, namely the preliminary, the contents, and the end section. The preliminary of the module consists of a cover, foreword, table of contents, and introduction (module description, module usage instructions, prerequisites for using the module, learning objectives, learning objective indicators, and concept maps). The contents section contains a Two-variable Linear Equation System (SPLDV). The end section consists of evaluation questions, a glossary, and a bibliography. The module framework will be developed as Table 4 follows.

Table 4. Module Framework

Section	Title
Preliminary	Cover module Foreword Table of contents
Introduction	1. Module description 2. Instructions for using the module 3. Prerequisites for using the module 4. Learning objectives 5. Achievement indicators 6. Concept map 7. Recall
Math contents	Two-variable Linear Equation System (Elimination Method): 1. Learning Activity 2 2. Example 3. Exercise
Evaluation	1. Examples 2. Practice questions
End section	1. Glossary 2. Bibliography

The module was created using Microsoft Office 2010 and Canva. The initial design of the module was dominated by blue as the background and many colors as complements and attractions. The coloring of the elements contained in the module must pay attention to color harmony to attract students' interest in reading. The module was made with A4 size 21 x 297 mm according to the ISO standard size according to the National Education Standards Institution (BSNP).

In addition to the module display, the validity, practicality, and effectiveness of the module instruments were also designed. The validity of the module includes material, language, and design. The practicality instrument includes student and teacher response questionnaires. The module effectiveness instrument includes a pre-test and post-test to measure students' mathematical literacy.

3.3 Development

In the development process, the module is compiled and the validity of the material, language, and design of the module is assessed. The front cover of the module is shown in Figure 4.

Figure 4. The initial design for the math module

The questions presented in the module are also designed according to the main competencies of mathematical literacy, as in the following image.

Figure 5. The initial design for the math module (example)

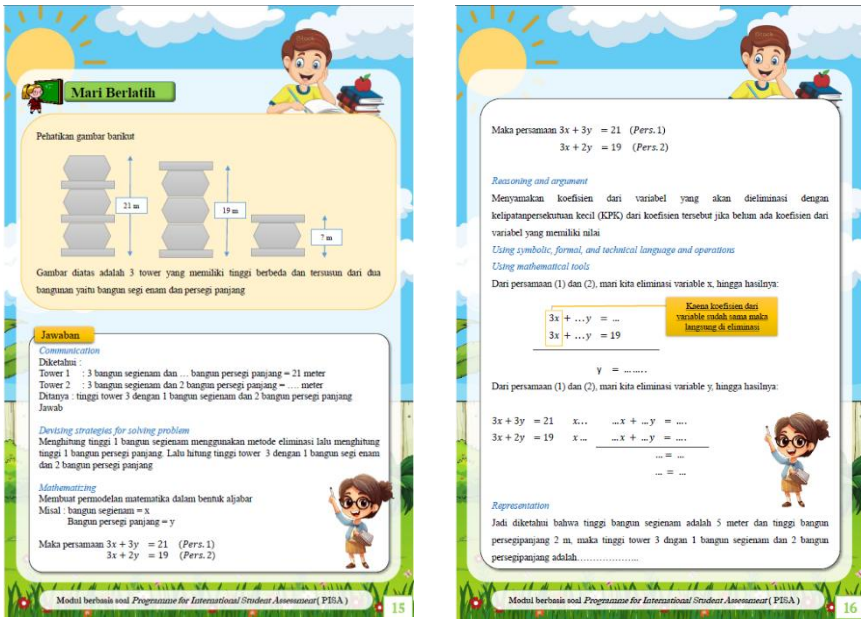


Figure 6. The initial design for the math module (practice)

The results of the validity test are presented in the Table 5 below.

Table 5. Validity results

	Description	Percentage	Criteria
Module	Math content	97.5%	Very valid
	Module design	89.6%	Very valid
	Language	93.3%	Very valid
Instruments	Pre-test and post-test	97.2%	Very valid

Although all three aspects are included in the valid category, the expert validator also provided several revision suggestions as Table 6.

Table 6. Revision suggestions from expert validators

Validation aspects		Suggestion(s)
Module	Math content	Use of mathematical symbols for all mathematical equations or formulas
	Module design	Use of relevant icons/images in each part of the module
	Language	Use of standard sentences Use of appropriate bibliography writing style
Instruments	Pre-test and post-test	Correct the pre-test answer writing error

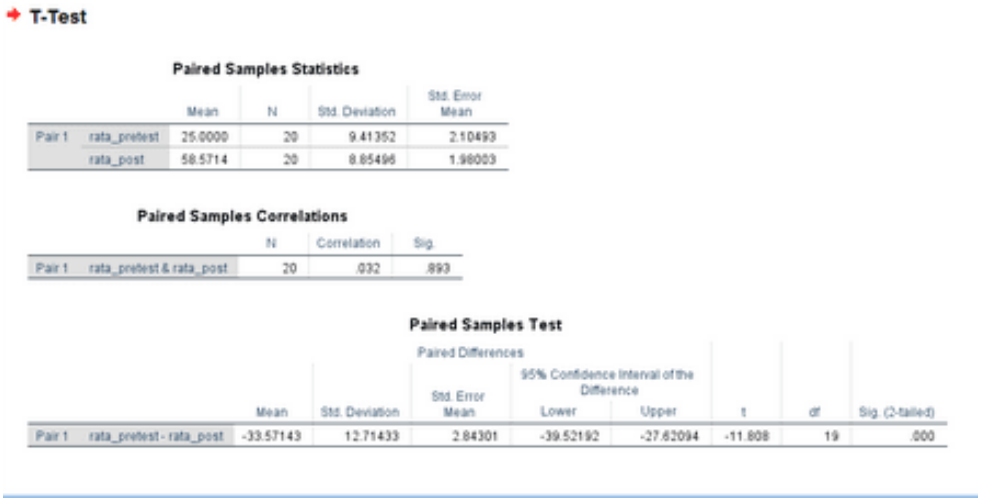
The next stage is to revise the module according to the validator's suggestions. The revised modules and instruments were then tested at the implementation stage.

3.4 Implementation

The implementation stage is carried out by using modules on students in one class. A pre-test was conducted before learning and a post-test after learning to determine students' mathematical literacy. Learning using modules is carried out by mathematics teachers during two meetings.

3.5 Evaluation

The practicality test was conducted by giving a student response questionnaire and obtained a score of 98.47%. The effectiveness test was conducted through a paired sample t-test. After the pre-test and post-test data were declared normally distributed, a paired sample t-test was conducted.



T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	rata_pretest	25.0000	20	9.41352	2.10493
	rata_post	58.5714	20	8.85496	1.98003

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	rata_pretest & rata_post	20	.032	.893

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	rata_pretest - rata_post	-33.57143	12.71433	2.84301	-39.52192	-27.62094	-11.808	19	.000

Figure 7. Paired sample t-test output

The null hypothesis states that there is no significant difference between the pre-test and post-test scores, while significance (0.000<0.05) indicates rejection of the null hypothesis. So it is concluded that there is a significant difference between the pre-test and post-test scores. With an average pre-test score of 25.00 and a post-test of 58.57. The N-gain score reached 76.72, thus it was declared effective. Thus, the developed module is valid, practical, and effective in improving students' mathematical literacy. The module that has been developed can be accessed by link: https://drive.google.com/file/d/1AMLceqHJvBsrjQYSp_EMPrTPo4ozA6BG/view?usp=sharing.

4. CONCLUSION

Based on the development process that has been carried out, the results obtained are that the module has been valid with an average validity score of 93.7%, practical with a score of 98.45%, and effective in improving students' mathematical literacy with N-gain score 76.72.

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