Development of Mathematical Literacy Teaching Materials: A Preliminary Research

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Abstract. Mathematical literacy is one of the relatively new courses in the S-2 Mathematics Education Study Program. The emergence of the course is due to following the development and needs in the world of education. This research explores the need for the development of teaching materials for Mathematical Literacy courses. This course is a compulsory course for students of the S-2 Mathematics Education Study Program. This paper focuses on preliminary research that includes two initial stages in the ADDIE development model consisting of Analyze, Design, Develop, Implement, and Evaluate. Furthermore, referring to the curriculum of the S-2 Mathematics Education Study Program, this course will only take place in the 2021/2022 academic year. Therefore, this course requires teaching materials so that students can master the material well. Thus, it is necessary to develop teaching materials for Mathematical Literacy courses to help students master the theory and then apply it in developing mathematical literacy tasks. The teaching materials referred to in this study are handouts and student worksheets which contain some knowledge and tasks that help students master Mathematical Literacy material and its application in developing mathematical literacy questions that meet valid and practical criteria.

Keywords: Teaching Materials, Handout, Student Worksheets, Mathematical Literacy

1 Introduction

Mathematical literacy can be defined as the ability to apply mathematical concepts and skills to solve practical problems in a wide variety of everyday life contexts, for example, at home, work, and participation in community life and as citizens [1]. Mathematical literacy is the ability of individuals to formulate, use, and interpret mathematics in different contexts. It involves using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena [2]. It helps individuals understand the importance of mathematics in the world, enabling them to make informed judgments as responsible and thoughtful citizens. There has been a growing emphasis on mathematical literacy in its application in everyday life, Mathematical Literacy is one of the

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Mathematics Education students are also given these courses so that they are not left behind by the outside world.

The development of this teaching material is expected to help students in mastering the Mathematical Literacy material that has been studied together to apply it in the next task, namely compiling mathematical literacy questions. This is done because it can be used as a teacher's provision in helping students facing AKM (Minimum Competency Assessment) at school. Based on the description above, it is necessary to develop teaching materials for Mathematical Literacy courses that can help students of the S-2 Mathematics Education Study Program in mastering Mathematical Literacy course material. Therefore, the purpose of this research is to develop teaching materials for Mathematical Literacy courses for students of the S-2 Mathematics Education Study Program that are valid and effective.

2 Literature Review

2.1 Teaching Materials

Teaching material plays a crucial role as a learning tool, providing packaged resources for effective instruction. These materials are thoughtfully organized to facilitate the learning process, ensuring accessibility through clear language suitable for different knowledge levels and ages to learn independently with the help or guidance of educators [3]. Students are expected to easily and freely control the desired learning activities in the form of learning speed, depth of understanding of learning, range of content of learning activities, and time used. The existence of teaching materials can provide easy access to be able to learn anytime and anywhere [4].

In higher education learning, teaching materials become a supporting tool for learning in the classroom. The teaching material must be able to be understood by students to generate interest in reading and be able to involve their thinking process awareness [5]. Teaching materials are a very important component because they can support learning process activities. Teaching materials can be developed according to the characteristics of the material and the needs of learning.

Teaching materials have functions including reflecting a tough point of view, presenting a rich and easy-to-read source of subject matter, providing a neatly arranged source of material, and presenting materials or means of evaluation and remedial that are harmonious and appropriate [6]. Based on these functions, this study emphasizes the function of teaching materials as a source of material and evaluation.

Based on the process, there are two types of teaching materials, namely printed and non-printed teaching materials. There are also several types of printed teaching materials, namely handouts, worksheets, modules, textbooks or textbooks, brochures, leaflets, and so on. In this study according to the description above, the teaching materials developed include handouts and worksheets.

2.2 Handout

Handouts are written materials prepared by a teacher to enrich students' knowledge [7]. In line with this meaning, Kosasih explained that handout material is teaching material that serves to support, clarify, and enrich the main teaching material. Handouts can be obtained in various ways, namely by downloading from the internet, adapting a book, summarizing from the main book, or various sources. Handouts can be in the form of notes that present concepts, principles, and main ideas about a topic to be discussed. Handouts can also take the form of diagrams that present charts, sketches, or drawings, drawn in full or incomplete. The final form of handouts is a combination of notes and diagrams.

2.3 Worksheets/Student Activity Sheets (LKM)

Teaching materials used in teaching and learning activities in the classroom that can support learning activities are Student Worksheets. Student Worksheets are a set of papers containing tasks that must be carried out by students to do a task and play a role in helping students combine their physical and mental activities during the learning process [8]. Additionally, student worksheets help teachers guide students in discovering concepts through their activities. Students are expected to complete learning exercises, express their creative ideas both individually and in groups, exercise critical thought, and cultivate positive group dynamics while using student worksheets. Students use worksheets, which are printed sheets of paper with information, summaries, and directions for carrying out learning exercises. These assignments, which can be either academic or practical, speak to the competencies that students must acquire. Their utilization is reliant on other educational resources.

This Student Worksheet is expected to increase student independence in learning so that the role of the lecturer is only as a facilitator in the classroom and students are actively involved in their learning activities [9]. The purpose of compiling this Student Worksheet is to increase student independence in learning in class and carrying out written exams [10].

2.4 Mathematical Literacy

Literacy skills are very important in the 21st century. In this technological era, the availability of information provides space for everyone to improve their quality of life. However, to be able to utilize the information properly, one certainly needs to be the "subject" of the information. In other words, a person needs to be able to choose good and useful information critically to be able to apply it in his life [11]. Mathematical literacy consists of the words literacy and mathematics. Based on these two words, mathematical literacy means mathematical literacy or literacy in mathematics. Thus, mathematical literacy is a person's ability to use mathematical knowledge to solve existing problems.

Mathematical literacy, also known as numeracy, is the application of mathematical concepts and skills to solve practical problems in everyday life. It involves the analysis and interpretation of quantitative information, such as graphs, tables, diagrams, and charts, and using this analysis to make predictions and informed decisions [1].

Mathematical literacy refers to an individual's ability to effectively utilize and understand mathematics in various situations. It encompasses the application of facts , mathematical concepts, tools, and procedures to describe, explain, and predict phenomena. This proficiency enables individuals to acknowledge the significance of mathematics in the real world, which in turn facilitates the development of sound judgments and the cultivation of constructive, compassionate, and thoughtful individuals. In line with this understanding, NCTM defines five competencies in learning mathematics: Mathematical Representation, Mathematical Reasoning, Mathematical Connection, Mathematical Communication, and Mathematical Problem Solving. These abilities are necessary for mathematical literacy. The ability to formulate, use, and comprehend mathematics in a variety of circumstances is known as mathematical literacy. It entails applying mathematical reasoning and making use of mathematical ideas, rules, data, and instruments to explain phenomena [2]. Individuals who possess this skill can appreciate the value of mathematics in daily life and take reasoned decisions. The ability to reason mathematically is crucial to one's future success. [8].

There are three important components in mathematical literacy: mathematical process, mathematical content, and mathematical context [2]. To measure these components, indicators include formulating situations mathematically, employing mathematical concepts, facts, procedures, and reasoning, and interpreting, applying, and evaluating mathematical outcomes. Mathematical literacy is demonstrated through a person's use of mathematical skills and abilities to solve problems.

3 Method

This research method is the development of R&D (Research and Development) using the ADDIE development research model starting at the Analyze stage, Design stage, Development stage, Implementation stage, and Evaluate stage [12]. The five stages are flowing as shown below.

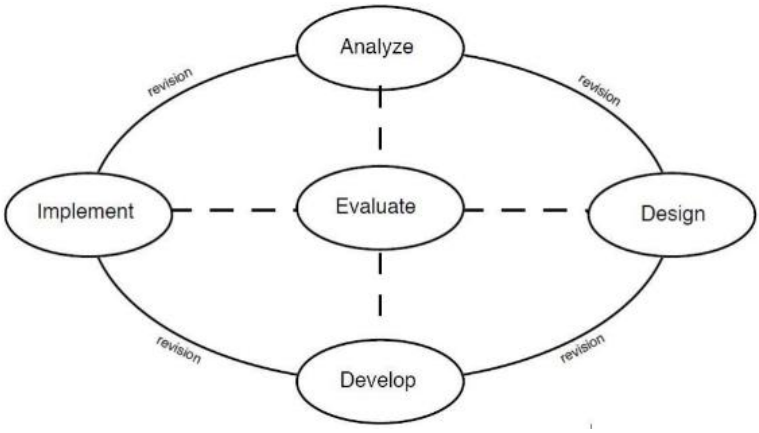

Fig. 1. The ADDIE model.

However, this paper is restricted to the first two stages, namely the analysis stage and the design stage. The activities for both stages are depicted in the following sceme (Figure.2).

3.1 Analyze

This stage is the data collection stage by conducting observations and initial interviews about learning and learning resources used by students. The first observation analyzes the use of learning resources in learning, as well as the characteristics of students and the basic competencies of the material being studied. Determine appropriate learning strategies to overcome existing problems. The results of the needs analysis are then processed to accommodate various limitations in the field and then followed up by designing media development.

3.2 Design

At this stage the researcher makes a design and focuses on the instructional objectives to be achieved. The steps taken by the researcher were as follows: 1) compiling supporting materials according to needs, 2) compiling learning objectives, 3) compiling tasks that can make students achieve learning goals, 4) drafting prototypes of Student Activity Sheets (LKM).

The following will present Figure 2 about the scheme of Activity Flow of Analyze and Design on this research.

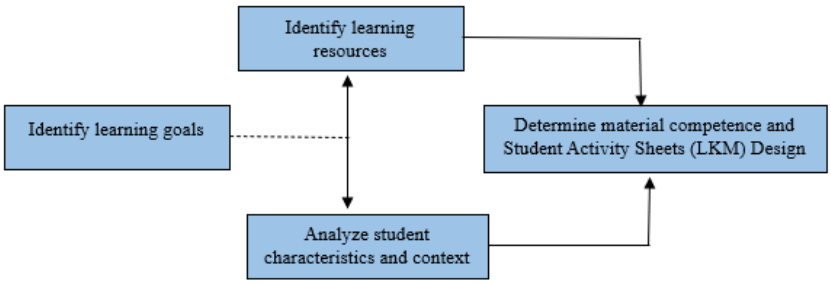

Fig. 2. Activity flow of analyze and design.

4 Results and Discussion

4.1 Analyze Stage

The curriculum of the S-2 Mathematics Education Study Program explains that the description of the Mathematical Literacy course is to examine knowledge about the understanding and modeling of contextual problems in mathematical literacy; basic concepts and the PISA-TIMSS framework; the link between mathematical literacy and

AKM (Minimum Competency Assessment), the application of mathematical literacy in learning; and the development of mathematical literacy questions [13]. Based on this description, the study materials of this course include (1) Some definitions of mathematical literacy, the PISA-TIMSS framework, PISA results 2000-2018, and the link between mathematical literacy and AKM, (2) Key concepts from the PISA framework, (3) Contextual problems in mathematics, (4) Identification of mathematical literacy, (5) Assessment process in PISA, (6) Application of PISA ideas in mathematics learning, (7) Influence of PISA in mathematics education, (8) Mathematical Literacy Support, and (9) Item development to measure mathematical literacy (PISA).

Furthermore, based on the above review materials and the review of several kinds of literature, 2 corresponding source books were selected, namely (1) Kaye Stacy. 2015. Assessing Mathematical Literacy. Springer International Publishing Switzerland [14]. and (2) Solomon. 2008. Mathematical Literacy. New York, Routledge [15]. Fig. 1. shows the materials in the source books that correspond to the above study materials.

Study Materials	Sourcebook
The Evolution and Key Concepts of the PISA Mathematics Frameworks	1
The Real World and the Mathematical World	1
Formulating the Problem: Identifying Mathematical Literacy	2
From Framework to Survey Data: Inside the PISA Assessment Process	1
Applying PISA Ideas to Classroom Teaching of Mathematical Modelling	1
PISA's Influence on Thought and Action in Mathematics Education	1
Supporting Mathematical Literacy	2
The Challenges and Complexities of Writing Items to Test Mathematical Literacy	1

Description:
1: Kaye Stacy and R. Turner. 2015. Assessing Mathematical Literacy. Springer International Publishing Switzerland
2: Solomon. 2008. Mathematical Literacy. New York, Routledge

Fig. 3. Activity flow of analyze and design.

The above material is studied using a panel discussion method which begins with students making a summary of the material and then discussed together. The learning of this course is project-based, meaning that students are required to complete a project as a final semester exam grade. The project is the preparation of mathematical literacy questions. Project-based learning can increase student involvement in learning and work together to obtain good solutions in solving problems. In addition, project-based learning gives students choices in activities and provides an assessment of their performance or product [16].

On the other hand the application of project-based learning makes student collaboration and interaction effective by placing students with different backgrounds and abilities in small groups to achieve common goals. Collaboratively managed classes are more motivating students, encourage curiosity, a sense of mutual assistance [17].

Furthermore, from some of the study materials above, it is necessary to take some materials that can support students to complete their projects. Based on the description, study materials, and learning methods, the study materials that will be developed into teaching materials for Mathematical Literacy courses for S-2 Mathematics Education students are The Real World and the Mathematical World, Formulating the Problem: Identifying Mathematical Literacy, and The Challenges and Complexities of Writing Items to Test Mathematical Literacy.

4.2 Design Stage

This stage aims to design a learning device prototype. Results at the design stage in the form of research instruments, namely handouts for mathematical literacy courses that students can use as references or references in the learning process and Student Activity Sheets (LKM) that students can use as training material to understand the concept of mathematical literacy. The device produced at the design stage this is called the initial draft. The results of each activity at the design stage are described as follows

Handout. Handouts contain essential material information about mathematical literacy based on the references used. There are 3 topics that will be studied by students. The topic is Real World and Mathematical World; The Challenges and Complexities of Writing Items to Test Mathematical Literacy; and Formulating the Problem: Identifying Mathematical Literacy.

Student Activity Sheets. LKM contain questions or commands that aim to see the extent of understanding of the content after the discussion is carried out. The LKM contains questions based on the problems presented in the handout. Students write answers based on the results of discussions with working groups in constructing ideas to produce appropriate problem solving solutions.

Both types of teaching materials will be used by lecturers and students together and designed systematically to obtain valid and effective results. Furthermore, the handouts developed are in the form of notes or diagrams that include objectives, material summaries, and references, while the student worksheets developed include (1) Topic Title, (2) Instructions, (3) Questions or commands related to the topic studied which are analysis or project in nature, and (5) References.

This is in accordance with the opinion of Branch (2009) that at the design stage. Common components that must be designed are topics, activity objectives, material concepts presented, questions to measure understanding before entering the development stage [12].

5 Conclusion

The results of the analysis stage are obtained from 2 source books along with the material to be developed for teaching materials. The first sourcebook, namely Kaye Stacy. 2015. Assessing Mathematical Literacy. Springer International Publishing Switzerland, includes material on The Evolution and Key Concepts of the PISA Mathematics Frameworks, The Real World and the Mathematical World, and The Challenges and Complexities of Writing Items to Test Mathematical Literacy. The second sourcebook, Solomon. 2008. Mathematical Literacy. New York, Routledge, includes material on Formulating the Problem: Identifying Mathematical Literacy.

The results of the design stage determined that the handouts developed were in the form of notes or diagrams that included objectives, material summaries, and references. The student worksheets developed included (1) Topic Title, (2) Instructions, (3) Questions or commands related to the topic studied which were analytical or project in nature, and (5) References.

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References

1. Ministry of Education and Culture, National Literacy Movement Numerical Literacy Supporting Materials. Jakarta: National Literacy Movement Team (2017).
2. OECD, PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic, Financial Literacy and Collaborative Problem Solving (Revised Edition) (2017).
3. D. Sunarsih, N. Yuliyanti, U. Muhadi, S. Brebes, U. Muhadi, and S. Brebes, “Development of Teaching Materials Based on Actıve Learning to Increase Literacy for Prospective Elementary School Teachers,” J. Elem. Edukasia, vol. 4, no. 2, pp. 379–387, 2021, doi: 10.31949/jee.v4i1.3280.
4. J. A. Lim, “Effectiveness of Modular Instruction in Word Problem Solving of BEED Students,” IOSR J. Math., vol. 12, no. 5, pp. 59–65, (2016). doi: 10.9790/5728-1205075965.
5. B. Setiawan and O. J. Dores, "Development of Teaching Materials Based on Metacognition Skills in an Effort to Improve Students' Mathematical Literacy Ability,” JPMI (Jurnal Pendidik. Mat. Indones., vol. 4, no. 2, p. 68, (2019.) doi: 10.26737/jpmi.v4i2.1412.
6. Aeng Muhidin and U. Al Faruq, Instructional Material Development Guidelines. Tangerang: UNPAM Press (2018).
7. T. Bambang, Textbook Writing: Handout. Semarang: Semarang State University (UNNES) (2017).
8. J. Wildani, I. W. Triyana, and W. Mahmudah, “Development of Student Worksheets (LKS) Based on Mathematical Literacy in Statistics Materials,” AKSIOMA J. Mat. dan Pendidik. Mat., vol. 11, no. 1, pp. 141–150 (2020). doi: 10.26877/aks.v11i1.3779.

9. R. Pasandaran, D. M. R. Kartika, and E. D. Masni, "Development of Student Worksheets (LKM) on Proving Triangle Theorems," Pros. Semin. Nas. Univ. Cokroaminoto Palopo, vol. 3, pp. 147–1532 (2013).
10. Rahmi, V. Angraini, and melisa, "Development of Student Worksheets Based on Problem Based Learning in Lectures," Pros. Semin. Nas. Sains dan Pendidik. Sains IX, vol. 5, no. 1 (2014).
11. D. S. M. First, Learning Inspiration that Strengthens Numeracy. Jakarta: Ministry of Education, Culture, Research and Technology of the Republic of Indonesia (2021).
12. R. Branch, Instructional Design: The ADDIE Approach. Boston: Spring (2009).
13. A. Lukito, R. Setianingsih, P. Wijayanti, and E. B. Rahaju, "Draft Curriculum Documents Of Outcome-Based Education (Obe) Mathematics Education Study Program At State University Of Surabaya," (2021).
14. K. Stacey and R. Turner, Assessing mathematical literacy: The PISA experience. Springer International Publishing Switzerland (2015).
15. Solomon. Mathematical Literacy. New York: Routledge (2008).
16. A. Miller. Designing PBL Projects to Increase Student Literacy. International Reading Association (2014).
17. Handayani, N. D., Mantra, I. B. N., & Suwandi, I. N. Integrating collaborative learning in cyclic learning sessions to promote students' reading comprehension and critical thinking. International Research Journal of Management, IT and Social Sciences, 6(5), pp. 303–308 (2019).

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