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Research Article

Development of Teaching Materials to Train Students' Geometry Literacy Skills

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Abstract: Geometry literacy is one of the critical skills to be mastered by students. However, teachers have not given more attention to that part. Therefore, this study aims to develop valid, practical, and effective teaching materials to train students' geometry literacy skills. This type of research is Research and Development (R & D). The stages of development refer to Plomp's development, namely: (1) preliminary research, (2) prototyping phase, and (3) assessment phase. The research instruments used in collecting data are validation sheets, learning implementation observation sheets, student response questionnaires, teacher responses, and learning outcome tests. Furthermore, the data obtained were analyzed using validity, practicality, and effectiveness analysis techniques. Based on the results of the analysis, teaching materials were obtained that met the valid criteria with an average validity score of 3.3, met the practical criteria with an overall average aspect of the implementation of the learning model of 1.68, and a positive response from the teacher, and met the effective criteria with a positive response from students and a percentage of students' critical thinking skills of 82.6% in the high category. Thus, using teaching materials can encourage students to improve their geometry literacy skills.

Keywords: Teaching material, geometry, literacy skills

1. INTRODUCTION

The current demands in the 21st century require students to have literacy skills and be able to solve problems in everyday life. Indonesia is currently in the era of literacy (Habibi & Prahmana, 2022). One of them is mathematical literacy which has become a vision in the world of mathematics education initiated by the National Council of Teaching Mathematics (NCTM), including five standards, namely problem-solving, reasoning, communication, mathematical connections, and representation skills (Maulyda, 2020). The five process standards include mathematical literacy competencies. The Programme for International Student Assessment (PISA) framework explains that mathematical literacy is the ability of students to analyze, reason, and communicate ideas effectively and formulate, solve, and interpret solutions to mathematical problems in various situations of everyday life (OECD, 2019). Stacey & Tuner (2015) stated that mathematical literacy could be used as strength to be better prepared to face life's challenges. Mathematical literacy skills are essential to solve problems faced in everyday life (Setiawan, Dafik, & Lestari, 2014; Kelana, Wardani, Firdaus, Altaftazani, & Rahayu, 2020).

Mathematical literacy based on the PISA study contains four mathematical contents, namely (a) space and shape, (b) change and relationship, (c) quantity, and (d) uncertainty and data. Space and shape content in PISA uses geometry material as the basis for its completion (Wijaya, 2012). Of the four contents, space and shape content related to geometry occupies the lowest position (Mahdiansyah & Rahmawati, 2014; Nurutami & Setyawan, (2019); Oktaviana & Rosyidi, 2019). This literacy ability, especially geometry literacy, is one of the essential abilities to be mastered by participants to face the challenges of today. The geometry literacy indicators are broken down from mathematical literacy: formulate, employ, interpret, and evaluate. Based on this, efforts are needed to support students literacy skills.

Zulkardi (2013) states that using a context close to students' lives will attract their attention and make it easier for them to recognize and understand a problem before solving it, and the result obtained is that learning mathematics becomes more fun and meaningful. It follows Freudenthal's view that mathematics must be connected to the reality of daily and mathematics as a human activity (Gravemeijer, 1994; Alani, Rahman, Nurhasanah, Kurniasih, Herdiyanti, & Damanik, 2020). Students' geometry literacy skills can be trained by preparing and planning suitable teaching materials. One teaching material that supports the teaching and learning process is the student textbook. Laili *et al*. (2019) argued that textbooks could improve the mastery of material for teachers and students.

Previous studies have developed teaching materials to train mathematical literacy skills, including Effendi,

Putri, & Yanawati (2019); Susanta, Sumardi, & Zulkardi (2022), teaching materials in the form of student worksheets. In contrast to previous studies, this study develops teaching materials in the form of textbooks devoted to training students' geometry literacy skills by loading the main components underlying geometry literacy into the textbook, namely communication, mathematizing, representation, reasoning, and argument, devising strategies for solving problems and using symbolic, formal, and technical language and operations. Thus, this study aims to develop valid, practical, and effective teaching materials to train students' geometry literacy skills.

1. RESEARCH METHODS

This type of research is research and development (R & D) and focuses on developing teaching materials that are valid, practical, and effective. The development procedure in this study refers to the Plomp development model, which consists of three stages, namely (a) preliminary research, (b) development phase, and (c) assessment phase. The product trial was conducted on class VIIIC MTs Madani Alauddin students, totaling 34 people. The research instruments include validation sheets, teaching material, implementation observation sheets, student activity observation sheets, teacher and student response questionnaires, and critical thinking tests. The data analysis technique analyzes validity, practicality, and effectiveness.

The form of activities carried out in the validity data analysis process is:

a. Recapitulate the assessment results of the level of expert relevance into the aspect table, namely the aspects assessed, the validator's score, and the level of relevance, namely the validator's assessment interpretation (A, B, C, and D). The inter-rater consistency model for content validity is shown in the following table.

b.

Table 1. Inter-rater Consistency Model for Content Validity

Validator I / Validator II	Weak relevance (items worth 1 or 2)	Strong relevance (item is worth 3 or 4)
Weak relevance (items worth 1 or 2)	A	B
Strong relevance (item is worth 3 or 4)	C	D

Sources: Ruslan (2009); Gregory (2015)

c. Find the content validity coefficient from all validators for each criterion with the formula:

"Content Validity Coefficient" = $\frac{D}{A+B+C+D}$

d. Determining the final result of the content validity coefficient after improvements have been made based on the suggestions of the validators who rated it weak (content validity coefficient ≥ 0.75 means instrument reliability).

The degree of validity is determined by considering the relevance of the assessment of the two experts. The instrument that has been made has a strong level of validity in deciding; an agreement model between two experts is used with the criteria that the assessment results of the two validators at least have relevance and that the content validation coefficient is more significant than 75%. The measurement or intervention results are valid.

The product's practicality was analyzed based on the implementation of learning, at least in the partially implemented category, and the teacher's response was in a positive category.

Observers assessed the implementation of learning. The criteria for the aspects in question are implemented and not implemented. The percentage scale to determine the implementation of learning uses the following formula.

$$PKP = \frac{number\ of\ learning\ stages\ implemented}{Total\ number\ of\ learning\ stages} \times 100\%$$

Description: PKP = percentage of learning implementation

The observation of each observer assesses by giving a score of 1 - 4. The assessment criteria are obtained by comparing the average rating scale given by the two observers with the assessment criteria below:

$$3.25 < Very\ Good \leq 4.00$$
$$2.50 < Good \leq 3.25$$
$$1.75 < Fair \leq 2.50$$
$$1.00 \leq Poor \leq 1.75$$

The calculation of the reliability of the instrument for the implementation of the geometry literacy learning model is based on the interobserver agreement obtained using the following formula (Borich, 2003).

$$Precentage\ of\ Agreement = \left[1 - \frac{A-B}{A+B}\right] \times 100\%$$

Description:
The validator gives a = The highest score
B = The lowest score is given by the validator
B = The lowest score is given by the validator

A is the rater's more significant score, and B is the more miniature score. The more significant score (A) is permanently reduced by the minor score (B). The instrument is reliable if the percentage value of the agreement is more or equal to 75%. If the resulting value is less than 75%, it should be tested for clarity and agreement from observers (Borich, 2003: 285).

The criteria for analyzing teacher and learner response data used are as follows:

Table 2. Teacher and Learner Response Criteria

Interval Score	Criteria
$PR < 50\%$	Not Positive
$50\% \leq PR \leq 100\%$	Positive

Source: (Arsyad, 2016)

The last stage of data analysis is analyzing product effectiveness data by paying attention to learning outcomes and positive learner responses. A learner is said to be complete in learning if they get a minimum score of 75. Learning is classically complete if at least 85% of students achieve a minimum score of 75 (Trianto, 2014).

2. Results and Discussion

Results of Preliminary Investigation Phase

At this stage, learner analysis, teaching material needs, and task analysis were carried out through observations and interviews. Learner analysis was conducted to determine the characteristics of students in class VIII MTs Madani Alauddin, Gowa Regency, South Sulawesi. Based on observations and interviews with mathematics teachers who teach at the school, students still have difficulty solving non-routine problems related to literacy, especially geometry literacy. Furthermore, needs analysis was conducted through interviews with students and teachers. Learners in learning geometry use limited textbooks provided at school but have not facilitated learners constructing their knowledge, including training literacy skills, namely geometry literacy. No teacher has tried to develop teaching materials to train students' geometry literacy skills. The subject matter discussed in the developed teaching materials is flat space with the following essential competencies:

a. Differentiate and find spatial figures' surface area and volume (cubes, blocks, prisms, and pyramids).
b. Solve problems related to flat-sided spaces' surface area and volume (cubes, blocks, prisms, and pyramids).

Task analysis is done by identifying the objectives to be achieved in learning. Assignments are based on the essential competencies that are the focus of development. In formulating the task, analysis is associated with learners' daily life on the subject matter geometry of flat-sided spaces, discusses to investigate problem-solving, find solutions, and express the results that have been obtained. The main components underlying geometry literacy are contained in the teaching materials developed. It is used as a reference to develop teaching materials for geometry literacy learning.

Results of the Development or Prototyping Phase

This stage is done by designing or developing teaching materials learning geometry literacy following the needs of participants' students and research instruments used to collect data on the quality of teaching materials developed. An overview of the components of teaching materials, namely the student textbook, consists of a cover, preface, table of contents, instructions for using the book for lecturers and students, concept maps, learning activities, assignments, and bibliography. The teaching materials are arranged based on the steps of activities that support the geometry literacy of students, namely introduction to geometry problem orientation, discovery, reason and argument development, evaluation, and review.

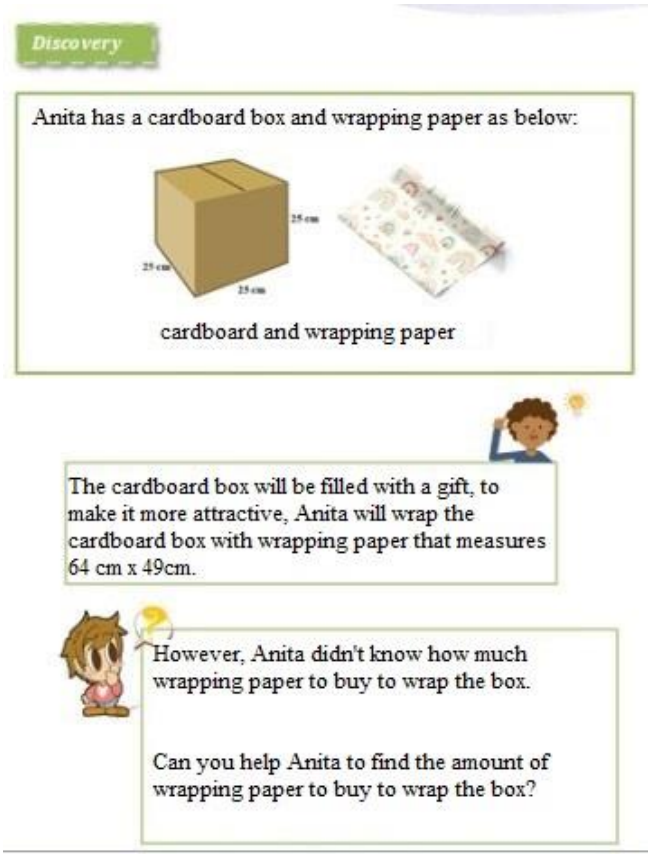

Figure 1: Initial Design of Discovery Activities in Geometric Literacy Teaching Materials

In making teaching material designs, the order of the material presented and the steps of the activities to be carried out must be considered, the format of the teaching materials must be consistent, and the appearance of the design is sought to be attractive.

Assessment Phase

Validity Test Results

The teaching materials developed were submitted to 2 validators to assess the feasibility of teaching materials. The revisions made based on suggestions from both validators include: 1) revising the arrangement of learning activities by adjusting to the syntax of the learning model used, 2) Presenting problems based on the context in the daily lives of students, 3) the images displayed should be relevant to the problems presented, and 4) in the discovery steps, students should be directed to work on problems/problems on the LKPD that have been provided. 5) the GeoGebra display displayed in class should be presented in teaching materials in images and video links. The results of the assessment of the two validators are summarized in the following table:

Table 3. Validator Team Assessment Analysis Results

Assessed Aspect	Coef. Validation	Description
Content	1	Valid
Construct	1	Valid
Language	1	Valid

Based on Table 3, a validation coefficient of 1 was obtained, so the module was feasible to be tested.

Before the trial, teachers were first trained to use teaching materials in learning, prepare students and prepare the learning environment. The trial was conducted to test the practicality and effectiveness of the module. The trial phase was carried out six times a meeting involving 34 students, a teacher, and two observers.

The syntax of the learning model on teaching materials in the form of textbooks, namely the first phase of introduction, begins with observing concrete objects and images of space buildings from GeoGebra and conducting experience / exploring students' knowledge of geometry material accompanied by feedback (communication). The second phase is geometry problem orientation by presenting problems and changing geometry problems in the natural world context to mathematical sentences (mathematizing). The third phase of discovery is working on LKPD in groups and finding solutions to geometry problems given on LKPD (devising strategies for solving problems and using symbolic / operation). The fourth

phase of reasons and argument development is group presentations and other groups' responses: phase evaluation and review, reinforcement, and individual assignments.

Practicality criteria are evaluated through teacher responses and learning implementation; the results of the analysis of both are described as follows:

Table 4. Summary of Analysis Results of Implementation of e-learning-based Learning

Assessed Aspect	Average Observation Results for Each Meeting						$\bar{X}$
	P1	P2	P3	P4	P5	P6	
1. Syntax	3.13	3.72	3.69	3.91	3.94	3.94	3.72
2. Social System	3.08	3.08	3.33	3.75	3.92	3.67	3.47
3. Reaction Principle	3.50	3.50	3.83	4	4	3.67	3.75
4. Support System	3.63	3.63	3.88	3.75	3.88	3.75	3.75
5. Instructional Impact	3.38	3.50	3.63	3.63	3.75	3.61	3.61
Overall Aspect Average							3.66
Percentage of Agreement							96.12

Based on Table 4, it is known that the implementation of aspects 1-5 on the collaborative learning model of geometry literacy is in the interval $3.25 < M < 4.00$, with the category Excellent. Viewed from all aspects of the geometry literacy learning model is 3.66, in the interval $3.25 < M < 4.00$, with a perfect category. Furthermore, the reliability of the implementation of the model is (R) = 96.12 ($\geq$ 75). That is, observers agreed that the components of the geometry literacy learning model were implemented with a percentage of 96.12%. Furthermore, the results of the teacher response analysis are described in the following table:

Table 5. Teacher Response Results

Aspects responded	Category			
	-	%	+	%
Teaching materials use an attractive appearance	0	0	2	100
Teaching materials equipped with images from GeoGebra, is a new thing	0	0	2	100
Exercise on teaching materials can train students' geometry literacy skills	0	0	2	100
Teaching materials are easy to use	0	0	2	100
Teaching materials use the correct language	0	0	2	100
Teaching materials use the proper notation	0	0	2	100
Teaching materials use the right systematics	0	0	2	100
Response Percentage	**0**	**0**	**14**	**100**

Based on Table 5, it is known that the percentage of teacher responses is 100% in the positive category. It means that all students accept the use of teaching materials in learning.

The effectiveness criteria are obtained through analysis of learner responses and learner learning outcomes tests. The results of the analysis of both are described as follows:

Table 6. Results of Student Response Analysis

Assessed Aspect	Category	
	-	+
Teaching materials use appropriate language	0	34
Teaching materials use inappropriate symbols	5	29
Teaching materials use appropriate systematics	0	34
Teaching materials are not practical to use	4	30
Teaching materials use an attractive appearance	0	34
The activity stages in the teaching materials help me follow the learning well	5	29
Teaching materials equipped with images from GeoGebra are new	3	31
Number of Responses	17	221
Percentage of Response	7.14	92.86

Table 6 shows that the percentage of students' responses is 92.86, which is in the positive category, and 7.14 in the harmful category.

Furthermore, the student's learning outcomes test can be described in table 7 below:

Table 7. Description of the Learner Learning Outcomes Test

Interval	Frequency	Percentage	Category
91-100	12	35.29	Very Good
75-90	20	58.83	Good
60-74	2	5,88	Fair
0-59	0	0.0	Poor
Average		86.65	High

Based on Table 7, it is known that the percentage of students' learning outcomes test is 35.29% in the excellent category, 58.83% in the good category, 5.88% in the good category, the average learning outcome of 86.65 in the high category and there are no students who have geometry literacy skills in the less category.

4. DISCUSSION

Geometry literacy learning combines the presentation of abstractions based on visual and spatial experiences, such as fields, patterns, measurements, and mapping. Brumfield suggests four reasons for studying geometry, including (1) geometry teaches logical accuracy, that is, a person is required to be more thorough and careful; (2) geometry is taught for practical purposes; in other words, geometry is taught to support other sciences; (3) after studying geometry, a person will have a broader insight in understanding the beauty of the shapes around him; (4) after studying geometry, a person will know to understand scientific thinking (Brumfiel in Wardhani, 2019). Some research on geometry literacy explains that constructing mathematical literacy problems/questions on geometry material, namely cubes, and blocks, by formulating situations mathematically and using mathematical concepts, facts, procedures, and reasoning (Malasari, Herman, & Jupri, 2017). In addition, research conducted by Rizki & Priatna (2019) states that mathematical literacy is one of the components needed to build skills in the 21st century, so each individual must understand mathematical literacy to solve problems faced in everyday life.

This research develops teaching materials in the form of textbooks to train students' geometry literacy skills by referring to the Plomp development model, which consists of three stages: preliminary investigation phase, development or prototyping phase, and assessment phase (Plomp & Nieveen, 2013). The results of this study support previous research by producing a valid and implementable geometry literacy textbook. The developed textbooks are organized with the content of learning materials concisely and containing concepts, contextual problems, equipped with images of buildings from the GeoGebra application, and exercises that direct learners to practice geometry literacy skills. The positive response of learners and teachers to geometry literacy textbooks concluded that learning using textbooks effectively improves learners' geometry literacy skills.

Based on this research, it is known that the quality of teaching materials in the form of textbooks meets the criteria of validity, practicality, and effectiveness. The validity criteria are obtained from expert assessments based on indicators of suitability to needs, firm theory, and consistency between components of teaching materials developed (Akker, 1999; Hunaidah *et al*., 2019). Validity can be described as the core of the development process, especially for measuring abstract concepts, or it cannot be observed directly (Hendryadi, 2017). According to Mustami (2017), aspects must be considered in validating textbooks: content/material construction, completeness of presentation techniques, integration, language, and benefits/usability (Mustami, 2017). Apart from the validity criteria, the quality of teaching materials is also seen from the criteria of practicality. The practicality of a product can be seen from the ease of using the product being developed (Abrar *et al*., 2021). Products that meet practical criteria will be effortless to use and utilize in the learning process (Kusuma, 2017; Mustofa & Cintamulya, 2017; Nerita *et al*., 2019). A product must pay attention to its practicality criteria before it is used (Riefani, 2019), both on practicality in preparation, product use, and product interpretation (Juliantri *et al*., 2017). After looking at a product's validity and practicality, the effectiveness criteria need to be considered to determine the achievement of learning objectives (Uno, 2007; Abrar *et al*., 2021), which are oriented to the process and results (Hutabri, 2017).

The results of this study indicate that the average geometry literacy skills are in the high category. This textbook trial uses learning activities that contain aspects that underlie the process of mathematical literacy, especially geometric literacy. In the introduction step, students observe concrete objects and crowdsource ideas accompanied by feedback to connect the previous material with the material to be studied. This activity contains communication aspects of geometry literacy. The geometry problem orientation step provides geometry problems, converts problems into mathematical sentences, and re-expresses the meaning of the problem/problem accompanied by feedback. This activity contains aspects of mathematizing, communication, and representation in geometry literacy. The next step is discovery, discussing working on LKPD to find solutions to the problems that contain representation, devising strategies for solving problems, using symbolic, formal, and technical

language and operations, and using mathematical tools for geometry literacy. The reasons and argument development step presents students' work in groups, and other groups provide responses that contain aspects of the reasons argument on the main components of geometry literacy. The last step is evaluation and review by reinforcing learners on the material that has been learned and emphasizing improvement. This activity contains aspects of communication in geometry literacy. Thus, learning activities such as presenting contextual problems related to students' lives and then crowdsourcing ideas accompanied by feedback, understanding and re-expressing geometry problems, and finding solutions by discussing, presenting, and providing responses can be applied to train mathematical literacy skills, especially geometry literacy of students.

This research is in line with Sumirattana, Makanong, & Thipkong (2017), which shows that proposing problems related to the real life of students and directing students to solve these problems individually or in groups can improve students' mathematical literacy skills. In addition, research by Widi *et al*. (2019); Susanta & Sumardi (2022) found that module development using problems that are close to the learners' environment during the learning process can support learners' literacy skills.

There are several advantages of textbooks that have been developed. This textbook presents learning steps that contain aspects that underlie the process of mathematical literacy, especially geometry literacy which is expected through these learning activities can train students' geometry literacy skills. This book is accompanied by pictures and contextual problems that are used as a bridge from something that can be seen as accurate towards mathematization or something abstract and is equipped with images of buildings from the GeoGebra application so that students understand geometry well. Particular findings in this study are that presenting learning steps that contain aspects of geometry literacy and the presentation of contextual problems in the textbook becomes a supporting factor for students' success in achieving individual and classical learning completeness. However, it is inseparable from the direct interaction of teachers with students, students with students, and multi-directional communication in the learning process.

5. Conclusion

Based on the results of this study, we obtained teaching materials in the form of textbooks that meet the criteria of valid, practical, and effective that can train students' geometry literacy skills. Further studies can be carried out by developing a support system in accordance with the characteristics of students, and test instruments that can measure students' literacy skills.

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