DEVELOPMENT OF MATHEMATICAL LITERACY-BASED TEACHING MATERIAL ON MATHEMATICS

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Abstract:
This study aims to produce mathematics teaching material based on literacy. This teaching material is purposively developed and designated for all students, both students with low, medium, and high levels of literacy. Consequently, teachers could easily apply it classically in various learning environments in the class. The design uses the Plomp development model. The research subjects were class VII students of MTsN 3 Central Aceh with instruments in the form of expert validation sheets, practicality assessment sheets, and effectiveness assessments. This study describes the process of developing good-quality textbooks that have fulfilled the criteria of validity, practicality, and effectiveness. The results of expert validation on the material indicator, the average V index score was 0.81, the mathematical literacy indicator was 0.77, the illustration indicator was 0.74, the layout/format indicator was 0.8, and the language indicator was 0.8. Based on these results, it is known that the developed textbooks have fulfilled the valid category. The results of the recapitulation of the practicality questionnaire by the rater have a total score of 137 and a mean score of 45.66. Therefore, the teaching materials are categorized as Very Practical based on the categories used. The tests carried out in the test group showed that the mastery of learning after using textbooks was above 85%, which means that it fulfilled the excellent category, and indicates that the teaching materials developed are effective.

Keywords: Mathematical Literacy, Mathematics Teaching materials

PENGEMBANGAN BAHAN AJAR MATEMATIKA BERBASIS LITERASI MATEMATIKA

Abstrak:
Penelitian ini bertujuan untuk menghasilkan bahan ajar matematika berdasarkan kemampuan literasi. Bahan ajar ini dikembangkan untuk dapat digunakan semua siswa, baik siswa dengan kemampuan literasi rendah, sedang, maupun tinggi. Dengan demikian guru dengan mudah mengaplikasikanya secara klasikal dalam pembelajaran di kelas. Desainnya menggunakan model pengembangan Plomp. Subjek penelitian adalah siswa kelas VII MTsN 3 Aceh Tengah dengan instrumen berupa lembar validasi ahli, lembar penilaian kepraktisan dan penilaian efektivitas. Penelitian ini menjelaskan proses pengembangan buku teks yang berkualitas baik telah memenuhi kriteria validitas, kepraktisan, dan efektivitas. Hasil validasi ahli

Firmansyah B[1], Muhammad Rijali Rais[2]

pada indikator material, skor indeks V rata-rata 0,81, indikator literasi matematika 0,77, indikator ilustrasi 0,74, indikator tata letak/format 0,8 dan indikator bahasa 0,8. Berdasarkan hasil tersebut, diketahui bahwa buku teks yang dikembangkan telah memenuhi kategori yang valid. Hasil rekapitulasi kuesioner kepraktisan oleh penilai memiliki skor total 137 dan memiliki skor rata-rata 45,66. Berdasarkan kategori yang digunakan, bahan ajar dikategorikan sebagai Sangat Praktis. Hasil tes yang dilakukan pada kelompok uji menunjukkan bahwa penguasaan pembelajaran setelah menggunakan buku teks di atas 85% yang artinya memenuhi kategori baik, dan menunjukkan bahwa bahan ajar yang dikembangkan efektif.

Kata Kunci: Literasi Matematika, Bahan Ajar Matematika

INTRODUCTION

Education is generally essential to prepare the younger generation to live in society. Thus they can carry out various daily activities from the simplest to the preparation for professional roles. Activities in the life process can not be separated from the role of technology and information that continuously grow. Technology developments were viewed by the emergence of the industrial revolution era in 1784 or known as Society 1.0 and until now it has become the era of Society 4.0 towards 5.0. In Society 4.0, technology began to be applied and used to fulfill life's needs and obtain information. In the Society 5.0 era, artificial intelligence will take on a role in transforming millions of data via the internet (internet of things) to improve the quality of human life.

How education, especially mathematics education in Indonesia, is created to equip life skills to welcome the era of society 5.0. This matter continues to be a critical question to keep improving the quality of education services in Indonesia. Unfortunately, mathematics learning in Indonesia still emphasizes students memorizing procedures to solve problems, not concepts. Therefore, they cannot solve mathematical problems that require understanding (Gradini & Firmansyah, 2019).

The OECD (Organization for Economic Cooperation and Development) every three year conducts a study on the achievements of 15-year-old school students internationally. The study is known as the Program for International Student Assessment (PISA). PISA measures one of the students' mathematical

literacy skills. PISA presents mathematical problems containing Content, Contexts, and Competencies. The mathematical problem presented is a situation in the real world that provides a context for applying mathematics. To solve these problems, students must have a level of ability that includes relevant mathematical content. PISA 2018 results show that the performance of 15-year-old Indonesian students in mathematics is at a score of 379 (level 1) whereas the OECD average is 489 (level 3) (OECD, 2019). This result is lower than the score in 2015, which was 388.

OECD (1999) defines "Mathematical literacy as an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged, and reflective citizens". From this definition, it can be understood that Mathematical literacy is the ability to use mathematical tools starting from understanding phenomena in the world, explaining phenomena, finding solutions and decisions, and predicting phenomena. De-Lange (2003) defines mathematical literacy as comprehensive literacy, which includes numeracy, awareness of quantitative literacy, and spatial literacy. Mathematical literacy is not about detailed knowledge of specific mathematical fields such as calculus, algebra, geometry, and others but rather an understanding of what mathematics is capable of achieving (Ojose, 2011).

Four types of contexts are usually attached to real daily problems relating to situations/personal contexts, occupational, societal, and scientific because the problems and solutions can come from different situations or contexts based on individual experiences (OECD, 2009). Mathematical literacy was found by NCTM (Owens,1989) as one of the visions of mathematics education; that is, students to be mathematically literate. In this vision, mathematical literacy is defined as "an individual's ability to explore, to conjecture, and to reason logically as well as to use a variety of mathematical methods effectively to solve problems. By becoming literate, their mathematical power should develop"

Several studies were conducted to find the factors that influence the mathematical literacy of students around the world. Akyuz & Pala (Akyuz & Pala, 2010), based on PISA data 2003 from Turkey, Finland, and Greece investigated the factors influencing students' mathematical literacy and

problem-solving abilities. Occupational factors, parental education levels, and students' self-confidence in mathematics significantly and positively affect mathematical literacy and problem-solving ability in these three countries. In addition, the attitudes towards mathematics significantly and positively affect mathematical literacy in the three countries. The study group of students significantly and negatively affected mathematical literacy in Turkey and Greece, except in Finland. According to Li (Li, 2019), many factors affect students' mathematical literacy. Some of the most relevant are 1) Individual subjective factors; 2) Mathematical cultural factors, and 3) Educational and environmental factors.

Kemdikbud defines numeracy literacy as knowledge and skills to be able to acquire, interpret, use, and communicate various kinds of numbers and mathematical symbols to solve practical problems in particular contexts of everyday life; can analyze information presented in some forms (graphs, tables, and charts) to make decisions. Mathematics textbooks that are most used so far are generally developed based on the demands of curriculum changes. Besides the demands of the curriculum, textbooks are also developed based on certain concepts because of the dynamic demands of education. Such as mathematics textbooks developed based on character education (Cahyono, Tsani, & Rahma, 2018), integrated Islamic values textbooks (Kholil & Usriyah, 2019), and many others.

In response to the government's policy of replacing the National Examination with a National Assessment, it is deemed necessary to develop mathematics teaching materials other than those that support the National Assessment. One form of the National Assessment is the Literacy-Numeration AKM. Numeration itself refers to the ability of mathematical literacy, which has become one of the focuses of the PISA test carried out by the OECD. Several criteria contained in learning resources can be used as a reference to see the support in assisting mathematical literacy. The components according to Gatabi and Stacey (2009) include: 1) Does this item contain references to real-world contexts; 2) Is the required formulation complex; 3) Does the textbook support problem formulation; 4) whether the students themselves do the formulation; 5) Is the question an open or closed problem, and 6) Whether the solution requires interpretation.

The purposes of this research are: 1) To find out the process of developing a mathematical literacy-based mathematics textbook; and 2) Produce valid and practical mathematical literacy-based mathematics

textbooks. The benefit of this research is the realization of mathematics learning textbooks that support the improvement of the quality of mathematics learning and the development of high school students' mathematical literacy skills.

The Organization for Economic Corporation and Development defines mathematical literacy as "Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to engage in mathematics, in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen." According to De-Lange (2003), mathematical literacy is a comprehensive literacy that includes numeracy, awareness of quantitative literacy, and spatial literacy, as shown in the following scheme.
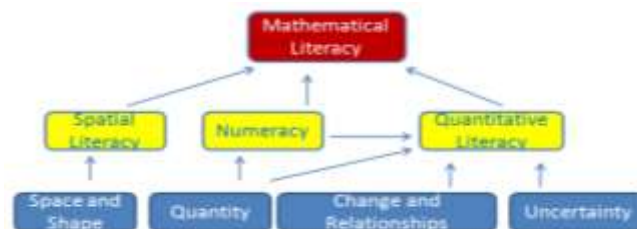

Figure 1. The Structure of Mathematical Literacy according to De Lange

Mathematical literacy is mathematical knowledge, methods, and processes that are applied in a variety of contexts in insightful and reflective ways. The Organization for Economic Cooperation and Development (OECD) states that mathematical literacy ability is defined as a person's ability to formulate, apply and interpret mathematics in various contexts, including the ability to reason mathematically and use concepts, procedures, and facts to describe, explain or predict phenomena/incident. Mathematical literacy skills help someone to understand the role or use of mathematics in everyday life and at the same time use it to make the right decisions on various problems/phenomena that occur.

Besides mathematical literacy, another popular similar term is called numerical literacy. According to Han, Susanto, Dewayani, Pandora, Hanifah, Miftahussururi, and Akbari (2017), numerical literacy is part of mathematics. Numeracy tends to focus on the skill in applying the concept and principle of math in real life, when the problems are often unstructured, own many ways

of solution, and even if there are no thorough solutions, and are often related to the non-mathematical factors.

In 2021, the government conducted the Minimum Competency Assessment, or Asesmen Kompetensi Minimum (AKM) as the replacement for the National Examination. Indonesian Ministry of Education and Culture released the Circulation Letter (Surat Edaran) Nomor 1 Tahun 2021 about the Implementation of School Examinations and one of the points was the abolition of 2021 National Examination. AKM itself is meant to see the competency of reading and numeral literacy of students. This regulation certainly alters the model and design of the final examination which has been long implemented in Indonesia and also will influence the teaching and learning process executed by teachers in the classroom.

As has been mentioned by Susanti and Syam (2017) that teachers play a crucial role in improving students' literacy ability, one of them helping students in developing a perspective on mathematics and initiating learning innovation. Teachers should have allowed students to build their insight and knowledge and appreciate the relationship between math and their lives.

Lestari, Juniati, and Suwarso (2017), in her research results, stated that most teachers do not have sufficient knowledge about mathematical literacy. This makes mathematics learning carried out by teachers focusing on teaching procedures for solving practice questions in specific subject textbooks. Regarding integrating literacy in learning, most teachers still think pessimistically about integrating mathematical literacy and mathematics learning in the future. It causes students' learning process to be less practice working on problem-solving questions and still emphasize routine and procedural questions (Diputra, Diputra, Suarjana, & Japa, 2019). In contrast, numeracy has a systematic relationship with skills such as information-processing skills, literacy, and other skills, as well as social and economic indicators (Grotluschen, Mallows, Reder, & Sabatini, 2016). Saefurohman, Maryanti, Azizah, Al Husaeni, Wulandary, and Irawan (2021) suggest that literacy impacts children's mindsets, including in solving daily life problems. Johar (2012) encourages mathematics education practitioners and experts to immediately innovate in the learning process and evaluate mathematics in schools starting from the elementary school level, leading to mathematical literacy.

One of the solutions that can be offered in this study is developing the learning media and math textbooks that are integrated with literacy in math

learning. The developed textbooks provide the problems positioned in real situations. Those problem contexts are included in the developed textbooks encompassing four contexts namely personal, occupational, social, and scientific contexts.

METHODS

This research is a type of development research using the Plomp development model. The Plomp development model consists of an initial investigation phase, a development or prototyping phase, and an assessment phase (Plomp & Nieveen, 2013). This research was conducted at MTsN 3 Central Aceh. The subjects involved as the users of math textbooks in this development research were 67 students of grade VII from two different classes. The description of the mathematical literacy ability of students at SMP in Aceh Tengah necessarily needs to be studied in further research. However, the quality of students' mathematical learning outcomes in Aceh Tengah can be depicted from the result of the National Examination of SMP at Aceh Tengah in 2019. Firmansyah and Gradini (2019) found out that the students' absorptive capacity towards numbers, algebra, geometry, and measurement material was still below the average.

Best-quality learning tools must fulfill the criteria of validity, practicality, and effectiveness (Nieveen, 1999). The validity test of the instrument in this study was used in the form of validation by experts (expert judgment) with as many as three validators. In order to calculate the validity of mathematics teaching materials content, it is based on the assessment of experts on an item by using Aiken's V formula.

If　lo = The lowest value of the validity assessment (it means = 1)

　　c = the highest number of validity assessments (it means = 4)

　　r = number is given by an evaluator

　　n = number of raters

Furthermore, the value of V is obtained from Retnawati (2016).

$$V = \frac{\sum (r - Lo)}{[n.(c - 1)]}$$

To assess the validity, the instruments – in the form of validation sheets- were used. The validation sheet was filled out by three expert judges who are experts in mathematics. Three of them assessed the aspect of material suitability, mathematical literacy, textbook layout/format, and language spoken. To assess the practical the questionnaire was employed. The

questionnaire was filled out by three mathematics teachers. All the teachers assessed the aspect of objectivity, systematic, construction, language, and practicality. Finally, the test was employed to evaluate the effectiveness of teaching material. The test covered prob problem-solving relevant and contextual content.

The data processing from the questionnaire on the practicality/ease of the instrument as an appropriate assessment tool is carried out by descriptive statistical analysis, that is to analyze the data by describing the data that has been collected, to make the general prevailing conclusions or generalizations. The effectiveness of teaching materials was analyzed descriptively from the learning mastery implementation of students (test results) after it used the teaching materials that had been developed.

RESULTS AND DISCUSSION

The following is an example of a problem in the teaching material on the topic of "Proportion":

Situasi 1: Kepadatan Penduduk

Berikut adalah data jumlah penduduk dan luas wilayah pada 5 kabupaten kota di Provinsi Aceh berdasarkan data dari Badan Pusat Statistik (BPS) Aceh.

Kabupaten/Kota	Jumlah Penduduk Tahun 2019 (Jiwa)	Luas Wilayah (km²)
ACEH TENGAH	212.494	4.318,39
ACEH UTARA	619.407	3.236,86
GAYO LUES	94.100	5.719,58
BENER MERIAH	148.175	1.454,09
BANDA ACEH	270.321	61,36
SABANG	34.874	153,00

* sumber: https://aceh.bps.go.id/

Pertanyaan 1

Mana keempat kabupaten tersebut yang

a. Jumlah penduduk paling banyak?

b. Jumlah penduduk paling sedikit?

c. Luas wilayah terbesar?

d. Luas wilayah terkecil?

Pertanyaan 2

Menurut kalian mana dari kelima kabupaten/kota tersebut yang memiliki kepadatan penduduk terbesar?

Berikan alasan kalian memilih kabupaten/kota tersebut!

Gambar menunjukkan kepadatan pemukiman penduduk di salah satu kampung di wilayah Kabupaten Aceh Tengah (sumber foto: https://lipsus.kompas.com/)

Figure 2. The Screenshot of Problems in the Teaching Material

Through this teaching material, students expectedly are accustomed to implementing problem-solving skills. The problem selected was relevant and contextual to students' surroundings and lives. Some of the problems raised in the local context (Aceh Tengah) in which this teaching material is developed. However, the majority of problems connect to more general issues. Each one of the issues was presented with some visualizations of images, diagrams graphs, and illustrations to help students visualize the concept of mathematics.

Besides presenting the issue itself, there is also some information in the form of general knowledge. Such information was intended to enrich students' insight for every raised context and also to accustom students to digging for information rather than focusing on solving the mathematics questions. Below is the sample information presented to the issue above:
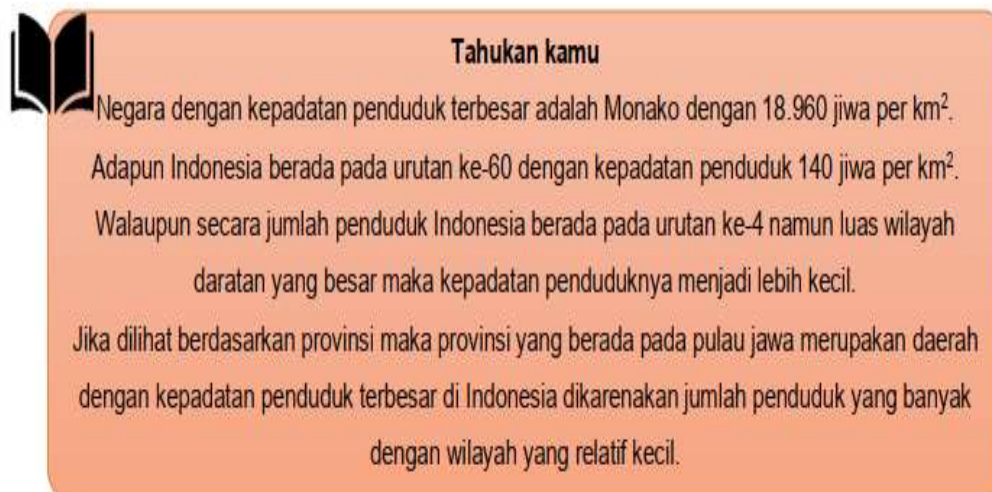

Tahukan kamu

Negara dengan kepadatan penduduk terbesar adalah Monako dengan 18.960 jiwa per km². Adapun Indonesia berada pada urutan ke-60 dengan kepadatan penduduk 140 jiwa per km². Walaupun secara jumlah penduduk Indonesia berada pada urutan ke-4 namun luas wilayah daratan yang besar maka kepadatan penduduknya menjadi lebih kecil.

Jika dilihat berdasarkan provinsi maka provinsi yang berada pada pulau jawa merupakan daerah dengan kepadatan penduduk terbesar di Indonesia dikarenakan jumlah penduduk yang banyak dengan wilayah yang relatif kecil.

Figure 3. The Screenshot of the Presentation of General Information related to the Content captured on the problem

1. Validity

The validity test was carried out to determine the degree of accuracy of the teaching materials developed as a whole. The validity test chosen is the validity of the experts produced from 3 expert judgments of mathematics. The three experts came from 2 mathematics lecturers at IAIN Takengon and one mathematics lecturer at IAIN Lhokseumawe. The indicators assessed by the expert included the suitability of material aspects consisting of 8 assessment criteria, the suitability of mathematical literacy consisting of 5 assessment criteria, the suitability of introductory illustrations in textbooks consisting of 3

assessment criteria, the accuracy of the language selection used consists of 5 assessment criteria, and the format or The layout of the textbook consists of 4 assessment criteria. The research results on the validity of the three experts involve the five indicators that can be seen in table 1 below.

Table 1. Results of Content Validity of Mathematical Literacy-Based Textbooks

Indicator	V Index	r critical	Note:
Material Suitability	0.88	0.3	Valid
	0.77	0.3	Valid
	0.89	0.3	Valid
	0.78	0.3	Valid
	0.89	0.3	Valid
	0.78	0.3	Valid
	0.89	0.3	Valid
	0.67	0.3	Valid
Mathematical Literacy	0.89	0.3	Valid
	0.78	0.3	Valid
	0.78	0.3	Valid
	0.67	0.3	Valid
	0.78	0.3	Valid
Introductory Illustration	0.67	0.3	Valid
	0.78	0.3	Valid
	0.78	0.3	Valid
	0.89	0.3	Valid
Textbook Layout/Format	0.67	0.3	Valid
	0.89	0.3	Valid
	0.67	0.3	Valid
	0.89	0.3	Valid
Language Spoken	0.78	0.3	Valid
	0.89	0.3	Valid
	0.89	0.3	Valid
	0.67	0.3	Valid

Based on table 1, it is known that the developed mathematical literacy-based mathematics textbooks are valid. The average V index score on the material suitability indicator is 0.81, while the average V index score on the mathematical literacy indicator is 0.77. Then for the introductory illustration indicator, the average V index score is 0.74, the indicator of layout/expert book format has an average V index score of 0.8, and the last indicator, namely

the language section of mathematical literacy-based mathematics textbooks, it has an average V index score of 0.8. Based on these results, it is known that the developed numeracy literacy-based mathematics textbooks fulfill the valid category. This means that the quality of the development product in the form of a numeracy literacy-based mathematics textbook is excellent, so it is feasible to use.

There are several validator records given by the validator as follows:
1) It is necessary to convey the learning objectives.
2) It is necessary to present indicators of proof of numeracy-based competencies.
3) Information should be laid down before the math problems/questions to support student literacy.
4) It is necessary to pay attention to the numerical indicators of this question (Situation 7: Exchange Rates).
5) The light image and information of earth distance in the speed of light units are irrelevant to the problem (situation 9: Riding speed), and those presented should be considered for replacement.
6) The exercise should be assisted with appropriate pictures/illustrations to support student literacy

2. Practicality

The practicality of mathematical literacy-based mathematics textbooks was obtained through the results of a practicality questionnaire given to 3 mathematics teachers at MTS N 3 Central Aceh as the users of numeracy literacy-based mathematics textbooks. Each teacher was given a practicality questionnaire, and a numeracy literacy-based mathematics textbook was developed and tested on students. The teacher fills out the questionnaire based on his experience and understanding of each statement in the practicality questionnaire. The researcher does not give any pressure or guidance to the rater in giving the assessment. The results of filling out a practicality questionnaire for numeracy literacy-based mathematics textbooks can be seen in table 2.

Table 2. The Results of the Textbook Practicality Test

Aspect	No	Indicator	Rater		
			1	2	3
Objectivity	1	The ability of teaching materials to support the accomplishment of goals	4	5	4
	2	The ability of teaching materials to support the strengths and overcome the weaknesses of students in learning	4	4	4
	3	The ability of teaching materials to support the proof of student literacy competencies	3	4	4
Systematic	4	The suitability of the material order in the teaching materials	4	5	4
	5	The steps for delivering the concept in detail and the proper order	3	4	5
Construction	6	The correctness of the sentence structure in the developed teaching materials	4	5	4
	7	The sentences in teaching materials are unbiased or have multiple meanings	4	4	5
language	8	The correct use of Indonesian by EYD	4	5	4
Practicality	9	The ease of learning implementation	4	4	4
	10	And administer learning to assessment	4	4	4
	11	The ease of teaching materials for general	4	5	4
Total Score			42	49	46
Mean Score			45.66667		

Based on table 2 regarding the results of the practicality questionnaire recapitulation by raters, it has a total score of 137 and a mean score of 45.66. To classify or decide which textbooks are practical or not, it is necessary to have a fixed standard regarding the identification of practicality mean scores. So, before it produces the score, the researcher first makes a benchmark table for the decision of the practicality of the instrument as in table 3 below.

Table 3. Criteria for Assessment Category Practicality Score

Mean Score	Criteria
$42.5 \leq x \leq 55$	Very Practical
$33 \leq x \leq 42.4$	Practical
$21.6 \leq x \leq 32$	Less Practical
$11 \leq x \leq 21.5$	Not Practical

Based on table 3 regarding the practicality score criteria, the mean score obtained by the practicality questionnaire in the field is 45.66, and the Mathematical Numeracy Literacy-Based Textbook is on the "Very Practical" criteria. It means the textbook is useful and easily implemented in the field.

3. Effectiveness

The test results determine the effectiveness of the developed mathematical literacy-based mathematics teaching materials to measure students' abilities. The results of the data analysis of students' overall ability scores are presented in table 4 below.

Table 4. Student Test Results After Using Textbooks

Class	The number of students	The Number of Mastery Students	Average Score	Percentage of Mastery Students
VII A	32	28	80.50	87.5%
VII B	35	31	82.77	88.57%

The result from the analysis of validity, practicality, and effectiveness inducted a satisfying result. Three experts concluded by evaluating the teaching material that it satisfied the valid category with some revisions. Three mathematics teachers agreed that the teaching material fulfilled the "very practical (*sangat praktis*)" category. Based on the test conducted in two classrooms, over 85% of students could complete the learning criteria or level after using the literacy and numeracy-based mathematics teaching material (textbook). The percentage indicated the number of students who completed the criteria belonged to the "good" category. This also indicated that the developed teaching material was effective. Therefore, according to Nieveen (1999), the developed teaching material could be considered to have a certain quality because it satisfied the criteria referred to the validity, practicality, and effectiveness.

Through this teaching material, students were accustomed to implementing problem-solving towards contextual issues by involving an understanding of the favorable concept. This is because the ability of mathematical literacy is not limited to the ability to count. Mathematical literacy skills also dealt with the implementation of mathematics in problem-solving in daily routine, how to put them into words, and communication, so

that students' mathematical thinking process could be made sense (Dinni, 2018). Besides the factor of teaching material and sources, students' mathematical thinking process could also be influenced by several factors, namely: 1) selected materials; 2) lessons given by teachers; 3) classroom atmosphere; 4) family support; 5) readiness in doing the test; and 6) students' ability (Styawati & Nursyahida, 2017). Finally, it is expected that there will be further study including this developed teaching material. The suggested topics might be the learning integrated with the treatment of how to teach, set the class environment, and differ the learning based on student's ability and other factors.

CONCLUSION

Based on the research and discussion results, it can be concluded that: 1) the developed mathematical literacy-based mathematics textbooks were in the very good and good categories. Therefore, the quality of numeracy literacy-based mathematics textbooks in Junior High School class VII in odd semesters is valid; 2) mathematical literacy-based mathematics textbooks in odd semester grade VII Junior High School developed is practical to use in learning; 3) the results of students' ability tests after using mathematical literacy-based textbooks has reached 85% in each class. This means that the test results are in a good category. Therefore, the quality of numeracy literacy-based mathematics textbooks in Junior High School grade VII in odd semesters that developed was effective.

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