

16. Numeration

by Budi Mulyono

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Numeration-Based Teaching Materials on Algebra Shape Materials for Blended Learning

M. David Safitra¹, Hapizah^{2*}, Budi Mulyono³, Ely Susanti⁴

Program Studi Pendidikan Matematika, Universitas Sriwijaya
Jalan Raya Palembang-Prabumulih Km.32, Palembang, Sumatera Selatan, Indonesia
^{2*}hapizah@fkip.unsri.ac.id

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Abstrak

Kebutuhan bahan ajar diperlukan untuk meningkatkan efektifitas pembelajaran dan pemahaman peserta didik. Penelitian bertujuan menghasilkan bahan ajar berbasis numerasi materi bentuk aljabar untuk blended learning yang valid, praktis dan memiliki efek potensial terhadap kemampuan numerasi peserta didik. Teknik pengumpulan data adalah angket, tes dan wawancara. Sampel penelitian ini adalah 24 peserta didik kelas VII salah satu SMP Negeri di Palembang. Kevalidan bahan ajar dilihat dari aspek kelayakan isi, bahasa, tampilan, serta komentar dan saran dari hasil uji coba one-to-one. Kepraktisan bahan ajar dilihat dari angket. Skor rata-rata kevalidan bahan ajar adalah 74,77 dengan kriteria cukup valid atau layak digunakan dengan revisi. Sedangkan skor rata-rata kepraktisan bahan ajar adalah 87,08 dengan kriteria sangat praktis. Bahan ajar yang dikembangkan memiliki efek potensial terhadap kemampuan numerasi dilihat dari hasil tes 8 peserta didik terkategori sangat baik, 9 peserta didik terkategori baik, 4 peserta didik terkategori sedang dan 3 peserta didik terkategori kurang.

Kata Kunci: Bahan Ajar; Bentuk Aljabar; Blended Learning; Numerasi.

Abstract

The need for teaching materials is needed to help improve effective learning and student understanding. This study aims to produce numeration-based teaching materials in algebraic forms for blended learning that are valid, practical and have a potential effect on students' numeracy abilities. Data collection techniques used are questionnaires, tests and interviews. The sample of this research was 24 class VII students of one of the state Junior High School in Palembang. The validity of teaching materials was seen from the aspects of content feasibility, language feasibility, display feasibility, also comments and suggestions from the results of one-to-one trials. The practicality of teaching materials can be seen from the questionnaire. The average score for the validity of teaching materials is 74.77 with the criteria being quite valid or suitable for use with revisions. While the average practicality score of teaching materials is 87.08 with very practical criteria. The developed teaching materials also have a potential effect on numeracy skills as seen from the test results with 8 students in the very good category, 9 students in the good category, 4 students in the moderate category and 3 students in the poor category.

Keywords: Algebraic Form; Blended Learning; Numeration; Teaching Material.

I. INTRODUCTION

In curriculum 2023, students are required to achieve some competencies, known as 21st century skills. One of the skills is numeracy skills (Diva et al., 2022). Numeracy is the ability to use numbers and arithmetic operations in daily life (Han et al., 2017). Numeration can assist someone in analyzing and solving daily problems (Patriana et al., 2021).

The test results of PISA (Program for International Student Assessment) in 2015 and 2018 and also TIMSS (Program for International Student Assessment) in 2016 revealed that Indonesian students score low in understanding Mathematics compared to other countries (Mariani et al., 2022; Masfufah & Afriansyah, 2022; OECD, 2016, 2019). Besides, the results of an interview with a mathematics teacher at Junior High School in Palembang city also showed that students had low numeracy skills. This can be seen from the ability of students to read data, interpret data presented in various forms, and provide conclusions or arguments from the information provided, including analyzing problems. According to (Ambarwati & Kurniasih, 2021; A. Lestari et al., 2022) students' numeracy abilities are still low after being explained by the teachers.

One of the efforts to develop students' numeracy skills is to use teaching materials and learning activities adapted to their numeracy abilities (Putri et al., 2020; Rahmawati, Cholily, & Zukhrufurrohmah, 2023). Teaching materials refer to any materials used for learning. Teachers must be able to develop learning tools by determining models, strategies and approaches that suit the needs of students

(Hapizah et al., 2022^a). The information in teaching materials must be set to achieve learning objectives (Hodiyanto et al., 2020).

The era of the industrial revolution 4.0 demands teachers to be able to develop learning tools that follow the current developments (Sungkono, Apiati, & Santika, 2022; Elyana, Wulandari, & Mulyani, 2022), such as teaching materials for blended learning. Blended learning is an innovative learning approach by utilizing technology (Utomo & Wihartanti, 2019). Blended learning is a combination of direct learning (synchronous) and indirect learning (asynchronous) (Chaeruman, 2013; Fadilah & Afriansyah, 2021; Ole & Dipan, 2023). Numerical indicators used during the implementation of blended learning include analyzing problems, using mathematical symbols in solving problems and determining decisions from the results of the analysis (Susetyawati & Kintoko, 2022).

Some relevant results of the study, such as in Lestari et al (2021), state that the use of numeracy modules in distance learning can improve students' numeracy skills. The use of teaching materials adapted to blended learning can be an option for teachers to improve the quality of learning (Dewi et al., 2019; Loli et al., 2018). However, researchers have not found any study on the development of numeracy-based teaching materials for blended learning.

Based on the explanation above, the purpose of this research is to develop teaching materials based on numeration in algebra for blended learning that are valid, practical and have a potential effect on students' numeracy abilities. This research is expected to be used by teachers as an

effort to improve effective learning and students' numeracy skills.

II. METHODS

This research is development research. The purpose of this study was to produce teaching materials based on numeration for algebraic course used for blended learning that are valid, practical and have a potential effect on students' numeracy abilities.

This research involved two stages; the preliminary study stage (preparation, analysis and design) and the formative evaluation stage using the Tessmer model (self-evaluation, expert review, one to one, small group and field test) (Tessmer, 1993).

Some indicators of numeracy ability used to measure the potential effect of teaching materials on students' numeracy abilities in this study include analyzing the information of the problem, using mathematical symbols in solving problems and making decisions based on the results of the analysis (Susetyawati & Kintoko, 2022).

This research was conducted in one of Junior High Schools in Palembang, academic year of 2022/2023. The subjects in this study were students of class VII.

The data collection techniques used were questionnaires, tests and interviews. The questionnaire was used to determine the validity and practicality of the teaching materials that have been developed. The test was used to find out the potential effect on students' numeracy abilities after learning using the developed teaching materials. The test used was in the form of numerical-based description questions on algebraic material. Interviews were conducted to support test results.

Teaching materials are said to be valid and practical if the average score obtained meets the good criteria (Amelia et al., 2021). Meanwhile, to find out the potential effect on students' numeracy abilities, it could be seen from the test results of students (Apertha et al., 2018). Student test scores to measure potential effects are classified in Table 1.

Tabel 1.
Score Criteria

Score	Criteria
$90 \leq \pi \leq 100$	Excellent
$80 \leq \pi \leq 89$	Good
$70 \leq \pi \leq 79$	Fair
< 70	Poor

III. RESULT AND DISCUSSION

This research involves two stages, namely the preliminary study stage (preparation, analysis and design) and the formative evaluation stage using the Tessmer model (self evaluation, expert review, one to one, small group and field test). The module components and the contents are adapted to blended learning. The context used is also adapted to the students' numeration needs in order to improve their numeracy skills measured from test results after learning is carried out.

The learning process using teaching materials works well. In the first meeting, it can be seen that students' activeness and understanding of the concept of material increases compared to learning before using numeracy-based teaching materials.

A. Preliminary Study Stages

Preliminary states consist of three stages; preparation stage, analysis stage, and design stage.

1. Preparation Stage

The preparation for this research is to develop numeracy-based teaching materials for blended learning in the form of modules. Researchers were searching for various sources regarding numeracy teaching materials for blended learning. Then, the researchers determined the components according to numeration-based blended learning.

The differences between this module and other modules are that this module contains learning material that can be done in blended learning. Also, the materials are adapted to the abilities of students and designed to improve students' numeracy skills.

2. Analysis Stage

In this stage, researchers did some analysis to the students, curriculum, and materials.

a. Students' Analysis

The analysis was carried out through interviews with math teachers of seventh grade to find out students' numeracy abilities. The results of the interview revealed that the learning outcomes and understanding of students in mathematics lessons were still relatively low. The difficulties experienced by students were in understanding, mastering and solving mathematical problems.

b. Curriculum Analysis

According to Assistant Principal of Curriculum, the curriculum used in the 2022/2023 academic year is the 2013 Curriculum, which demands to develop a balance between students' behavior, knowledge and skills.

c. Material Analysis

In curriculum 2013, algebraic forms are material studied in seventh grade in odd semester. The standard competence of algebra lies in point 3.5. This point contains explaining algebraic forms and performing operations on algebraic forms (addition, subtraction, multiplication, and division). Point 4.5 of standard competence also contains solving problems related to algebraic forms and operations. Students are expected to understand the symbols used in algebraic form and be able to perform operations on algebraic forms and use these abilities in solving mathematical problems in everyday life.

3. Design Stage

In this stage, the initial design of numeration-based teaching materials on algebraic forms which contains material and student activities for blended learning is executed. The components in the teaching materials developed include KD (standard competence), IPK (indicator competence of achievement), General Description, Literature Review, Trigger Questions, Meaningful Understanding, Learning Descriptions, Learning: Material, Assessment, Reflection and Glossary.

B. Formative Evaluation Stage

1. Self Evaluation

In this stage the researcher reassessed Prototype 1 independently. The improvements made were in the background design of teaching materials and the context in the example questions. The results of the self-evaluation are called prototype 1.

2. Expert Review

At this stage, prototype 1 was validated by 2 expert validators; EK and JA, lecturers

at Faculty of Education and Teacher Training of Universitas Sriwijaya. This review took place on September, 20 2022. The validation process was carried out directly using a validation questionnaire consisted of 11 statements in terms of content and language. The results of the validation sheet showed that the teaching materials developed were valid in terms of the feasibility of the content and language, Overall, the teaching materials is worthy to use with minor revision. This is relevant to the research by Kimianti & Prasetyo (2019) regarding products that have been developed are suitable for use if the validation results obtained match the criteria used. The score of teaching material validation results can be seen in Table 2.

Table 2.

Validator Score Result			
Validator	Average Score		
EK	Content	Language	Display
	75	81,25	87,5
JA	78,57	62,5	93,75
	76,78	71,87	90,62

From the results of the validation, an average score of 76.78 for content eligibility was obtained, 71.87 for language eligibility and 90.62 for display eligibility with a fairly good category or suitable for use with revisions. Comments and suggestions from the validator can be seen in Table 3.

Table 3.




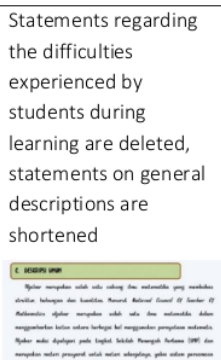


Comment and Suggestion from Validators		
Validator	Comment/Suggestion	Revision Decision
EK	<ul style="list-style-type: none"> Please provide problems related to algebraic forms. There are still found usual numeric 	<ul style="list-style-type: none"> Problems have been revised as suggested

	<ul style="list-style-type: none"> operation, not algebraic forms. The picture used is better replaced with the new one 	<ul style="list-style-type: none"> Pictures have been replaced
JA	<ul style="list-style-type: none"> Delete the statements about the low difficulty of students in general description. General description should be focused on the explanation of algebra and its forms. Revise the sentences on sub-chapter of reinforcement materials. Revise the layout of figures and tables 	<ul style="list-style-type: none"> These statements have been deleted as suggested. General description has been revised as suggested. Sentences on sub-chapter of reinforcement materials have been revised. Layout of figures and table has been revised.

The researcher made some revisions according to the validators' comments and suggestions in order to obtain valid teaching materials. Teaching materials are said to be valid if the validator assesses that the teaching materials developed use various theories (Yuliasuti & Soebago, 2021). Improvements to teaching materials carried out by researchers can be seen in Table 4.

Table 4.

Revision in Expert Review Stage

Before Revision	After Revision
<p>The problems are in forms of ordinal number operations</p> 	<p>The problems are changed into algebraic forms problems</p> 
<p>Paragraph about the difficulties experienced by students</p> 	<p>Statements regarding the difficulties experienced by students during learning are deleted, statements on general descriptions are shortened</p> 
<p>The context used is one of the museums in the city of Palembang</p> 	<p>replaced because the museum image was an old image and was replaced with one of the tourist objects in Palembang city</p> 

3. One-to-One

Prototype 1 was tested on three students with different levels of ability. These students were selected and suggested by a mathematics teacher of seventh grade. One-to-one activities were carried out from 04 to 05 October 2022. This stage aims to find out students' responses to teaching materials developed. Student comments and suggestions during one-to-one can be seen in Table 5.

Table 5.

Comment and Suggestions in One-to-One Stage

Initial	Comment/Suggestion
AZU	<ul style="list-style-type: none"> The material is easy to understand Book cover has good colour Asynchronous questions is hard to understand
GJT	<ul style="list-style-type: none"> The teaching material is good and interesting The materials are easy to understand Asynchronous questions are too difficult
MTJ	<ul style="list-style-type: none"> It is a good teaching material The instruction in questions is not clear

Based on the comments and suggestions at the one-to-one stage, the researcher found that readability related to content and language used in teaching materials was quite good. This is known from the understanding of students after being given teaching materials. Students can understand the content and language used in teaching materials. Students also seem to understand the material and examples of questions in teaching materials. However, students have difficulty understanding in the asynchronous question part. Teaching materials are categorized as good if after being given teaching materials students are able to understand the contents contained

in teaching materials (Ladyawati & Rahayu, 2022). Therefore, the researcher made improvements to the problem part of the problem. The changes made are composing the problem questions which can be seen in ² Figure 1.

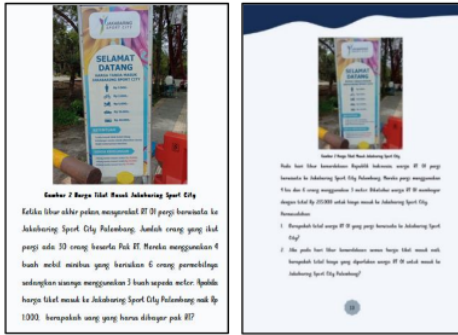


Figure 1. Before revision (Left), After revision (right) at One-to-One stage

Both prototype 1 and prototype 2 have been through expert review and one-to-one respectively. Both prototypes were said valid.

4. ² *Small Group*

Prototype 2 was tested on six students of seventh grade with different ability levels. This activity was carried out from 05 to 06 October 2022. The activity at this stage aims to see students' responses to the level of practicality of the teaching materials that have been developed. Data collection at this stage used a practicality questionnaire which contained 13 statements, consisting of 7 positive statements and 6 negative statements. The ² results of the assessment score at this stage can be seen in Table 6.

Table 6.

Average Score of Small Group

No	Initial	Average Score	Criteria
1	LS	82,5	Very agree
2	MF	85	Very agree
3	VR	80	Very agree
4	SK	100	Very agree
5	KA	92,5	Very agree
6	AS	82,5	Very agree
Average Score		87,08	Very Practical

Based on the scores obtained from questionnaires, the average score obtained was 87.08 in the very practical category. After teaching materials was learned, students were able to understand the contents from teaching materials. Students also discussed in groups to solve problems in the asynchronous part. During face-to-face learning (synchronous), students took part actively (Gella & Bien, 2022). During the discussion, students were still confused with the problems in the questions, particularly in determining steps to use to solve problems because students are not used to working on problems in the form of problems in everyday life. This is in line with Putri et al., (2021) which stated that students' unfamiliarity with questions related to everyday life resulted in frequent errors when solving these problems.

² Students are also asked to provide comments and suggestions that have been provided. Researchers then make improvements from the results of comments and suggestions. The revision results based on student comments can be seen in Figure 2.

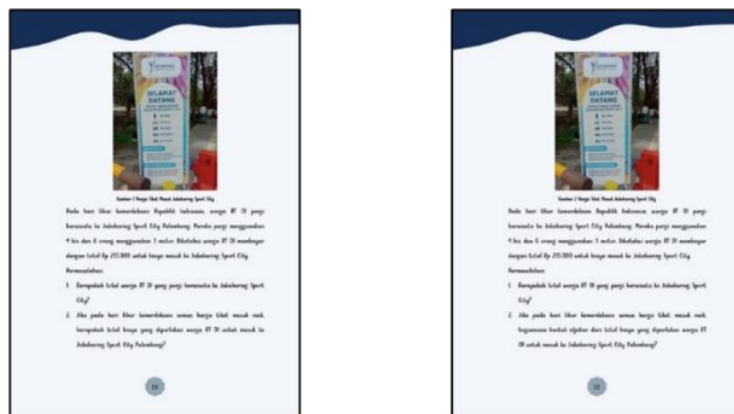


Figure 2. Before revision (Left), After revision (right) in Small Group Stage

The teaching material that was developed was said valid and practical after going through this stage. This is in line with Rismawati et al (2022) that states teaching material is considered practical if the score obtained from questionnaire is positive. The Prototype 2 that has been gone through this stage is called Prototype 3.

5. Field Test

Prototype 3 was tested in the field. Field tests were carried out to see the potential effects of teaching materials on students' numeracy abilities. Subjects at this stage were 26 students of seventh grade. This stage was carried out from 07 to 08 October 2022. One mathematics teacher in seventh grade served as a model teacher. The method used was blended learning with the flipped classroom model. Teaching materials were used for one meeting. In the next meeting a written test, consisting of 1 description question with 4 problems, was conducted. On October 7, 2022, during an asynchronous meeting, the teacher distributed teaching materials to class groups via WhatsApp and gave instructions to students to understand the material available in the teaching materials and provided opportunities for students who

wanted to ask questions. Students were instructed to work on questions in the asynchronous section. On October 8, 2022, during a face-to-face meeting (synchronous) the teacher distributed teaching materials that had been developed in printed form and began discussing material and sample questions. The teacher then divided students into 5 groups consisting of 5-6 people to discuss asynchronous tasks. The learning outcomes of asynchronous could be seen from the discussion process that took place. The modules compiled could also be reviewed for the appropriateness of the content and language, and the feasibility of the modules from the responses and understanding of students after being given the module. The teacher provided an opportunity for representatives of one of the groups who would like to present the results of their discussion in front of the class. Then, other groups were expected to ask questions or give their opinion from the results of the group's presentation. The discussions were very active among groups because students seemed to have understood the material in the teaching materials given asynchronously. Blended learning can

provide comfort and interest in learning for students in order to create effective and innovative learning. Indirect learning (asynchronous) and direct learning (synchronous) are carried out to develop students' numeracy skills in analyzing the information available from the material or the questions, and using mathematical symbols in solving problems and making decisions.

On October 8, 2022, the subject research were given description test questions. The analysis of students' test results could be seen in Table 7. The use of teaching materials prepared with a particular learning approach was able to improve the students' learning outcomes (Cahyo Putro & Setyadi, 2022; Rokhim et al., 2020).

Table 7.
Criteria of Students' Test Results

No	Number of Student	Kriteria
1	8 people	Excellent

2	9 people	Good
3	6 people	Fair
4	2 people	Poor
Total		26 Orang

The researcher then selected 3 students to be interviewed for each criterion in the test results. They were selected after the results of the analysis of answers in numeracy abilities released. The answers of each student on each category were almost the same, but there were students who made mistakes in the calculations and did not fully describe the answers.

a. Students with Excellent Ability

This is the student who have high numeric ability, acquired from the written test. The initial of this student's name is MM. The researcher asked for him to be interviewed regarding the results of the tests. He brought up all indicators of numeracy ability in the items. The results of his answers can be seen in Figure 3.

Analyzing information
He was able to analyze information by writing down the information available from the question and he knew what to do next.

Using Mathematics Symbols
He could apply mathematics symbols in completing the question

Determining the Decision from Analysis Result
He was able to determine the next step in solving the problems and made the decision based on the result obtained

Figure 3. Answer of Student with Excellent Numeric Ability

As seen from the answers, this student was able to bring up all the numeration indicators in its completion and had the highest score among other students. He could analyze and make decisions based on the answers. He was also able to use mathematical symbols in solving problems. However, he was wrong in using the symbol a because this symbol was not used as in the example given. During the interview, he explained that he followed the teacher's explanation during the lesson. This is in line with research by Sari et al (2017) which states that high-ability students can master

numeration indicators even though there make some mistakes. He also studied independently using teaching materials provided at home.

b. Student with Fair Ability (NA)

NA is the student who have fair numeric ability, obtained from the test. The researchers asked him for the interview regarding with the test he had completed. NA showed all indicators of numeration in the question; however, there were still found some mistakes, as seen from the Figure 4.

The image shows a handwritten student answer for a math problem. The problem is about renting a car. The student lists variables for car types and prices, then solves for the number of cars based on total cost. Annotations highlight 'Analyzing information and taking decision' and 'Using Math Symbols'.

Analyzing information and taking decision
NA wrote the information available and determined what to do next.

Using Math Symbols
NA was able to use the symbols, but he did not explain the solution.

Figure 4. NA's Answer

Based on the answers, NA could show all numeration indicators. NA was able to analyze questions, classify what was known from the questions, and make decisions based on the results of the analysis. NA could also use mathematical symbols in solving problems. However, the NA calculation results were still errors. After being interviewed, NA stated that the problems in the test questions were quite difficult. NA experienced difficulties in working on the questions if he did not see the material or examples of questions

previously explained by the teacher. Students tend to experience confusion in solving problems because they have not fully mastered the concept of the material (Rezky et al., 2022). Based on the results of the interviews, NA stated that he used the teaching materials provided as a source of learning algebraic material.

c. Students with Low Ability (MA)

MA is a student with low numeric ability. This is known from the test results obtained. The researcher asked for the MA's willingness to be interviewed regarding the

results of the tests that had been completed. From the MA answers, he was unable to bring up indicators of numeracy ability on the items. MA's answers can be seen in Figure 5.

Figure 5. MA's Answer.

Based on the answers, MA could not bring up all numeration indicators. The answer given by MA was not in accordance with the problem in the question. After conducting interviews, it was found that the MA did not understand the material so that it made the MA confused in solving problems. This is in line with Putri et al., (2021) who stated that students' low numeracy skills can cause students to be unable to solve various kinds of math problems.

The field test results show that numeration-based teaching materials in algebraic forms for blended learning have a potential effect on students' numeracy abilities, as known from the results of tests using numeration questions after being given learning using teaching materials. Teaching materials also contain material, examples of questions and practice questions for high, medium and low levels so that students can understand the material and practice their understanding. This is relevant to the research of Rahman et al (2021) stating that the teaching

materials that have been developed are stated to have potential effects in terms of learning outcomes or the acquisition of student scores after learning using teaching materials.

However, there are also students who experience problems in understanding the material during blended learning (Syifa et. al., 2022). These obstacles include discipline, independence, motivation and honesty in learning (Hapizah et al., 2022^b).

IV. CONCLUSION

Based on the results of research on the development of numeration-based teaching materials on algebraic material for blended learning, the results obtained at the expert review and one-to-one stages showed that the teaching materials were valid (2nd prototype). At the small group stage, the teaching materials were declared to be practical (3rd prototype). At the field test stage, it is known that teaching materials have a potential effect on students' numeracy abilities in terms of the average test scores obtained by students after learning to use numeration-based teaching materials for the developed blended learning. Learning using teaching materials gives interest to students to create active learning during the teaching and learning process. This is also supported by the results of interviews related to learning to use numeration-based teaching materials for blended learning algebraic material. Teachers can use teaching materials that have been produced as an effort to improve students' numeracy skills and make mathematics learning effective so that it can compete in the 21st century.

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