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Development of teaching materials on algebra using the mind mapping model with a scientific approach.

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Abstract. Most students dislike studying mathematics because they believe it contains much difficult material. Algebra is one of the topics considered difficult to learn in mathematics. The teaching material used is one factor that influences the low mastery of material in algebraic language. This research aims to develop valid teaching material using the Mind Mapping mode for algebraic topics. The modules and leaflets of the students' activities are the materials made. This research refers to the Kemp model, which consists of 10 stages of development. However, the scope of this research is only from the need analysis stage to the validation stage. Device validation sheets are used as data collection tools. This research uses qualitative and quantitative data analysis methods. Three people - a lecturer, a teacher, and a ninth-grade student - validate the teaching material that has been made. The results of the validation stage show that the teaching material is declared valid with little revision. The results of this study show that the teaching material is ready to be implemented.

Keywords: Teaching Materials, Mind Mapping, Scientific Approach

INTRODUCTION

Education is very influential in the progress of a country. In addition, education is also an effort to create active learning to develop an individual's potential (Dewi & Izzati, 2020). One of the fields that play an important role in education is mathematics. The magnitude of the role of mathematics makes mathematics one of the compulsory lessons at the education level. However, most students do not like learning math because they view many topics in math subjects as very difficult (Meidia Sari & Afriansyah, 2020; Nada et al., 2020).

One of the topics considered difficult when learning mathematics in Junior High School in grade 8 is algebra (Lestari & Suryadi, 2020; Maskur et al., 2020; Nugraha et al., 2015). The topic is very abstract for students, plus the teacher's learning process that is not contextualized makes students not interested in learning it.

The teaching material used is one component that affects the low mastery of material algebra in the learning planning process. In reality, many teaching materials used by teachers are still too broad or too little, too deep or too shallow, the order of presentation is not correct, and the type of teaching material does not follow the competencies to be achieved by students. Note that the problems in the learning system in the classroom have an impact on the lack of realization of several general objectives of mathematics learning (Saputra et al., 2022).

The 2013 curriculum has been implemented throughout Indonesia. However, in reality, there are some shortcomings in implementing this curriculum, including the lack of socialization of the 2013 curriculum, making many teachers not understand the contents of this curriculum; as a result, they have difficulty applying it in learning and making learning tools. This forces schools to make new preparations and strategies to adapt to implementing the 2013 curriculum (Mowendu et al., 2019). Some of the problems above have an impact on not creating the ultimate goal of implementing the 2013 curriculum: to create productive, creative, innovative, and effective learners through strengthening attitudes, skills, and integrated knowledge.

Productive, creative, innovative, and effective learners certainly cannot be produced if the implementation of the 2013 curriculum has not gone well and the learning process in the classroom still uses conventional methods. So, achieving these goals requires a systematically organized, interesting learning model that can lead students to achieve the desired competencies. The mind-mapping learning model is appropriate for learning algebra subject matter. The mind-mapping learning model directs students to think divergently and openly. It makes it easier to record subject matter according to the flow of students' thoughts, making it easier to remember and develop. In addition, the mind-mapping learning model can create an interesting learning atmosphere, motivate students, and make it fun when students learn the material (Buzan, 2006).

Thus, learning success is supported by various factors, three of which are found in lesson planning. The factors in question are learning models, teaching materials, and approaches used by teachers. Learning using the mind-mapping

learning model can achieve effective results if the teaching materials used by the teacher are appropriate, so it is necessary to develop teaching materials that follow the model and refer to the scientific approach, which is the approach of the 2013 curriculum. Based on some of the background descriptions of these problems, this article discusses development research conducted by researchers to develop valid teaching materials using the mind mapping model with a scientific approach.

RESEARCH METHODS

This research is a development research. This research develops teaching materials consisting of modules and learner worksheets. The development of teaching materials refers to the Kemp design model (Bajracharya, 2019). This research was conducted in grade 8 in one of the junior high schools in Kupang City. The research class was randomly selected and was heterogeneous, meaning that high, medium, and low-ability students were evenly distributed in the class. Kemp's development model is outlined in the following illustration.

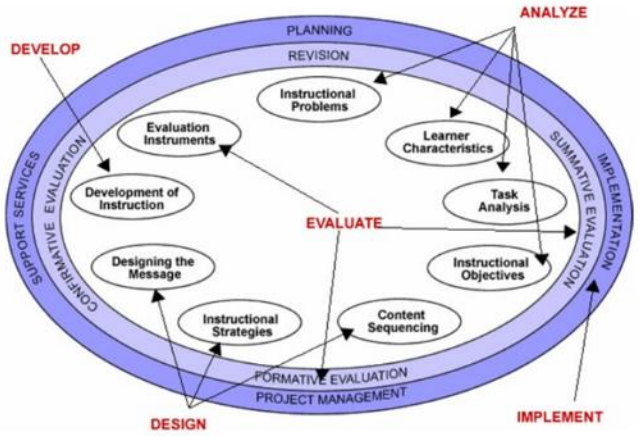

Figure 1. Kemp Design Model

The instruments in this research are a student learning style questionnaire and a validation sheet. The student learning style questionnaire is used to obtain information about students' learning styles, which is useful in developing teaching materials. Questionnaires are made to identify visual, auditory, and kinesthetic learning styles. The teaching material validation sheet is used to obtain input in the form of suggestions and criticisms about the experts' assessment of the developed teaching materials used to improve the teaching materials. Expert validation

includes content and language validation and all learning tools developed. Suggestions from experts (validators) are used as a basis for improving or revising the developed learning tools. From the validation of experts, then transformed into qualitative sentences.

In determining the interpretation of data validation results, the criteria listed in Table 1 are used (Arikunto & Jabar, 2018).

No	Interval	Interprets
1	81% - 100%	Excellent / Very Good
2	61% - 80%	Good/Eligible
3	41% - 60%	Fairly Good/Fair
4	21% - 40%	Less Good/Less Feasible
5	< 21%	Not Very Good / Not Very Decent

Table 1: Interpretation of Data Validation Results

The data from this validation will be used as material for the initial revision of the learning media developed.

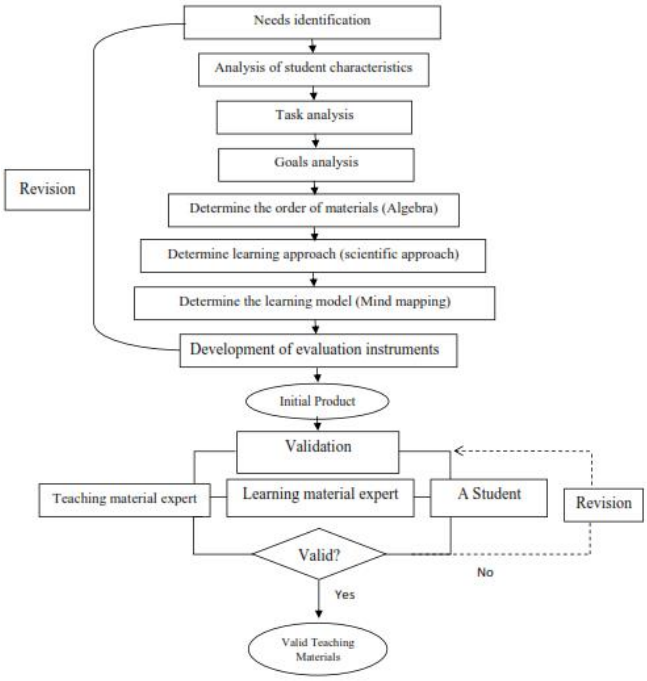

Figure 2. Research Procedure

In this validation test, teaching materials can be said to be valid if the results of the validator's assessment of each aspect tested are in the range of 61% - 80% or the range of 81% - 100% in other words in the "feasible" or "very feasible" criteria. Furthermore, the research procedure is described in Figure 2.

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RESULTS AND DISCUSSION

This study aimed to produce valid, practical, and effective teaching materials using the mind-mapping model with a scientific approach to algebra. The development results are in the form of modules and learner worksheets. The results of the development of teaching materials can be described as follows.

Description of Needs Identification Stage

This learning design begins with identifying needs or problems in learning mathematics in the classroom. There are 4 steps involved in analyzing the needs: planning, implementation, data analysis, and final report.

After carrying out the 4 stages mentioned, a list of learning problems and a plan for the solution process is presented in the following table.

No	Problem Identification	Problem-solving plan
1	The learning process is not based on the 2013 curriculum and uses the scientific approach (5M)	Create a Learning Implementation Plan (RPP) per the 2013 curriculum and the scientific approach.
2	The teaching materials used are not interesting in presentation nor motivate students to use them.	Develop teaching materials that are interesting and motivate students to use them.
3	The learning process without using LKS to guide students to find their concepts from the material studied.	Developing Learner Activity Sheets (LKPD) so students can find the mathematical concepts they have learned.
4	The learning media used is not interesting and motivates students to learn.	Using media that students can easily use and understand in learning activities.
5	Planting concepts that are not mature to students and not achieving learning objectives.	Models and methods following student conditions are to be used in selected and

Table 2. Results of needs identification

Based on the results of the needs analysis, it was found that one of the urgent needs for the learning process in the classroom is the development of teaching materials that are interesting and motivate students to use them, as well as the preparation of Student Activity Sheets so that students can find their mathematical concepts learned (Soeyono, 2014). Therefore, researchers must conduct

development research to produce teaching materials to overcome the problems described. Teaching materials developed in the form of modules and learner worksheets.

Description of Student Characteristics Analysis

The analysis of student characteristics included a test of students' initial abilities, analysis of personal and social characteristics, and learning styles. The results of the analysis of the three characters are explained as follows.

a. Students' Initial Ability

All students selected as research subjects attended the math ability test. The test is a description question containing prerequisite material, namely number patterns. The results of the student's work were then examined and analyzed further to determine the student's initial abilities.

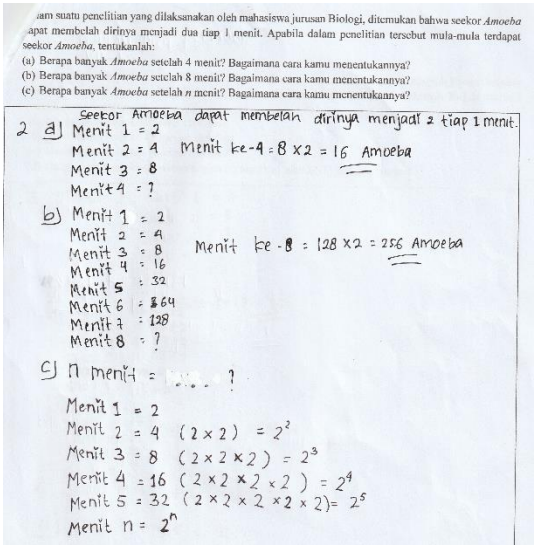

Figure 3. Work of high-ability students

Students are categorized as low ability if their test score is 50, medium ability if their test score is 80, and high ability if their test score is 80. After the test, the results of the students' work were examined, revealing that 10 students were categorized as having low ability, 12 students as having medium ability, and three students as having high ability. The results of this analysis will be useful for the designer in forming heterogeneous groups. An example of the work of high-ability students is presented in Figure 3.

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Based on the results of student work depicted in Figure 3, it is evident that students can identify the fourth and eighth terms of the sequence. Furthermore, they demonstrate the ability to extrapolate from the provided number pattern by formulating the formula for the nth term. The score awarded for this task is 100, classifying the student as having high ability.

b. Personal and social character

Based on observations, students generally have a religious character, are disciplined, and care about other friends. In addition, in learning, students tend to be diligent and orderly when paying attention to the lesson. However, in working in groups of more than three students, the researcher observed that only a few students were actively discussing, as shown in the following picture.

Figure 4. Some students are not active in the discussion

From the observation of students' social skills, it can be seen that most students have good abilities in observing problems and things related to mathematics. However, they tend to have difficulty asking the teacher questions. In addition, only a few students were active in group discussions, and only a few could process information and arrive at learning outcomes. Therefore, the researcher concluded that in developing learning, the researcher must design a lesson to encourage students to work together in groups. It is so that each student is active in learning and establishes good interactions between students and students and their teachers (Rahmi, 2023).

c. Student Learning Style

Students' learning styles were identified by administering a questionnaire on their learning style tendencies. The questionnaire was distributed to all students in the research class, who then completed it based on their experiences and feelings during learning. The analysis revealed that 11 students had visual learning styles, 7 had auditory learning styles, and 7 had kinesthetic learning styles.

The results of this analysis indicate a predominant tendency towards the visual learning style among students. These findings inform the selection of learning strategies and models that can engage all students, including those inclined towards visual, auditory, kinesthetic, or a combination of these styles.

Description of Task Analysis

In conducting task analysis, two things become the focus of attention, namely the results of the needs analysis and the characteristics of students that have been obtained. The stages in conducting this task analysis are topic analysis and procedural analysis.

a. Topic Analysis

The topic analysis in Algebra for Class VIII junior high school aims to identify its main components within the 2013 Curriculum. By analyzing the Core Competencies (KI) and Basic Competencies (KD) of this curriculum, the learning objectives are set to develop students' attitudes, including spiritual and social aspects, and to enhance their knowledge based on the established competencies. This analysis leads to a clear outline of the study's material, as shown in the following table.

Subject matter	Subject matter Sub-section	Explanation
Algebra	1. 1. Definition of variables, coefficients, constants, and types of algebraic terms	• Transforming real problems into Algebraic form • Definition of variable • Definition of coefficient • Definition of constants • Types of first, binomial, and polynomial terms.
	2. 2. Operation of addition and	• Similar and dissimilar terms • Addition operation of algebraic forms • Subtraction operation

	subtraction of Algebraic forms	• Commutative, associative, and distributive laws of addition and subtraction.
3.	3. Multiplication operation of Algebraic form	• Algebraic form factors • Commutative, associative, and distributive laws of multiplication. • Multiplication of first term with second term • Multiplication of two terms with two terms
4.	4. Division of Algebraic form	• Compound division of algebraic forms • Remaining division of the algebraic form • Factoring of algebraic forms
5.	5. Simplifying Algebraic form	• Fractions of Algebraic forms • Simplifying the addition form of Algebraic fractions • Simplifying the multiplication form of Algebraic fractions • Simplify the division form of Algebraic fractions

Table 3. Results of Algebra Material Analysis

b. Procedure Analysis

Based on the topic analysis described, the steps or procedures for learning the Algebra topic can be determined as follows.

1. Definition of variables, coefficients, constants, and types of algebraic terms

   The following procedure is presented when discussing the sub-topic "understanding of variables, coefficients, constants and types of algebraic terms": a) Provide examples of real-life problems related to algebraic operations. b) Transform and simplify real problems into algebraic form. c) Ask students to provide several other examples of Algebraic forms. d) Distinguish variables, coefficients, and constants of existing algebraic forms. e) List all variables, coefficients, and constants of existing algebraic forms. f) Distinguish the types of terms of existing algebraic forms. g) Ask students to explain the meaning of variables, coefficients, and constants.

2. Addition and subtraction of Algebraic shapes

   The following procedure is presented in the discussion of the sub-topic "Operation of addition and subtraction of Algebraic forms": a) Provide examples of real-life problems related to the operation of addition

and subtraction of algebraic forms. b) Simplify the problem into algebraic form and find a solution to the problem. d) Provide illustrations about the addition and subtraction operations of similar terms. e) Explain the commutative, associative, and distributive laws as they apply to addition and subtraction operations involving algebraic forms. f) Provide examples of problems to students about the operations of addition and subtraction of algebraic forms. g) Summarize the learning outcomes of algebraic forms' addition and subtraction operations.

3. Multiplication of Algebraic forms

   The following procedure is presented in the discussion of the sub-topic "Algebraic form multiplication operation": a) Provide examples of real-life problems related to the operation of multiplying algebraic forms. b) Simplify the problem into algebraic form and find a solution to the problem. c) Recognize and understand the factors of algebraic form. d) Explain the commutative, associative, and distributive laws related to addition and subtraction operations involving algebraic forms. e) Provide discussion material to students about multiplying one term with two terms and multiplying two terms with two terms. f) Ask students to conclude the discussion results. g) Provide examples of problems about the operation of multiplying algebraic forms.

4. Algebraic Division

   The following procedure is presented in the discussion of the sub-topic "Division of Algebraic Forms": a) Provide examples of real-life problems related to the operation of dividing algebraic forms. b) Provide examples and solutions to the division of algebraic forms by composing. c) Students work on problems and distinguish the division of algebraic forms that produce the remainder of the division. d) Explain how to factorize algebraic forms. e) Determine the results of division by factoring algebraic forms. f) Students solve problems about division and factoring of algebraic forms.

5. Simplifying Algebraic Forms

   The following procedure is presented in the discussion of the "Simplifying Algebraic Forms" subject matter: a) Provide illustrations about simplification and fractions of algebraic forms. b) Explain strategies to simplify algebraic forms. c) Simplify the addition and subtraction of Algebraic fractions. d) Simplify the multiplication of Algebraic fractions. e) Simplify the division of Algebraic fractions. f) Students solve problems about simplifying fractions of algebraic forms.

Description of Material Ordering

In designing instruction, it is important to consider the sequencing of materials, as efficient sequencing can help students achieve their objectives (Ni'am, 2016). Strategies for sequencing materials based on learning-related sequencing consist of five elements, which are described as follows:

a. Identification of Prerequisite Materials

   The prerequisite for learning this teaching material is material about integers, especially for integer operations, namely addition and subtraction operations, multiplication and division operations, and multiplication. In addition, the concept of fractions must also be mastered by students because it will be very useful in learning how to simplify algebraic forms.

b. Familiarity

   In designing teaching materials, each sub-course will begin with real problems that students have heard, seen, and experienced themselves in their daily lives. After students observe these problems, they will then be converted and simplified into algebraic form.

c. Difficulty Level

   The material is given from a low level of difficulty to a higher one, starting from providing material from concrete things that students often encounter. The difficulty level of the material in the teaching materials is adjusted to the results of the topic analysis and procedure analysis.

d. Fascination

The materials will be organized in a visually appealing and engaging format to enhance students' interest in using teaching materials and improve their retention after studying. Additionally, essential points in the material will be conveyed through beloved comic characters, with the aim of captivating students' interest and aiding their comprehension.

e. Development

After students understand the meaning of variables, coefficients, constants, and types of algebraic terms; Addition and subtraction operations of Algebraic forms, Multiplication and division operations of Algebraic forms, and Simplification of Algebraic forms, then students can solve problems related to this material.

Description of Learning Approach Determination

The teaching material will be developed using the scientific approach mandated by the 2013 curriculum. The scientific approach to learning as intended includes observing, questioning, digging for information, reasoning, and communicating (Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 103 of 2014 concerning Learning in Primary Education and Secondary Education, 2014).

Description of Learning Model Determination

After determining the learning strategy, the next step is to determine the learning model. The results of the student character analysis show that it takes a lesson that can motivate and activate all students in the class, as well as the results of the analysis of student learning styles which show that the tendency of the learning style of the research class students is a visual learning style, the learning model determined in the development of this teaching material is the Mind Mapping learning model. According to Michalko and Buzan (2005), the mind-mapping learning model is useful in various fields, including education. The usefulness of the mind-mapping learning model in education includes: 1) Students can express their opinions freely. 2) Students can work together with other friends. 3) Notes become denser and clearer. 4) Students find it easier to find the necessary

information. 6) Notes are more focused on the core of the material. 7) Students easily understand the overall mind map picture. 8) It can help the brain organize, remember, compare, and connect. 9) Review is easier and faster. 10) It is unique and can be a novelty that makes learning fun.

This learning model makes the subject matter visually and graphically patterned, which aims to help make it easier to record and recall information that has been learned. In addition, developing this teaching material aims to attract attention and motivate students to use it, so the Mind Mapping model is very suitable. In developing this teaching material, mind mapping will summarize the main points of the material that students have learned. Students will be creative and imaginative and make their mind maps as personal notes that will be used for home learning (Buzan, 2006).

Description of Evaluation Instrument Development

The evaluations used in this study are formative evaluation and summative evaluation (Arikunto & Jabar, 2018). The description of the evaluation in question is as follows:

a. Formative Evaluation

Formative evaluation is an evaluation used to assess the learning process that has been implemented. We designed an observation sheet to be used. The observation sheet developed aims to see the extent of the practicality of teaching materials used by both teachers and students during the learning process. The data generated from the observation results will be analyzed using quantitative data. In the end, the analysis results will be used as a reference to determine whether the teaching materials used are practical or not.

b. Summative Evaluation

Summative evaluation is given after the entire learning implementation plan has been completed. The main purpose of this evaluation is to determine the value that symbolizes students' success after following the learning process provided. The value of each learner will be analyzed, and the percentage of class completeness will be calculated to determine the effectiveness of the teaching materials developed. The instrument of this evaluation is a student

competency test consisting of questions prepared according to the indicators and learning objectives of the subject of algebra. The student competency test prepared will be put together with the module developed and validated together.

After going through the stages that have been described, the researchers succeeded in developing initial products, namely teaching materials on the subject of algebra consisting of modules and LKPD using the mind-mapping learning model with a scientific approach. Before the implementation stage, the devices that have been developed will go through the validation stage first (Suwandi; Utaminingsih, Sri; Darmanto, 2021). Validation will be carried out on teaching materials by 3 validators, namely 2013 curriculum experts, learning material experts, and a person. The validation stage in question will be described as follows.

Description of Validation Stage

The initial product that has been produced will be validated by experts. Expert validation focuses on format, content, and language, including lesson plans and teaching materials. The results of expert validation in the form of corrections, criticisms, and suggestions are used as a basis for making revisions and improvements to learning devices. After being revised, Learning devices declared valid by validators will be immediately implemented in the classroom. The assessment conducted by the validator includes format, content, and language indicators on the teaching materials developed. In making revisions, the researcher refers to the results of the discussion by following the suggestions and instructions of the validator.

The results of expert validation of teaching materials are presented as qualitative and quantitative data. Qualitative data is in the form of suggestions from each validator, while quantitative data is in the form of a recapitulation of the score of the validation results, each presented in the following table.

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Table 4. Quantitative Data Recapitulation of Teaching Material Validation

No	Assessed Aspect	Number of Validators Who Rate				
		1	2	3	4	5
I	**FORMAT**					
	1. The attractiveness of the cover design packaging.	0	0	0	1	2
	2. The accuracy of the typeface used in the cover.	0	0	0	2	1
	3. Accuracy of typing layout	0	0	0	1	2
	4. Consistency in the use of various types and font sizes.	0	0	0	1	2
	5. Clarity of writing or typing					
	6. Accuracy of image placement	0	0	0	0	3
	7. Consistent use of numbering system.	0	0	0	1	2
		0	0	0	0	3
II	**LANGUAGE**					
	8. Use of good and correct Indonesian language in teaching materials.	0	0	0	2	1
	9. Simplicity of sentence structure used in teaching materials.					
	10. Suitability of sentences with the level of thinking and reading ability of students.	0	0	0	1	2
	11. Clarity of instructions and directions	0	0	0	2	1
	12. The commutative nature of the language used					
		0	0	0	0	3
		0	0	0	2	1
III	**ISI**					
	13. The accuracy of the formulation of learning objectives according to KD and indicators	0	0	0	2	1
	14. The correctness and suitability of the grouping of material content	0	0	0	1	2
	15. The suitability of the sequence of material with a scientific approach:					
	16. Appropriateness of the use of illustrations and examples	0	0	0	2	1
	17. The accuracy of the selection of images used in teaching materials following the mind mapping model.	0	0	0	2	1
	18. The content of exercises, worksheets, and competency tests should be suitable for indicators and learning objectives.	0	0	0	2	1
	19. Varied mind map design to attract students' attention.					
	20. Accuracy of color selection in teaching materials according to the mind mapping model.	0	0	1	1	1
		0	0	0	1	2
		0	0	0	3	0
IV	**COMPETENCY TEST QUESTIONS**					
	21. Questions are prepared following basic competencies, indicators, and learning objectives.	0	0	0	0	3
	22. The questions can represent the material that has been learned.	0	0	0	1	2
	23. The questions are not too easy and not too difficult.					
	24. The sentences used in the questions are clear, precise, and easy to understand.	0	0	0	3	0
		0	0	0	2	1
	25. The questions are arranged according to the student's level of thinking.	0	0	0	2	1
	26. The sentences in the questions do not cause multiple interpretations.					
	27. The time allocation given is appropriate. Not too fast and not too long.	0	0	0	2	1
	28. The questions compiled are suitable for measuring the effectiveness of the teaching materials.	0	0	0	2	1
		0	0	0	3	0

The comments and suggestions from each validator include: 1) The cover design is good, but there needs to be additional images related to using algebraic forms in everyday life. 2) Enlarge the title on the cover. 3) Write KD and Indicators so that the learning objectives are more detailed.

Based on the results of data analysis in Table 3.3 validation of teaching materials, the percentage of validity of teaching materials is 89.5%, and if adjusted to the interpretation of data in Table 2.1, then teaching materials using mind mapping models with a scientific approach have very good / very good criteria (Arikunto & Jabar, 2018). Based on these results, it can be concluded that the teaching materials developed are valid and can be implemented with minor revisions. Teaching materials were revised based on the validator's comments and suggestions.

Revision of Teaching Materials

Based on comments, suggestions, and in-depth discussions with validators, minor revisions to the teaching materials were required. Some components of teaching materials before and after revision are described as follows:

a. Cover

   Based on the second validator's suggestion, it is necessary to make changes to the cover of teaching materials, namely the addition of images related to the use of algebraic forms in everyday life and the addition of font size to the title of teaching materials.

b. Add Basic Competencies and Indicators to teaching materials.

   Based on the second validator's suggestions and discussions about the revision components, the researchers accepted the validator's suggestions. They made revisions to the teaching materials, namely the addition of KD and learning indicators in Chapter II. This revision aims to make the learning objectives more detailed and understandable to students. The basic competencies and indicators added follow the 2013 curriculum syllabus.

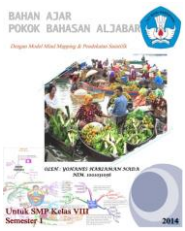

Before

After

Figure 5. Cover changes before and after revision

CONCLUSIONS

Based on the results of the study, it can be concluded that the development of teaching materials using the modified Kemp learning design model, which consists of 9 stages of development, from the needs analysis stage to the validation stage, has produced "Mathematics teaching materials for algebra subject matter using mind mapping models with a scientific approach." The percentage of validity of teaching materials is 89.5%. Teaching materials using the mind mapping model with a scientific approach have excellent criteria, so it can be concluded that the teaching materials developed are valid and can be implemented to test their practicality and effectiveness (Maskar & Dewi, 2020; Raibowo et al., 2020; Wahyuni & Etfita, 2019).

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