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Development of mathematics learning modules with PBL models on the metacognitive skills of students

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ABSTRACT

The teaching materials used do not facilitate students' metacognitive skills, causing students' metacognitive skills to be low. The research aims to produce products in the form of valid, practical, and effective learning modules on the metacognitive skills of grade V students. Teaching materials are developed using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. This research developed Mathematics teaching materials with PBL models for grade V elementary school students. The subjects of this study were grade V students of SD Negeri 060874 Medan, which consisted of 27 students. Teaching materials that have been developed meet the validity criteria shown by using validation sheets on aspects of material, language, and design, with each aspect with very valid categories. The teaching materials developed also meet the practical criteria indicated by the questionnaire response given to students after the application of teaching materials, with the criteria obtained being very practical. Furthermore, the teaching materials developed also meet the effective criteria, as shown by the results of the comparison between the Pre-test and Post-test, which were tested using N-Gain, as well as the acquisition of N-Gain scores, metacognitive skill questionnaires, and student learning outcomes, all of which fall into moderate categories, meeting the effective criteria.

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ABSTRAK

Bahan ajar yang digunakan kurang memfasilitasi keterampilan metakognitif siswa sehingga menyebabkan keterampilan metakognitif siswa rendah. Tujuan dari penelitian adalah untuk menghasilkan produk berupa modul pembelajaran yang valid, praktis dan efektif terhadap keterampilan metakognitif siswa kelas V. Jenis penelitian yang dilakukan adalah penelitian pengembangan Research and Development (R&D). Bahan ajar dikembangkan dengan menggunakan model pengembangan ADDIE yang terdiri dari lima tahapan yaitu Analysis, Design, Development, Implementation dan Evaluation. Penelitian ini mengembangkan bahan ajar Matematika dengan model PBL untuk siswa kelas V siswa Sekolah Dasar. Subjek penelitian ini merupakan siswa kelas V SD Negeri 060874 Medan yang terdiri dari 27 siswa. Bahan ajar yang telah dikembangkan memenuhi kriteria kevalidan yang ditunjukkan dengan menggunakan lembar validasi pada aspek materi, Bahasa dan desain dengan masing-masing aspek dengan kategori sangat valid. Bahan ajar yang dikembangkan juga memenuhi kriteria praktis yang ditunjukkan dengan angket respons yang diberikan kepada siswa setelah penerapan bahan ajar dengan kriteria yang diperoleh adalah sangat praktis. Dan bahan ajar yang dikembangkan juga memenuhi kriteria efektif hal ini ditunjukkan dari hasil perbandingan Pre-test dan Post-test yang diuji dengan N-Gain dengan perolehan skor N-Gain angket keterampilan metakognitif dan hasil belajar siswa dengan kategori sedang dengan kriteria efektif.

Kata Kunci: *bahan ajar; keterampilan metakognitif; Matematika; PBL*

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INTRODUCTION

The learning process is a dynamic interaction between teachers and students facilitated by learning tools within the learning environment. The learning process required now is a student-centered approach, where students are actively engaged during learning, with the teacher serving as a facilitator. However, in reality, the learning process still relies on teacher-centered learning, where the teacher conveys the material from the beginning to the end of the lesson, making the teacher the sole source of information for students. As a result, students are limited to listening and do not have the opportunity to find the information they need. Students' desire to see their information will make students remember the information they find longer and get used to being independent in finding information, processing the information they encounter, and thinking critically about whatever information they encounter so that they will get used to thinking critically in their daily lives (Rakhmah, 2020; Amin *et al.*, 2020).

The learning process is considered successful if the learning objectives have been met. Yusuf, in a book entitled "*Asesmen dan Evaluasi Pendidikan,*" explained that formulating learning objectives will make it easier for teachers to determine the methods and supporting media that will be used in the learning process. Setting learning objectives is crucial to ensure that teachers can design an effective learning process for students, encompassing both the methods and learning media to be used. According to Mahtumi in the book "*Pembelajaran Berbasis Proyek,*" learning objectives typically outline the skills and knowledge that students are expected to acquire upon completing the learning process, ensuring that learning has clear and meaningful objectives. Learning objectives are typically related to the environment around students, ensuring that learning is significant and the knowledge gained can be applied in their daily lives. Zulqarnain, in a book entitled "*Psikologi Pendidikan,*" states that the learning process is affected by several factors, including students, teachers, curriculum, facilities, infrastructure, and the learning environment. Students as subjects or learning targets, teachers as facilitators, curriculum as a reference and guideline for the learning process, facilities and infrastructure, and the learning environment as support for the learning process. All of these aspects must be carefully considered to create an effective learning process and achieve learning goals.

The learning process, in its implementation, will not be separated from obstacles or problems, whether they are encountered within the learning process itself. One of the subjects that elementary school students find difficult is mathematics (Arifin, 2020; Permatasari, 2021). Mathematics learning is one of the subjects that is always considered difficult and tedious for students. One of the problems in learning mathematics is the assumption of students that mathematics is a complex subject (Utari *et al.,* 2019). The difficulties experienced by students in learning mathematics usually vary. Mathematics learning difficulties experienced by students are typically related to understanding concepts, developing numeracy skills, and effective problem-solving. Because students struggle to understand concepts, develop numeracy skills, and solve problems, it creates additional challenges. It is hoped that students will be able to manage their learning process, identify the difficulties they encounter, and find solutions to these difficulties. Students who can manage their learning are students with good metacognitive skills.

Metacognitive skills are one of the skills that can improve student understanding during the learning process. Students with good metacognitive skills will be able to find ways to learn that suit them and assess their abilities, thereby developing a desire to improve their learning methods and enhance their understanding during the learning process. In addition, having good metacognitive skills enables students to be active in the learning process, which in turn has a positive impact on their learning outcomes, specifically by increasing (Priantiningtias & Azizah, 2021; Syaripuddin *et al*., 2020; Rasjid, 2015). By possessing good metacognitive skills, students will be able to solve problems, specifically by designing, monitoring, and assessing the strategies used to track their learning progress (Anwar *et al.,* 2022). Meanwhile, students with skills that are still classified as low can sometimes understand the meaning of the problem but have difficulty writing what

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is known and what is asked in the problem. Sometimes, students are unable to understand the meaning of the problem, which prevents them from writing what is known and what is asked in the problem.

Additionally, they struggle to solve the problem correctly (Larasati *et al.,* 2020). Therefore, students' metacognitive skills must be considered by the teacher. However, in reality, students' metacognitive skills have not received maximum attention from teachers, resulting in low metacognitive skills among students (Utama *et al.,* 2019). Meanwhile, metacognitive skills are one of the key factors that impact student learning success (Ermawati *et al.,* 2020).

Based on interviews with the fifth-grade teacher of SD Negeri 060874 Medan and observations made, it is known that the metacognitive skills of class V.B students are still relatively low. This is obtained from the results of interviews and observations made, namely when students find difficulties, both difficulties in understanding the material and difficulties in solving problems, and when finding difficulties students tend to be silent without trying to find solutions to the difficulties experienced, this shows that students are less able to manage their learning process and are unable to find solutions to the difficulties encountered. In learning Mathematics, one of the difficulties students experience is solving story problems. In solving story problems, the difficulties experienced by students vary, some students are less able to understand the meaning of the problem so that they are unable to write what is known and what is asked in the story problem so that they also have difficulty in determining the formula to be used and are unable to perform arithmetic operations according to the formula, and when they find this difficulty, students tend to be silent without asking the teacher or other students who understand better.

One of the causes of students' low metacognitive skills is the learning process that tends to be teacher-centered, where the teacher plays an active role during learning and students primarily listen to the teacher's explanations, leading to a passive learning approach (Aniah *et al.,* 2022). The teacher-centered learning process is still often found in elementary schools, resulting in students being passive during the learning process. Moreover, based on interviews and observations conducted at SD Negeri 060874 Medan, it is evident that the learning process is still centered on the teacher, resulting in students being passive during the learning process. They primarily listen to the teacher's explanations, becoming accustomed to receiving material only. When students struggle to understand the material, they often lack the confidence to ask the teacher, especially in mathematics.

According to Raditia *et al.,* (2022) one of the efforts that can be made by teachers in improving students' metacognitive skills is to present an enjoyable learning process so that students find it easier to understand the material, and one of the supports for the learning process in making it easier for students to understand the material is teaching materials and modules, which are one of the supports for the learning process that can make it easier for students to understand the material because the learning module contains steps for use and learning activities in the module are clearly explained (Maghfiroh & Hardini, 2021). The learning module includes steps or stages that students must follow to learn how to use it effectively. This approach enables students to understand the learning process, making it easier for them to learn independently. In addition, the learning module also outlines the steps of the learning model, emphasizing the group learning process to train students in discussing the difficulties they encounter during the learning process.

According to Deviana (2018), the use of modules in the learning process encourages students to learn independently. It contains material concepts that can be studied independently by students, thereby promoting active learning and facilitating their ability to work on evaluation questions. Usually in the module there are steps that students must take in working on evaluation questions, making it easier for students to work on problems in the form of story problems, because usually the problem experienced by students in working on story problems is that students do not know the steps to be taken to solve story problems (Alfatihah *et al*., 2022). A learning module is a set of teaching materials that are systematically and engagingly arranged, including instructional content and evaluation questions. This module helps students understand the learning material; additionally, it can be used independently by students to achieve the expected competencies.

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Based on an interview with the fifth-grade teacher of SD Negeri 060874 Medan, it is known that in the process of learning Mathematics, the teaching materials used by students are only Mathematics books published by Mediatama publishers, and teachers have never made or developed a module that is prepared by adjusting the characteristics and level of understanding of students. The teaching materials used by students have several shortcomings, namely there are no instructions or steps in the learning process so that students do not have guidance in carrying out the learning process so that students have difficulty learning to use the book independently, the questions contained in the book have usually been done by students during the learning process in class so that students do not have questions to do at home as learning materials for students to hone students' understanding again, the pictures in the book are less varied in color so that it is less interesting for students, there is no self-reflection that can be used by students to reflect on their knowledge after carrying out the learning process even though self-reflection for students is very important to do because by students reflecting on themselves, students will know their abilities, know what has not been understood and what students need to learn again and the language used in the book is sometimes difficult for students to understand.

In addition to the lack of use of teaching materials, teachers rarely apply varied learning models, especially in Mathematics learning, causing the learning process to be unvaried. A learning process that fails to utilize learning models will cause students to be passive and bored, as the active role is typically reserved for the teacher in delivering the material (Tarigan *et al.,* 2021). Applying a learning model will provide students with engaging learning experiences, as each model typically offers uniqueness, resulting in a more enjoyable and varied learning process. Learning models usually. One of the interesting learning models is the Problem-Based Learning (PBL) model, as it requires students to solve a problem. So that students will become accustomed to solving problems and will later be able to apply this skill to problems encountered in everyday life. In line with Hartata's opinion in the book "*Meningkatkan Motivasi dan Prestasi Belajar Sejarah dengan PBL,*" the PBL model is defined as a learning model that directs students to think at a high level, focusing on problem-solving to provide meaningful experiences for students.

Teaching materials are needed in the form of modules that align with the needs and characteristics of fifth-grade elementary school students and outline the steps of the learning model. Teaching materials that are in accordance with the needs and characteristics of students will make it easier for students to understand the material and present learning as interesting, coupled with teaching materials that contain the steps of the learning model so that it makes it easier for students to use teaching materials because they contain the steps of the PBL model. It is intended that the availability of teaching materials in the form of learning modules will be valid, practical, and effective in developing the metacognitive skills of fifth-grade elementary school students.

LITERATURE REVIEW

Learning Module

Teaching materials are a set of materials that can make it easier for students to understand learning materials, including being able to understand the material by learning independently, teaching materials are arranged systematically and adjusted to the applied curriculum so that it is hoped that the teaching materials will make it easier for teachers to deliver learning in accordance with the sequence of material and make it easier to achieve the competencies that must be completed (Nuryasana & Desiningrum, 2020). The use of teaching materials enhances the learning process, making it both practical and enjoyable (Arifah *et al*., 2023; Minarni *et al.,* 2019). Teaching materials are all learning tools that contain material, methods, and evaluations arranged systematically and presented in an interesting way to encourage students to participate in the learning process. This is because teaching materials are prepared according to the characteristics of the

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students (Lidayni *et al.,* 2022; Susrini, 2021). Teaching materials are a set of learning materials that are systematically arranged and compiled based on the applied curriculum.

Modules are the simplest teaching materials. Learning modules are one of the teaching materials that students can use as a guide to independent learning. According to Zulfahmi et al. in the book "*Kisi-Kisi Praktis Menulis Buku Aja*r," modules are arranged systematically and as interestingly as possible, with components that include learning objectives, materials, and evaluation tasks that students can complete independently to achieve the learning objectives described in the module. The module consists of learning materials and evaluations that are systematically arranged to help students achieve the expected learning objectives. In line with the opinion of Yusuf et al. in the book "*Call For Book Tema 3 (Media Pembelajaran)*," it states that the module is arranged and tailored to the learning speed of each student, thus encouraging students to learn independently as well as according to their abilities.

Based on the description above, it is concluded that the module is one of the teaching materials that students can use to support their learning process and facilitate their understanding of the learning materials. Learning modules encourage students to learn independently, allowing them to progress at their own pace in understanding the material and learn according to their ability to grasp it.

Learning Mathematics

According to Pramesti and Rini in their book, "*Pembelajaran Matematika Sekolah*," mathematics is considered the parent of science because it encompasses several components, including the language used by mathematicians and the ideas and symbols that have meaning. Mathematics learning is a process that teachers and students engage in to acquire mathematical knowledge. According to Sutama et al. in the book "*Pembelajaran Matematika Kolaboratif,*" a teacher is required to implement an engaging learning process for students by applying learning models and supporting the learning process, such as utilizing learning media and teaching materials that facilitate students' understanding of the material. Furthermore, Jayanti et al. in a book entitled "*Numerasi Pembelajaran Matematika SD Berbasis E-Learning*" state the characteristics of Mathematics learning in elementary school, namely: 1) Mathematics learning uses a spiral mode, which is to familiarize students with relating and recalling the concept of material that has been learned or has been mastered by students so that new concepts arise; 2) Gradual mathematics learning, in which mathematics learning materials are taught to students in a gradual manner starting from simple concepts to complex concepts; 3) Mathematics learning adheres to consistent truth; and 4) Mathematics learning is meaningful.

In addition, Ariani et al. in the book "*Model Pembelajaran Inovatif untuk Pembelajaran Matematika di Kelas IV Sekolah Dasar*" also suggest the characteristics of learning mathematics in elementary schools, namely; 1) The use of the spiral method, learning materials are always associated with previous learning materials because each material is always related and the new material taught is the development of the previous material; 2) Learning in stages, namely the learning material given to students is given in stages, starting from the basic or simple to the complicated stage; 3) Learning with the use of the inductive method, meaning that in the learning process students are directed to think from a special situation and then go to a general situation, for example in flat building material, students start by giving pictures of flat buildings and then the definition of the flat building itself so that students will understand the concept of the material; 4) Adhering to the truth of consistency, meaning that there is no contradiction between one reality and another or one truth with another reality. A statement is said to be true if the previous statement has been recognized as accurate; and 5) Learning should be meaningful, meaning that the way the material is delivered should be concerned with understanding rather than memorization.

According to Aryanti in the book "*Inovasi Pembelajaran Matematika di SD (Problem Based Learning Berbasis Scaffolding, Pemodelan dan Komunikasi Matematis)*" learning Mathematics in Elementary Schools aims to make students able to; 1) Understand mathematical concepts, explain the relationship between concepts and

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be able to apply concepts and solve problems; 2) Communicate ideas with symbols and tables in explaining a problem; 3) Show an attitude of appreciating the use of Mathematics in everyday life by showing curiosity, high interest, enterprising and a confident attitude in solving a problem or problem. So that learning Mathematics is one of the essential subjects to be applied because it trains students to be able to understand abstract Mathematics concepts, connect concepts and apply concepts that have been learned in everyday life, and learning Mathematics trains students always to be able to solve problems and think critically and increase students' curiosity.

Model Problem-Based Learning (PBL)

The PBL learning model is a learning approach that emphasizes problems encountered in students' daily lives, providing issues at the beginning of the learning process and innovative learning models that encourage students to be active participants in the learning process. According to Yustina and"Problem-Based Mahadi in the book "*Problem Based Learning (PBL) Berbasis Higher Order Thinking Skill (HOTS) Melalui E-Learning*," there is a problem exposure, where students will be able to solve problems using strategies that they determine themselves. According to Amaludin in the book "*Model Pembelajaran Problem Based Learning Penerapan dan Pengaruhnya Terhadap Keterampilan Berpikir Kritis dan Hasil Belajar,*" the PBL model is defined as one of the learning models that emphasizes the learning process in groups, a learning model with learning characteristics raised from a problem, where this problem becomes the starting point of the learning process. Students are required to possess research skills, problem-solving abilities, and higher-order thinking skills.

Based on the explanation above, it is concluded that the PBL model is one of the group learning models, with the main characteristic of PBL being the use of problems as a starting point in the learning process. The problems given to students will shape them into individuals who possess problem-solving skills and high-level thinking skills, and will also help them improve their communication skills, both with their peers and with classmates. Presenting problems at the beginning of learning provides opportunities for students to solve them by determining solutions or answers.

According to Amaludin in the book "*Model Pembelajaran Problem Based Learning Penerapan dan Pengaruhnya Terhadap Keterampilan Berpikir Kritis dan Hasil Belajar*" giving problems in the learning process will provide several benefits for students, namely; 1) stimulating students' abilities and providing opportunities for students to acquire new knowledge, meaning that they have never been obtained by students and are able to develop this new knowledge; 2) foster critical thinking skills, increase students' motivation to learn and develop their previous abilities and connect with the new knowledge obtained; 3) by solving problems so that students will be able to apply them in their daily lives; 4) motivate students to learn throughout life, this is in accordance with the nature of education, namely learning throughout life; and 5) instill awareness in students that learning does not only depend on the presence of the teacher, but also depends on the motivation that comes from within the student to learn.

According to Setyo et al. in the book "*Strategi Pembelajaran Problem Based Learning*" the learning model has several characteristics, including; 1) The learning process is carried out by presenting a problem; 2) Learners work together to obtain information and solve problems; 3) The learning process is centered on students; 4) The teacher acts as a facilitator and guides students to achieve learning objectives; 5) Students are allowed to convey the results of group cooperation. According to Hosaini et al., in a book entitled "*Metode dan Model Pembelajaran untuk Merdeka Belajar,*" the main objectives of the PBL model are: to improve skills and abilities, to provide satisfaction for students to find new knowledge, for students; help students to become independent individuals and take responsibility, to increase student motivation and learning activities, and to provide opportunities for students to apply the knowledge they already have in their daily lives.

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According to Huriah in the book "*Metode Center Learning*", what distinguishes the PBL model from other learning models are; 1) PBL model is student-centered learning; 2) Students are formed into small groups to discuss the problems given at the beginning of learning; 3) The teacher acts as a facilitator in the learning process; 4) Problems become the focus of learning and as a means of developing students' problem-solving skills; and 5) New knowledge is gained from independent learning. The PBL model consists of five stages, beginning with orienting students to the problem that will be the focus of their learning. Students are then required to solve problems by discussing them with group members. The second stage involves organizing students to learn; at this stage, students will discuss with group members to study in groups and seek references to help solve problems. The fourth stage involves developing and presenting the results of discussions with students. At this stage, students will find solutions to problems presented at the beginning of the learning process and then present the results of their discussions. The fifth stage involves analyzing and evaluating the problem-solving process. At this stage, students, along with the teacher, will analyze and assess the problem-solving process that the students have carried out.

Metacognitive Skills

Metacognition refers to an individual's awareness of their learning process. In relation to individual awareness in learning, a strategy is needed that can be applied to meet the learning needs of an individual. The conscious process is referred to as metacognition (Kasalak & Dağyar, 2020). Furthermore, their ability to understand and assess whether the learning strategies they use are effective in solving a problem is referred to as metacognitive skills. According to Siswati and Corebima in the book "*Pembelajaran IPA & Biologi di Indonesia*," teachers play a crucial role in the learning process to improve students' metacognitive skills. This is because teachers can help students assess whether the learning strategies used are effective or not.

Metacognitive skills refer to the ability of students to manage their learning process and regulate their knowledge and skills within the learning process (Ermin, 2021; Fitri, 2017). According to Listiana et al. in the book "*Model Pembelajaran Pemberdayaan Keterampilan Metakognitif*," metacognitive skills are the skills that direct students in determining what they should do during the learning process and enable them to solve problems encountered to achieve their learning goals. Students with good metacognitive skills will be able to manage their learning process, determine and solve the problems they encounter, and effectively address them. The metacognitive skills of each student differ because the ability to manage student learning varies.

Based on the description above, it can be concluded that metacognitive skills are a set of skills that direct a student in planning, monitoring, and evaluating their learning process, allowing them to manage their abilities and determine what to do during the learning process, including when encountering a problem or difficulty.

METHODS

The type of research conducted is development research (RnD), which is a type of research that produces a product. The development model used is the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. This research begins with the analysis stage, followed by the design stage, which is then developed and continued through the implementation stage, culminating in the evaluation stage. The research was conducted at SD Negeri 060874 Medan, located on Jl. Ibrahim Sei Kera Hilir, Medan, with the research subject of Class V.B Elementary School. The data collection techniques used in this research include interviews, questionnaires, and tests. Interviews were conducted with the homeroom teacher of class V.B at SD Negeri 060874 Medan and students of class V.B at SD Negeri 060874 Medan to determine the conditions of teaching materials and the process of learning Mathematics in the classroom. Questionnaires are used to determine the level of validity, practicality, and effectiveness of the teaching materials that have been developed. The questionnaire used consists of two parts, namely a product

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validation questionnaire, a practicality questionnaire, and a student metacognitive skills questionnaire. Tests are conducted to determine student learning outcomes before and after the use of teaching materials that have been developed to measure the effectiveness of these materials.

RESULTS AND DISCUSSION

Mathematics Learning Module Development Process

In developing Mathematics teaching materials, researchers use the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

The first stage is the analysis stage. At this stage, the researchers analyzed the data through observations and interviews with teachers and fifth-grade students of SD Negeri 060874 in Medan. At the analysis stage, two analyses were conducted: a needs analysis and an analysis of student characteristics. A needs analysis is performed to determine the type of teaching materials that students require. Based on the analysis of the needs and characteristics of students conducted, it is known that students need Mathematics teaching materials that contain language that is easy for students to understand, include pictures with attractive colors to attract students' interest in learning and contain clear steps of the learning process because some students find it challenging to understand the learning material because the books used do not include steps that make it easy for students. The teaching materials developed are adapted to the school's curriculum, specifically the Kurikulum 2013.

The second stage is the design stage. At this stage, the design of the learning module to be developed begins with determining the components that will be included, identifying material references from books, selecting images for the teaching materials, and defining the evaluation questions that will be incorporated into the teaching materials. Additionally, it determines the type of design to be used for the cover of the front page and the content of the teaching materials to be developed.

The third stage is the development stage. At this stage, the design prepared in the previous stage will be developed. Each component designed in the last stage will be loaded into a single file, resulting in a product that serves as teaching materials. These materials will generally contain content, images, and evaluation questions. After the teaching materials have been developed, an expert conducts a validation test to determine the validity of the materials.

The fourth stage is the implementation stage. After obtaining valid teaching materials, trials were conducted with class V.A students to achieve improvements, ensuring that the materials were both valid and suitable for fifth-grade students. Furthermore, revisions are made based on the results of the trials conducted to refine the teaching materials. After the trial, the teaching materials were then applied in class V.B.

The last stage is the evaluation stage. The evaluation stage spans from the initial design of teaching materials to the final development stage. The evaluation stage is carried out to assess and make improvements to the learning modules that have been developed.

The Validity of the Mathematics Learning Module

Validators subsequently validate the developed teaching materials. The validation test is conducted to determine the validity of the developed learning module by assessing three aspects: content, language, and design. The determination of validity criteria and the validation results for the developed teaching materials are presented in **Table 1**.

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Table 1. Criteria for the Validity of Teaching Materials

No.	Percentage	Criteria
1.	81-100	Very Valid
2.	61-80	Valid
3.	41-60	Moderately Valid
4.	21-40	Less Valid
5.	0-20	Not Valid

Source: Riduwan and Sunarto in the book "Pengantar Statistika untuk Penelitian: Pendidikan, sosial, komunikasi, ekonomi, dan bisnis"

The results of the validity test for the teaching materials are presented in **Table 2.**

Table 2. Results of the Teaching Material Validity Test

No.	Aspect	Percentage	Criteria
1.	Material	81%	Very Valid
2.	Language	87%	Very Valid
3.	Design	86%	Very Valid

Source: Research 2024

Based on the validation results in **Table 2**, it is known that the developed learning module is declared very valid with a percentage breakdown of 81% in the material aspect with very valid criteria, 87% in the language aspect with very valid criteria, and 86% in the design aspect with very valid criteria. The following diagram presents the validity test results for the three aspects of the learning module.

Practicality of Mathematics Teaching Materials

The practicality test is conducted to determine the ease of use of the developed learning module. The practicality test was conducted by providing a response questionnaire to students after they had implemented the learning using the developed learning module. The determination of practicality criteria and the results of the practicality test are presented in **Table 3** below.

Table 3. Criteria for the Practicality of Teaching Materials

No.	Percentage	Criteria
1.	81-100	Very Practical
2.	61-80	Practical
3.	41-60	Quite Practical
4.	21-40	Less Practical
5.	0-20	Not Practical

Source: Riduwan and Sunarto in the book "Pengantar Statistika untuk Penelitian: Pendidikan, sosial, komunikasi, ekonomi, dan bisnis"

The results of the practicality test for the teaching materials are presented in **Table 4** below.

Table 4. Results of the Practicality Test of Teaching Materials

No.	Aspect	Percentage	Criteria
1.	Student Interest	84%	Very Practical
2.	Process of Use		
3.	Increase in Usage		
4.	Evaluation		

Source: Research 2024

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Based on the practicality test results in **Table 4**, the use of learning modules in the learning process is deemed very practical, with an efficient percentage. This means that the developed learning module can be used effectively by students, helping them in the learning process.

The Effectiveness of the Mathematics Learning Module

The effectiveness test of the learning module is conducted to determine whether the intended objectives have been achieved. A learning module is considered adequate if it can have a positive influence or impact on the objectives for which it was developed, where the purpose of creating the teaching materials is to facilitate students' understanding of the learning material (Weriyanti *et al.,* 2020). The effectiveness test in this study was conducted by analyzing test results, specifically the pre-test and post-test, using an N-Gain test to determine the difference in student learning outcomes before and after the implementation of the learning module. Based on the N-Gain test conducted, the data obtained is shown in **Table 5** as follows.

Table 5. Data Pre-test Post-test

N	Average		N-Gain Score	Category	Criteria
	Pretest	Posttest			
27	40,37	73,81	0,56	Currently	Effective

Source: Research 2024

Table 6 shows the initial and final metacognitive skills data of the students.

Table 6. Data on Students' Initial and Final Metacognitive Skills

N	Average		N-Gain Score	Category	Criteria
	Pretest	Posttest			
27	26,70	39,26	0,49	Currently	Effective

Source: Research 2024

Based on the results of the effectiveness test in **Table 5** and **Table 6**, it is known that the learning module developed is declared effective as evidenced by the results of the metacognitive skills questionnaire and student learning outcomes seen from the increase in the average student metacognitive skills at the beginning of learning before and after the application of the learning module and the increase from the pre-test results to the post-test average. Student learning outcomes before the application of the learning module averaged 40.37 and increased to an average of 73.81 after the module was applied. The questionnaire results on metacognitive skills also showed that students' metacognitive skills at the beginning of learning were 26.70 and increased after the application of learning modules, with an average of 39.26. This demonstrates that the learning module developed can achieve the objectives of creating teaching materials, namely, making it easier for students to understand the learning materials and improving students' metacognitive skills.

Discussion

In developing teaching materials, the first step is analysis, which needs explicit analysis, curriculum analysis, and an examination of student characteristics. In this study, it is evident that students' metacognitive skills are still relatively low, which is attributed to several factors, including the availability of learning tools in the form of teaching materials and the learning methods employed by teachers. Students with low metacognitive skills tend to remain silent when they encounter a problem in learning, and learning is often carried out without group discussion activities, so students are not accustomed to discussing difficulties even when they arise. Additionally, in the learning process, teachers rarely employ innovative learning models.

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The learning process is an interaction between teachers and students, carried out in a learning environment that utilizes various learning tools, including teaching materials and learning modules. Teaching materials are a set of tools used during the learning process to facilitate the delivery of material and enhance student understanding of the learning material. The teaching materials used should be adapted to the character of students and be attractive in terms of appearance and also the presentation of material so that it is hoped that teachers will be able to be creative in presenting an enjoyable learning process, one of which is innovative in using teaching materials used, including creative in developing teaching materials, because teachers understand what kind of teaching materials are suitable for students (Magdalena *et al.,* 2020). Teaching materials used in the student learning process often have several shortcomings, so teachers need to develop new materials that suit students and address the shortcomings found in previous materials.

The development of teaching materials is carried out to produce new teaching materials that correct the shortcomings of previous ones. According to Dewi and Widinyani in the book "*Desain Pembelajaran PPKn di Sekolah Dasar*" explained that in developing teaching materials there are several things that need to be considered, namely; 1) Teaching materials developed can meet student needs; 2) Can increase student interest in learning; 3) Make it easy for students to increase confidence so that they dare to communicate. They have an understanding because they read teaching materials; 4) Teaching materials developed must be relevant to students; and 5) Can facilitate students to learn independently.

The use of teaching materials with an attractive presentation is likely to increase students' interest in learning, both in class and independently (Ginantara & Aguss, 2022). Good teaching materials for students are those that contain language easy for students to understand. If teaching materials contain language that is difficult for students to understand, it will cause students difficulty in grasping the learning material. In addition, interesting teaching materials are those that contain attractive pictures with vibrant colors. This is because elementary school students still prefer teaching materials with interesting pictures and colors. Furthermore, pictures make it easier for students to understand learning materials, especially in mathematics. Teaching materials should outline the steps of the learning process, enabling students to learn how to use them effectively, including when learning independently.

Some previous studies have also explained how to improve students' metacognitive skills by applying learning models and developing effective teaching materials. Some of them are research studies conducted by Bachri *et al.* (2022), which found that the development of problem-based Mathematics learning tools can train students' metacognitive skills. Another study, conducted by Erayani and I Nyoman Jampel (2022), found that the application of the PBL model, aided by interactive media, can improve students' metacognitive skills. The primary difference between this research and previous studies lies in the product developed, which is a learning module in this study. This learning module incorporates the steps of the PBL model, as the PBL model is one of the learning models that trains students in problem-solving.

CONCLUSION

Based on the research conducted, the developed learning module is deemed valid and feasible for use in the learning process, as evidenced by the assessment obtained from the validator in terms of material, language, and design. The learning module that has been developed is also declared practical, as evidenced by the practical tests conducted on students after the completion of the learning process. Moreover, the learning

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module developed is also declared effective, as evidenced by the improvement in students' metacognitive skills before and after its application. Specifically, students' metacognitive skills after the application of the learning module are higher than those before the application. Students' metacognitive skills have increased after the application of the learning module that was developed. To other researchers, it is recommended that they develop teaching materials on learning materials or other subjects tailored to the needs and characteristics of students, to accompany student teaching materials. This approach enables students to utilize multiple references during the learning process, making it easier for them to understand the learning materials.

AUTHOR'S NOTE

The authors declare that there is no conflict of interest related to the publication of this article. The authors emphasize that the data and content of the article are free from plagiarism. Additionally, the researcher would like to thank those who have contributed to this research.

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