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Teaching Materials Using the Discovery Learning Learning Model to Facilitate the Mathematical Communication Skills of Junior High School Students

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ABSTRAK

Siswa Indonesia berada pada kategori rendah dimana siswa hanya memiliki kemampuan dasar matematika. Hal ini disebabkan karena sulitnya pembelajaran matematika pada materi lingkaran, memerlukan kreativitas guru dalam mengembangkan pembelajaran, yaitu dari segi bahan ajar, media, dan metode yang digunakan dalam proses pembelajaran. Materi pembelajaran yang terintegrasi dengan model pembelajaran yang baik sangat diperlukan untuk memudahkan siswa dalam belajar matematika. Oleh karena itu penelitian ini bertujuan untuk mengembangkan bahan ajar menggunakan model Discovery Learning untuk meningkatkan kemampuan matematika siswa pada materi lingkaran kelas VIII SMP. Jenis penelitian ini adalah penelitian pengembangan dengan mengacu pada model pengembangan ADDIE (Analysis, Design, Development, Implementation dan Evaluation). Subyek penelitian ini adalah guru dan siswa kelas VIII SMP. Berdasarkan angket guru mata pelajaran dan siswa dapat disimpulkan bahwa bahan ajar mempunyai kriteria baik. Respon siswa terhadap media tergolong positif, hal ini terlihat dari nilai respon positif siswa yang mencapai 83,83%. Jika dilihat dari kemampuan matematika siswa dapat dikatakan cukup baik, yaitu dilihat dari skor hasil tes ketuntasan siswa mencapai 44%. Berdasarkan semua itu, dapat disimpulkan bahwa bahan ajar tersebut dapat memfasilitasi peningkatan kemampuan matematika siswa.

ABSTRACT

Indonesian students are in the low category where students only have basic mathematical abilities. It is caused by difficulties in learning mathematics in the circle material, requires teacher creativity in developing learning, namely in terms of teaching materials, media, and methods used in the learning process. Learning materials that are integrated with good learning models are needed to facilitate students in learning mathematics. Therefore this study aims to develop teaching materials using the discovery learning model to improve students' mathematical abilities in the circle material for class VIII junior high school. This type of research is development research with reference to the ADDIE development model (Analysis, Design, Development, Implementation and Evaluation). The subjects of this study were teachers and students of class VIII junior high school. Based on the subject teacher and student questionnaires, it can be concluded that the teaching materials have good criteria. Students' response to the media was positive, this can be seen from the value of students' positive responses which reached 83.83%. When viewed from the students' mathematical abilities, it can be said to be quite good, that is, seen from the score of the students' completeness test results reaching 44%. Based on all this, it can be concluded that these teaching materials can facilitate the improvement of students' mathematical abilities.

1. INTRODUCTION

Mathematics is a scientific field that has an important role both in school and in everyday life. Previous study said that, learning mathematics in schools is different from that found in the daily lives of students and Indonesian educators in educating students are more focused on meeting the target exam

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scores as the end of the learning process, so there needs to be some improvement both in the learning process and the availability of learning resources for students so that the results obtained are maximized (Iqbal & Karim, 2018). Learning that has good quality can be a driving force in increasing the value of education (Alzaber et al., 2021; Gazali, 2016). In 2011 on class VIII students showed that the results of the mathematics achievement scores of Indonesian students were 386, where the international average score was 500, placing Indonesian students in the 2nd rank. -38 out of 42 participating countries. From this score it shows that Indonesian students are in the low category where students only have basic mathematical abilities (Mirwan & Zetriuslita, 2023; Sari, 2011). One of the many mathematical materials found in everyday life is a circle. Circle material is included in the scope of geometric aspects that are studied in class VIII SMP. Based on research of previous study the results showed that many students had difficulty understanding the circle concept, this was because during the learning process the teacher only asked students to read and then memorize the circle material that had been summarized in a teaching material (Norsanty & Chairani, 2016).

Discovery learning learning model is a model that manages learning that can make students gain knowledge independently and are not actively known by themselves. The discovery learning model helps in focusing attention on students in working on problems more than being centered on the teacher, so that the discovery learning model helps students to learn actively and the teacher has a role in directing learning so that it is in accordance with learning objectives (Al Mamun et al., 2022; Ariana et al., 2020). Teaching materials are the most important thing in increasing students' knowledge, with the knowledge possessed by students they can communicate mathematical problems easily. However, specifically for learning mathematics, there are no specific teaching materials to facilitate mathematical communication skills and learning that prioritizes students in building their knowledge. Even though these teaching materials are needed to facilitate mathematical communication skills (Murtiyasa & Perwita, 2020; Tussholeha et al., 2023).

The researcher conducted an interview with a class VIII math teacher at SMPN 4 Dumai to obtain information about the teaching materials used by teachers and students. The teaching materials used by teachers and students of SMPN 4 Dumai are the 2017 Revision of the Ministry of Education and Culture of the Republic of Indonesia provided by the government and the Mathematics Package Book published by one of the well-known publishers in Indonesia where the book is contextual but not close to the lives of students, so the material used contained in teaching materials cannot be mastered properly by students. Difficulties in learning mathematics in the circle material, requires teacher creativity in developing learning, namely in terms of teaching materials, media, and methods used in the learning process (Haryonik & Bhakti, 2018; Meliana et al., 2022).

Teaching materials are a set of materials that are arranged systematically, both written and unwritten so as to create an environment/atmosphere that allows students to learn. Teaching materials are knowledge, skills, and attitudes that students must learn in order to achieve predetermined competency standards. According to prevuious study teaching materials are all materials (whether information, tools, or text) that are systematically arranged to present a complete figure of competence that will be mastered by students and used in the learning process (Anharuddin & Prastowo, 2023). According to other study teaching materials are all forms of materials used to assist teachers or instructors in carrying out teaching and learning activities in class (Kurniasih, Imas & Sani, 2014).

From several views regarding the understanding of teaching materials, it can be understood that teaching materials are all forms used to assist the learning process, namely in the form of oral and written information used as the basis for learning to be more directed and systematic. This teaching material is prepared before the start of the learning process, starting from the opening, content and closing. So that the teaching and learning process can run well. Examples of teaching materials that are often used include Student Worksheets (LKS), Modules, books etc. One of the learning models in the 2013 curriculum is the discovery learning model, according to other study states that the discovery learning model is a learning model that emphasizes students to discover their own concepts of knowledge and skills (Jayadiningrat et al., 2019). Learners are guided to observe the learning stages to organize their own findings in the form of concepts. Meanwhile, according to Permendikbud No. 58 (2014: 358) states that the discovery learning learning model is the process of learning activities in which it is not presented in the form of a final concept, this requires students to organize their own way of learning to find concepts (Esterlina, 2019).

Previous study said, discovery learning is a model for developing an active way of learning students by finding themselves, investigating themselves, then the results obtained will be loyal and long-lasting in memory, students will not easily forget (Hosnan, 2014). By learning discovery, children can also learn to think analytically and try to solve their own problems. This habit will be transferred in people's lives. Based on the explanation above, the researcher concludes that discovery learning is a way of learning to make students more active where students work more independently by investigating and

solving their own problems so that students can discover new things. So that the material taught will be easy to understand and increase knowledge. According to previous study communication in general can be interpreted as a way to convey a message from the messenger to the recipient of the message to inform opinions, or behavior either directly orally or indirectly through the media (Kamilia & Imami, 2018). Communication is essentially the process of delivering messages from the sender to the recipient. Mathematical communication is an important skill in mathematics, according to The Intended Learning Outcomes in the author Armiati, mathematical communication is the ability to coherently express mathematical ideas to friends, teachers, and others through written spoken language. This means that with mathematical communication teachers can better understand students' abilities to interpret and express their understanding of the concepts they are learning. According to previous study mathematical communication can be channeled in two ways, namely through writing and orally or verbally (Mahmudi, 2009). Written communication in the form of the use of words, pictures, tables and so on which describes students' thinking processes. Meanwhile, oral communication can be in the form of disclosure and verbal explanation of a mathematical idea. Oral communication can occur through interaction between students in learning with group discussions. In development research to produce a product that is correct and appropriate, it is necessary to test the validity. Previous study argues that validity is the most important requirement in an instrument evaluation (Vartiainen et al., 2016). An evaluation technique is said to be valid if the assessment technique can measure what is the goal to be measured. Validity is the accuracy of interpretation resulting from test scores or evaluation instruments. Thus the notion of validity in this study is a measure that shows the level of validity of teaching materials with the goals to be achieved.

Various types of instrument validity according to previous study, it is divided into two, namely internal validity and external validity (Nusantoro & Kurniawan, 2014). Internal validity is the validity that refers to the condition of an instrument that meets the valid requirements based on reasoning or rational results. Internal validity is divided into two, namely content validity and construct validity. External validity is a validity criterion that is based on criteria that are outside the instrument, namely based on empirical facts or experience. Based on the type of validity that has been described, in this study internal validity was used. This is because the aspects assessed in the teaching materials are compared to the current curriculum provisions. The aims of this study is to develop teaching materials using the discovery learning model to improve students' mathematical abilities in the circle material for class VIII junior high school.

2. METHOD

This research is classified as Research and Development (R&D) development research, namely research that is important to do in an effort to find solutions to learning problems with certain products (Tegeh & Kirna, 2013). The development model used in developing this teaching material is the ADDIE development model which consists of five stages of development namely Analysis, Design, Development, Implementation, and Evaluation. The test subjects in this research and development were class VIII students at SMPN 4 Dumai in class VIII. 2 totaling 25 students. The object of this research is teaching materials using the discovery learning learning model which was developed to facilitate the mathematical communication skills of junior high school students. The data collection technique used was to test the validity of teaching materials. The validation data from the validator is then analyzed descriptively by examining the results of the validator's assessment of the teaching materials. The validator is a math teacher at SMP Negeri 4 Dumai with a total of 5 people. The validity instrument in this study was in the form of a validation sheet which was used to validate the teaching materials filled in or assessed by the validator. The validation sheet used is in the form of a form containing statements using a Likert scale consisting of 4 alternative answers, namely 1, 2, 3, and 4 with the following categories as show in Table 1.

Table 1. Rating Scale Table

1	2	3	4
Not good	Not good	Good	Very good
Not exactly	Less precise	Appropriate	Very precise
Not easy	Less easy	Easy	Very easy
Not covered	Less covered	Covered	Very covered

The teaching material validation indicators are used as guidelines in the preparation of validation sheets containing assessment component items consisting of 4 aspects, including appearance aspects,

material aspects, language aspects, and presentation aspects. The assessment criteria in the validation sheet were developed based on research (Tegeh & Kirna, 2013).

To determine the validity of the developed teaching materials is carried out based on the following steps: 1.) The results of the analysis of the validator's assessment are obtained through a validation sheet and the results will be presented in the form of a table containing the average score. The data collected from the average score is then converted with a score conversion guideline on a scale of 5. 2.) Then change the quantitative data into qualitative data. Guidelines for converting quantitative data into qualitative data are presented in Table 2.

Table 2. Quantitative Data Guidelines Become Qualitative

Score Intervals	Mark	Category
x>3.40	A	Very Valid
2.80 < x < 3.40	B	Valid
2.20 < x < 2.80	C	Valid Enough
1.60 < x < 2.20	D	Invalid
$x \leq 1.60$	E	Invalid

After that describe the validation results, teaching materials using the Discovery Learning learning model to facilitate the mathematical communication skills of junior high school students are said to be valid if the scores obtained fall into the valid or very valid category.

3. RESULT AND DISCUSSION

Result

Validation of Teaching Materials by Mathematics Teachers

After the questionnaires were distributed and filled in according to the indicators in the study Tegeh & Kirna (2013), then the data is processed and obtains the results as show in Table 3.

Table 3. Validation of Teaching Materials by Mathematics Teachers

Aspect	Average score	Mark	Criteria
Appearance	3.27	B	Good
Material	3.08	B	Good
Language	3.7	A	Very good
Presentation	3.49	A	Very good
Total Score	13.5		
Average Score	**3.38**	**B**	**Good**

From Table 3 it can be seen that the average value of each aspect, then from all these aspects the average is sought. According to the teacher as a whole has an average score of 3.3. These values were converted with conversion guidelines on a scale of 5. From the average conversion results it can be concluded that according to the teachers, the teaching materials were declared "Good". The teacher stated that the teaching materials were worth trying out.

Evaluation of Teaching Materials by Students

After the questionnaires were distributed and filled in by students according to the indicators in the study (Tegeh & Kirna, 2013), then the data is processed and obtains the results as show in Table 4.

Table 4. Evaluation of Teaching Materials by Students

Aspect	Average score	Mark	Criteria
Appearance	3.33	B	Good
Material	3.33	B	Good
Language	3.42	A	Very good
Presentation	3.31	B	Very good
Total Score	13.39		
Average Score	**3.35**	**B**	**Good**

From Table 4 according to students as a whole it has an average score of 3.35. These values are converted with conversion guidelines on a scale of 5. From the average conversion results it can be

concluded that according to students, the teaching materials are declared "good" and the teaching materials are worthy of being tested.

Student Response

Interactive learning media are media or intermediaries used by educators to convey messages or learning content to students so that there is stimulation of pleasure (feelings), curiosity (thoughts), liveliness (talent), attention, and interest, so as to create a conducive learning environment. as well as the existence of good feedback (response) from the students themselves (Munadi, 2013).

In addition to the evaluation questionnaire by students, students were also given a student response questionnaire. This student response questionnaire aims to find out the percentage of students' positive responses to this learning media. The following are the results of student responses as show in Table 5.

Table 5. Student Response

Aspect	Category					Total
	SS	S	CS	TS	STS	
Happiness	26 %	63 %	11 %	0 %	0 %	100 %
Curiosity	22 %	68 %	10 %	0 %	0 %	100 %
liveliness	32 %	62.67 %	5.33 %	0 %	0 %	100 %
Attention	32 %	58 %	10 %	0 %	0 %	100 %
Interest	34 %	52 %	14 %	0 %	0 %	100 %
Total Average	29.2 %	60.73 %	10.07 %	0%	0%	100%

From these data it can be determined a positive response from students. The results of positive response data from students is show in Table 6.

Table 6. Positive Student Response

Aspect	Positive Response	Category
Happiness	83 %	Positive
Curiosity	82.40 %	Positive
liveliness	85, 33 %	Very Positive
Attention	84, 40 %	Positive
Interest	84 %	Positive
Total Average	**83.83 %**	**Positive**

Test Instrument Validity

Testing the validity of this test instrument uses the product moment correlation technique and is carried out to class VIII.2. The reason researchers use the product moment technique is to determine the strength of the relationship between the correlations of the two variables where other variables that are considered influential are controlled or fixed (as control variables). From the results of the validity test it is known that the validity of the test instrument reaches 5.1031, then to decide whether the instrument is valid or not, the price is consulted with the r table value. With n = 25 (number of students) 5% error rate obtained 0.3233. Because $rhitung \geq rtabel$ for an error level of 5% (5.1031 > 0.3233), the item is declared valid, so the acquisition of instrument validity is 5.1031 included in the high validity category (T).

Reliability

After the validity analysis was carried out, then the reliability analysis was carried out. The reliability test of this test instrument uses the Cronbach alpha coefficient technique. It is known that it is said to be reliable if the alpha value is > 0.60 and is tested in the same class, namely class VIII.2. the reason researchers used reliability analysis was because the reliability test was carried out in order to obtain a reliable instrument in the sense that it must have a level of consistency and stability. Reliable instruments when used several times to measure the same thing will produce the same data. From the results of the reliability test it is known that the reliability of the test instrument reached 1.082 > 0.60. The results of the reliability test analysis are included in the high category.

Teaching Materials Test Results

Student tests are carried out after students use the media. This test is used to see students' mathematical abilities, if students' mastery is high, it can be concluded that students' mathematical

abilities are high, and vice versa. From the results of validity and reliability it is known that the instruments used to assess the quality of the media are high enough so that the instruments used can be used to measure the quality of the media in learning. Through the results of these tests obtained the value/score used to measure the quality of the media.

Table 7. Teaching Materials Test Results

The number of students	Number of Completed Students	Completeness Percentage
25	11	44%

Base on Table 7, out of a total of 25 students of class VIII. 2 which is used to determine the quality of teaching materials is known that 11 students have fulfilled the KKM and as many as 14 students have not fulfilled the KKM, so the percentage of completeness is 44% and 56% are incomplete.

Discussion

Analyze Stage

Analysis is the earliest stage of ADDIE's R&D model. The analysis carried out in this study is the analysis of the problems most often faced by junior high school students when studying circle material. This is also in accordance with the opinion of previous study showed that many students had difficulty understanding the circle concept, this was because during the learning process the teacher only asked students to read and then memorize the circle material that had been summarized in a teaching material (Norsanty & Chairani, 2016). Circle material at the junior high school level is one of the materials that must be mastered by students because it is included in the KD of mathematics. One of the KD that must be achieved by students in circle material is understanding the elements, circumference and area of a circle. If students master KD, it is expected that students can determine the elements and parts of a circle, discover the concept of a circle and be able to solve problems related to the circumference and area of a circle.

Design Stage

The design stage is in the form of determining the content so that the entire initial design can be developed (Chan et al., 2019; Ghani & Daud, 2018). The teaching material developed is in the form of a book (Figure 2) which has a paper size of 17.6 × 25 cm using the discovery learning model. This teaching material consists of three parts and contains several components, namely Introduction, Core material, and Closing / evaluation, divided into 4 sub-materials from circle material: 1) circle elements, 2) the relationship between the central angle and circumferential angle, 3) circumference and area of a circle, and 4) the relationship between the central angle, arc length, and area of the sector. The teaching material cover is show in Figure 2.

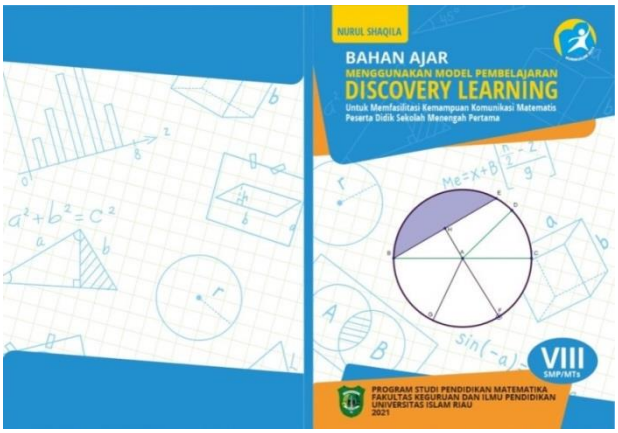

Figure 2. Teaching Material Cover

Development Stage

The development of this learning media follows the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). Step by step has been carried out according to

development needs. All stages of the development of teaching materials are very important and one of the stages is the development stage, namely the preparation of teaching materials and evaluation by mathematics teachers and students. The purpose of the evaluation by experts is to obtain input, criticism, and suggestions for improvement for the perfection of the teaching materials being developed. Media trials on six mathematics teachers were assessed by each teacher. From this assessment, input, criticism, and suggestions for improvement were obtained which became the reference for the final revision of the media. In addition to input from teachers, evaluation questionnaire data was also obtained to determine the quality of the media seen from the eyes of educators who know the characteristics and abilities of their students. From the data that has been obtained, it can be seen that the media that has been developed achieves an average score of 3.38 with reference to conversion guidelines on a scale of 5, then the media is declared "good". Student evaluation scores were obtained from student questionnaires that were given to students after the tryout. The number of students to fill out this questionnaire is 25 students. From the questionnaire data that has been obtained, it can be seen that the media that has been developed achieves an average score of 3.35 with reference to conversion guidelines on a scale of 5 (table 2), then the media is declared "good". Participant responses were obtained from student response questionnaires that were given after the media trial was carried out. The number of students in filling out the student response questionnaire was as many as 25 students. From the student response questionnaire data, it can be seen that students responded positively to learning media with a percentage of 83.83%. (Munadi, 2013)

Implementation Stage

The response of students' enjoyment of learning media shows 83% and is in a positive category. This percentage shows that students feel happy with the learning media that has been developed. The pleasure aspect includes: 1) Students feel happy following the learning of this circle material. 2) Students also feel that using this learning media makes learning in class more fun. 3) Students are happy to carry out learning activities using the learning media. 4) After learning by using the learning media, students become happier learning mathematics. The response of students' curiosity towards learning media shows 82.40% and with a positive category. This percentage shows that students feel their curiosity about the material increases after using the learning media that has been developed. Curiosity aspects include: 1) Students try to take part in learning circle material using the learning media until it is finished. 2) Students try to learn more deeply all the circle material in the learning media (Khechine et al., 2020; Liu et al., 2021).

The active response of students to learning media showed 85.33% and was in a very positive category. This percentage shows that students feel active in learning by using the learning media when learning in class. The liveliness aspect includes: 1) By using this learning media, it makes students not feel bored following learning this circle material. 2) Students carry out all learning activities using the media. 3) Students try to be more active in the learning process (Firdaus & Pahlevi, 2022; Widiyanti & Nisa, 2021). The response of students' attention to learning media shows 84.40% and is in a positive category. This percentage shows that students pay attention to the material because they use the learning media when learning in class. The aspects of attention include: 1) Students can focus their attention on the circle material intensively. 2) Because students can concentrate well so they can master circle material. The active response of students to learning media shows 84% and is in a positive category. This percentage shows that students are interested in the material because they use the learning media when learning in class. Interesting aspects include: 1) The learning media is very interesting for students, so that students become more enthusiastic in learning circle material. 2) So that all material, especially mathematics, uses teaching materials based on discovery learning (Akhmad et al., 2018; Augustha et al., 2021).

Out of a total of 25 students of class VIII. 2 which is used to determine students' mathematical communication skills. Mathematical thinking ability is a form of accumulation of mathematical thinking concepts which indicates the development of abilities: (1) understanding of mathematics; (2) solving mathematical problems; (3) mathematical reasoning; (4) mathematical connections; (5) mathematical communication (Kamilia & Imami, 2018; Minarti et al., 2020). It is known that 11 students have fulfilled the KKM and as many as 14 students have not fulfilled the KKM, so the percentage of completeness is 44%. Based on the rating scale using the categories disclosed then the media has a pretty good category (Hashim et al., 2018; Nusantoro & Kurniawan, 2014). Based on these categories it can be concluded that the media that has been used is said to be of sufficient quality as an alternative teaching material on circle material so that it can improve students' mathematical communication abilities. This is because this teaching material is quite capable of concretizing circle learning material so that it is relevant to real life which makes it easier for students to better understand circle material. In addition, this teaching material is able to bring out the interaction of students and teachers. The use of teaching materials in this category

is quite capable of increasing the activity and independence of student learning in using this teaching material.

4. CONCLUSION

Discovery learning mathematics teaching materials developed based on the ADDIE development model (Analysis, Design, Development, Implementation and Evaluation) can be used as an alternative interactive teaching material in the pretty good category. Judging from the results of the evaluation by the mathematics teacher, this teaching material is in a good category in terms of appearance, material, language and presentation. The results of evaluations by students, this learning media is in a good category which can be seen in terms of appearance, material, language and presentation. The results of the tests conducted concluded that this teaching material can improve students' mathematical communication skills.

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