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Prototype of Computer-Based Mathematics Learning Media with Scientific Approach in Class VIII Junior High School with Circle Materials

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A B S T R A C T

This study aims to produce a prototype design for computer-based learning media with a scientific approach to circle material. The development model used is the Plomp model which consists of three phases, namely; (1) Preliminary Investigation Phase, (2) Prototyping Phase, and (3) Assessment Phase. The instrument used was a validity instrument in the form of a validation sheet and a practicality instrument in the form of a student response questionnaire. The data collection techniques used were validation sheets and student response questionnaires. This media prototype is designed to make it easier for students to understand abstract material, especially on circle materials.

1. Introduction

Science develops over time. The development of science supports the progress of the times and marks the creation of new technologies. So far, the technology developed has entered the digital stage. Indonesia is one of them, and all sectors including the education sector have used technology to promote employment (Lestari, 2018). In the world of education, laws regarding the need for technology have been regulated. Regulation of the Minister of Education and Culture Number 22 of 2016 concerning process standards explains that one of the efforts that teachers can make to improve the quality of learning is to take advantage of developments in computer technology and information in learning activities.

The National Council of Teachers Mathematics (NCTM) states six principles of school mathematics, namely: justice, curriculum, teaching, learning, assessment, and technology. With regard to technology principles, NCTM states that "Technology is essential in teaching and learning mathematics; it influences the mathematis that is taught and enhances students learning". From this statement that technology has an important role in learning. Technology as something

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essential in learning mathematics can affect the mathematics being taught and improve learning in students. Technological aspects have also been incorporated into the school curriculum as an effort to foster and foster interest and positive attitudes towards technological developments, and the mathematics curriculum cannot escape from this technological flow.

Characteristics of abstract mathematics It necessitates a high level of concentration and seriousness, even over a long period of time, in order to comprehend it, particularly when dealing with symbols that are often difficult to comprehend (Mustamid, 2015). The key aim of the learning process is for students to understand the subject matter. As a result, using the media as a learning innovation is critical at this moment. Learning media that are commonly used today are computers (Akhmadan, 2017).

Computers allow students to more easily understand a concept so that the use of computers for teaching is better than using books, films, or other traditional methods. This is because computers have the ability to run multimedia (Malik & Agarwal, 2012) which refers to more than one sense, such as sight and hearing (Aloraini, 2011). Through computer media the teacher can create learning media that is attractive to students so that students are motivated to follow learning well. The advantages of computers in storing and processing data and making animation are able to make a different appearance in learning mathematics so that it can attract learning interest in students (Karuniakhalida, 2019).

The 2013 curriculum was developed with reference to the goals of national education and the vision of education for 2025, which is to create smart, comprehensive and competitive Indonesians. The 2013 curriculum structure does not include Information and Communication Technology (ICT) subjects as subjects in primary and secondary schools. ICT subjects are integrated in all subjects. Based on the demands of the 2013 curriculum, the learning media used in the learning process must apply a scientific approach. The application of scientific methods in learning involves process skills such as observation, measurement, prediction, interpretation and drawing conclusions. In implementing this process, teacher assistance is needed, but along with the maturity of students or increasing student levels, teacher assistance will decrease (M. Hosnan, 2014). The implementation of the 2013 curriculum related to this method is carried out in all subjects including mathematics. (Sholikha, 2015).

Based on data on the results of national examinations in 2018 and 2019, the level of mastery of students on geometry material is still not satisfactory. The completeness of student learning outcomes on geometry material is still low, namely, in 2018 with a completeness level of 42.83% and in 2019 with a completeness level of 41.40%.

Seeing the reality on the ground, several schools have been equipped with computer laboratories. The existence of this computer is undoubtedly very supportive of the use of technology as a support in the learning process, but the function of the laboratory has not been fully utilized. The laboratory can also be

used to support the learning process, especially in learning mathematics. In the case of schools, some teachers have used technology to support learning activities. However, some teachers only use computers to display learning material slides. Even through computers, teachers can develop interesting learning media for all subjects including mathematics. The teacher must be able to present the main points in the slide, attractive colors, sufficient animation, and not too many slides. Computer learning media using a scientific approach can also help the learning process to be effective and efficient so that learning objectives are achieved. In addition, offerings that are less attractive in learning make students bored and less enthusiastic in participating in the learning process. Students are also not given the opportunity to participate during the learning process. So that students tend to be passive and accept the learning given by the teacher. When the teacher gives questions to students, not a few students do not believe in their own abilities. Students tend to ask friends around them who are not necessarily correct in answering the question.

According to Safitri (2017), improving the quality of learning using computer assisted media is an appropriate alternative. Besides being able to attract students 'interest and attention through computer assisted media, it can also accelerate understanding and increase learning independence so that students' academic achievement can be better. Teachers as messengers have a great interest in facilitating their duties in conveying messages or learning materials to students. Without media, learning material will be difficult for students to understand, especially complex learning materials, Rosmandi (2021). According to Dianta (2021) Learning media can help the learning process of mathematics at the junior high school level. Cognitively, junior high school students are in a transition period from the concrete operational cognitive stage to the formal operational stage. Students already have the ability to think abstractly and logically. In Apriani's (2018) research, the development of interactive multimedia powerpoints in a scientific approach to improve the ability to understand mathematical concepts on the subject of statistics is very effective, as many as 74% of students have reached the minimum completeness criteria.

Based on the problems described above, the researcher has a desire to provide solutions in these conditions. Researchers want to develop computer-based learning media with a scientific approach to the subject matter of the circle. According to Waryanto (2018) circles are a geometric material that is difficult for students to understand. The difficulties experienced include: difficulty in solving questions because the subject matter has not been mastered and difficulties in determining the formula. For this reason, it is necessary to make a learning media that can help students in overcoming these difficulties. The use of appropriate media will help students to understand concepts that are considered difficult to become easier. Through computer-based media development research with a scientific approach, it is hoped that it can help students to be more independent so as to obtain maximum learning outcomes. This media is designed to contain words that make students able to interact with the media presented, so that students can understand the material independently so as to encourage researchers to develop computer-based learning media with a scientific approach, especially

on the circle materials. It is hoped that this media can help the learning process in schools. The purpose of this study is to describe the results of developing a prototype of computer-based mathematics learning media with a scientific approach on the circle materials that are valid and practical.

2. Methodology

This study uses the Plomp development model. Plomp model application using three phases, namely (1) Preliminary Investigastion by analyzing the problem or analyze needs such as gathering and analyzing information, problem definition, and the continuation of the project plan; (2) Prototyping Phase, aims to design instructional media that will be developed to produce prototypes; (3) the Assessment Phase in this phase the resulting prototype is validated and then tested (Puspasari, 2016). The research instrument in this development was a validity instrument in the form of a validation sheet for media and material; practical instrument in the form of student response questionnaire sheet. The data collection technique used was to provide validation sheets to the validators and student response questionnaires. The data analysis technique used is validity analysis which is determined by the average score given by the validator. Data analysis on the validation sheet is calculated using the following formula (adapted from Sudijino, 2011).

$$\bar{M}_v = \frac{\sum_{i=1}^{n} \bar{V}_i}{n}$$

Note:
$\bar{M}_v$: the average total validation
$\bar{V}_i$: validation mean of the ith validator
n : number of validators

The average analysis validation criteria used can be seen in Table 1

Table 1. The Category of Learning Media Validity

Interval	Category
$3,25 < \bar{x} \leq 4,00$	Very Valid
$2,50 < \bar{x} \leq 3,25$	Valid
$1,75 < \bar{x} \leq 2,50$	Less Valid
$1,00 \leq \bar{x} \leq 1,75$	Invalid

Source : Arikunto (2012)

As for the practicality of this media, the following formula is used (adaptation of Sudijono, 2011).

$$V_p = \frac{Tsa}{Tsh} \times 100\%$$

Note:
V_p : respondent score

Tsa : the total score of respondents
Tsh : the maximum total score expected

The criteria for analyzing the response questionnaire results based on the value of each item can be seen in the Table. 2

Tabel 2. The Category of Learning Media Practicality

Interval	Category
85,01% - 100,00%	Very Practical
70,01% - 85,00%	Practical
50,01% - 70,00%	Less Practical
01,00% - 50,00%	Very Impractical

Source : Akbar (2013)

According to Akbar (2013), learning media can be used if the percentage value obtained is more than 70%. The media developed fulfills the practical aspect if the minimum level of practicality achieved is practical.

3.   Results and Discussion

This study uses the Plomp development model which consists of three phases, namely; (1) Preliminary Investigation Phase, (2) Prototyping Phase, and (3) Assessment Phase. The results are as follows.

Preliminary Investigation Phase

All information related to mathematics learning problems in the classroom was observed and informal interviews with mathematics teachers in schools. From the results of the interview, there were several obstacles in the learning process, especially in the circle material. Teachers are still not maximal in using computers in the mathematics learning process. The teacher only uses the computer in the presentation of Word and Power Point ordinary with projectors. The unavailability of practical learning media and according to the 2013 curriculum. Furthermore, the teacher's lack of understanding in the use of IT, especially computer programs. So that researchers follow up on this by increasing teacher understanding in usingdevices IT, providing computer-based learning media that is practical, relevant and in accordance with the learning process and the 2013 curriculum.

Based on the results of the interview above, the researcher will design mathematics learning media that is practically used in the learning process at school. The media is designed to fit the 2013 curriculum.

Prototyping Phase

After the initial investigation phase, the researcher made a computer-based instructional media design using a scientific approach. The prototype-making

phase, namely designing the program structure, collecting materials, validating instruments, making questionnaires, and realizing construction. The following are the steps carried out in this phase;

Design the structure of the program

The program will begin with an intro as the cover. Then entering the main menu will present a menu of instructions for use, containing technical information using the program so that students are able to operate the program correctly and the learning menu, which contains the subject matter of the circle which is divided into 4 meetings, where each meeting is conveyed learning objectives, material descriptions subject circle, practice questions. The design of the material title in each discussion can be seen in Figure 2 and the display design of the learning material can be seen in Figure 3.
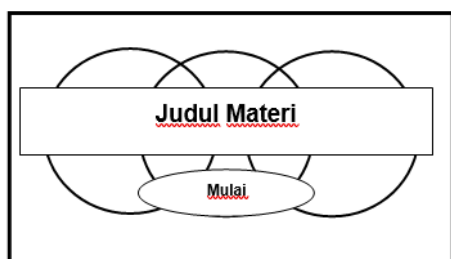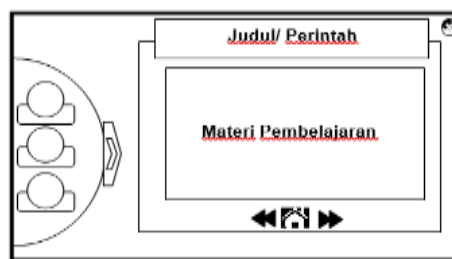

Figure 1. Media startup page display design.

Figure 2. Learning material display design.

The practice questions are made with multiple choice answers and use responses. The exercise display design can be seen in Figure 3. If the student's answer is wrong, then the student will be given two button choices, the hint button and the retry button. At the instructions button students will be directed to see the stages of working on the questions so that students can check and match the answers. The design of the wrong answer can be seen in Figure 4.
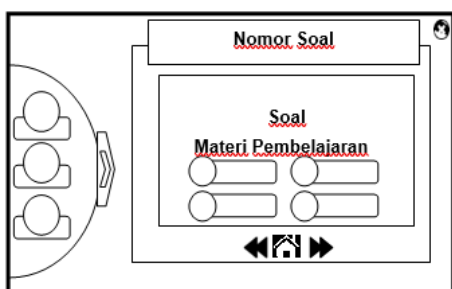

Figure 3. Exercise view design.

Figure 4. The animated design for incorrect answers.

But if the student's answer is correct, then the student can continue the next question or see the discussion of the correct answer. The correct answer display design can be seen in Figure 5.
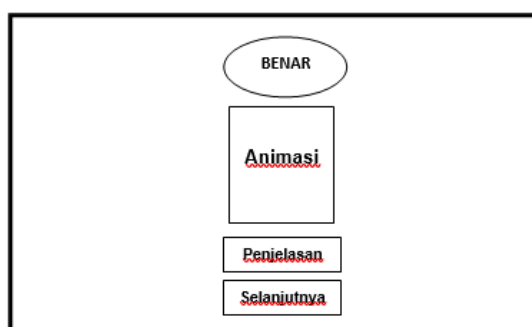
Figure 5. The animated design for correct answers.

Material Collection

The collection of materials is in the form of searching for teaching sources of circle subject matter including; the elements of a circle, the center and perimeter of the circle, the arc length and area of the circle, as well as solving contextual problems related to the circle. Learning media was developed for the subject matter of class VIII junior high school circles. Circle learning material is in KD 3.7 explaining the center angle, perimeter, arc length and area of the circle and its relationship and 4.7 to solve problems related to the center angle, perimeter angle, arc length, and the area of the circle's circle and its relationship. Researchers develop KD 3.7 and 4.7 into learning media and are arranged in four meetings. The first meeting to the fourth meeting will discuss the elements of a circle, the center angle and perimeter, the relationship between the center angle and the perimeter, the relationship between the arc length and the area of the circle, and solving contextual problems related to the circle. The following is the design of the teaching materials for each meeting.

Design of learning materials for first meeting

The first meeting on the developed learning media explains the elements of the circle, the center angle and the circumference of the circle. The presentation of learning media is designed as follows:

1. The lesson begins by presenting two pictures. Students are asked to choose a circle image from the 2 images presented
2. Furthermore, the circular elements are displayed with animated illustrations showing the center point, radius, diameter, tembereng and apothem along with the meaning of each element of the circle.
3. Then students are presented with a problem about determining the point of the corner and presented examples of the center angle and the circumference of the circle.
4. At the first meeting, three exercises were presented relating to the elements of the circle and the center angle and circumference of the circle.
5. At the end of the learning media, a test question is presented. This test aims to test students' understanding of the material in instructional media-1.

Design of learning materials for second meeting

The second meeting on the developed learning media explains the relationship between the center angle and the perimeter angle. The presentation of learning media is designed as follows:

1. The lesson begins by presenting a picture of the Ferris wheel. Students are presented with the angle contained in the circle illustration on the Ferris wheel.
2. Furthermore, the relationship between the center angle and the perimeter angle is displayed by recording the 4 images provided.
3. Then the students were asked to look for a comparison of the perimeter and center angles on the data that had been presented and the relationship between the perimeter and the center angles was displayed.
4. At the second meeting two relationship exercises were presented in terms of the perimeter and center angle of the circle.
5. At the end of the learning media, a test question is presented. This test aims to test students' understanding of the material in instructional media-2

Design of learning materials for third meeting

The third meeting on the developed learning media explains the relationship of the circumference and area of a circle to the arc length and area of the circle's circle. The presentation of learning media is designed as follows:

1. Learning begins by presenting a circle with an arc and a circle. Students are presented with a circle illustration of the arc length relationship with the circumference of the circle and the relationship between the area of the circle and the area of the circle.
2. Next, the slide is presented how to determine the length of the arc with the circumference of the circle and the area of the circle with the area of the circle.
3. After these two relationships are presented, the relationship between the circumference and area of the circle to the length of the arc and the area of the circle is presented.
4. At the third meeting two exercises on the relationship of arc length and circle area are presented.
5. At the end of the learning media, the test questions are presented. This test aims to test students' understanding of the material in learning media-3

Design of learning materials for fourth meeting
The fourth meeting on the developed learning media explains contextual problems related to circles. The presentation of learning media is designed as follows:

1. Learning begins by presenting contextual problems related to circles.
2. Students are presented with daily problems related to circles and the stages of their completion.
3. At the fourth meeting two exercises with completion were presented.
4. At the end of the learning media, a test question is presented. This test aims to test students' understanding of the material in learning media-4.

Validation instrument

The learning media validation instrument includes material aspects and media visualization. The validation instrument was made based on the material validation questionnaire grid and media visualization.

Questionnaire

Student response questionnaires are designed based on the grid. This questionnaire is designed to see students' responses to the use of circular learning media.

Realization of counsturction

At this stage the researcher makes computer-based learning media based on the design of the program structure. The program used to make this learning media is Microsoft PowerPoint 2013. The display consists of an opening page, content, practice questions and tests. The results of the development of learning media can be described as follows.

Opening Page

On the opening page, researchers use a combination of black, blue and gray. The background is made dark to focus on the lighter text. The main page display can be seen in Figure 6.

Figure 6. Main page view

Materials Page

On the material page, as in the initial design, there are navigation buttons next slide, previous slide and home at the bottom of the page. On the left side of the page there is a navigation menu that can be opened and closed to make it easier for users to move between material pages, practice pages and test pages. The results of the development of instructional media can be described in general as

follows. The material is presented in 4 powerpoint files with each material according to the distribution of learning materials on the learning media.

At the reception, two circles are displayed and students are asked to choose one. If it is true or false, it will be given an animation that matches the answer. Problems or apperceptions can be seen in Figure 7.
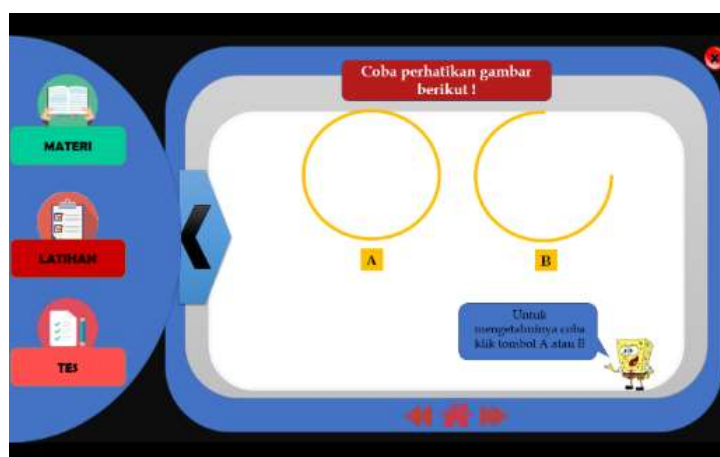

Figure 7. Problems/ Apperception

In the material presented material about the elements of a circle through animated illustrations along with explanations of their respective meanings. Next, we present the problem of the center angle and the circumference of the circle. After students press the next button an illustration is displayed about determining the center angle of the circle. Then an image is displayed showing the center angle and the perimeter of the circle.

Exercise Page

On the exercise page, the display is still the same as the material page with the navigation buttons home, next slide,previous slide at the bottom of the page. On this page some questions are presented. Each question presented has 4 choice options and students must choose the right option to answer the question. The exercise page is designed to be able to respond according to the answers given by the user.

The response given is in the form of an animated correct answer, if the user can answer the question correctly and the animation for the wrong answer is if the user chooses the wrong answer option. In the wrong answer animation, there are two navigation buttons, namely the "help" button and the "try again" button. The "help" button will direct students to a page that contains instructions for solving the questions, so that users can get instructions for solving the questions given. The "retry" button will redirect the user back to the question, so the user can try again until they find the correct answer. The display of the instructions page and the animation for wrong answers can be seen in Figure 8.
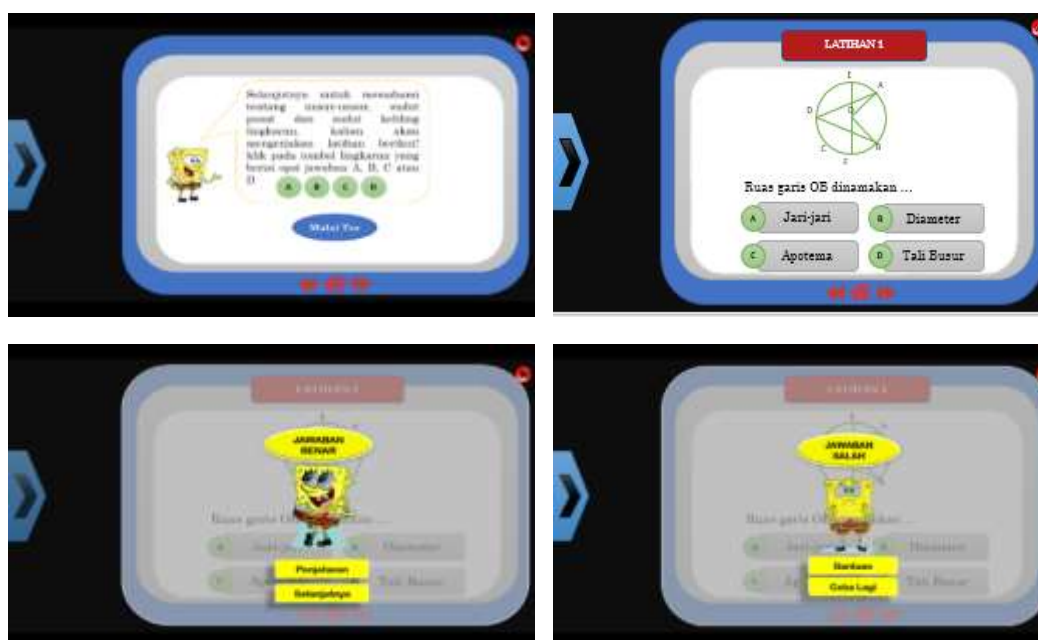
Figure 8. Instructions for answering questions, practice questions, correct and wrong answer responses

In the correct answer animation, there are two navigation buttons. The first is the "explanation" button which will direct the user to the question completion discussion page. The two "continue" buttons will direct students to the page that contains the next question.

Test page

On the test page, there are questions that must be answered by the user. At the top there is a textbox which shows that the page being opened is the test page and the navigation buttons are home, next slide, previous slide at the bottom of the page. During the process of making this learning media, the researcher consulted with the supervisor. After the media is approved by the supervisor, the media development stage continues to the validation process.

4.   Conclusion

Based on the description in the above discussion, it can be concluded that the prototype of computer-based learning media with a scientific approach is designed using the plomp model as a solution to convey abstract learning, especially on circle subject matter. Step by step can be seen clearly in its development. Starting from the Preliminary Investigation stage, Prototyping Phase, and Assessment Phase. The stages are clearly visible so that the prototype design is formed.

Based on the above conclusions, it can be suggested that this learning media prototype needs to be validated and then tested in small groups and large groups. After that, this computer-based learning media can be disseminated for use in the learning process in the classroom.

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