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Development of Interactive Learning Media Using Scratch on the Learning Outcomes of Fiber Optic Network for Grade X TJKT Students

Anisa Aprilia[1,*], Pratama Benny Herlandy[2], Edi Ismanto[3]

[1,2,3] *Pendidikan Informatika, Universitas Muhammadiyah Riau Pekanbaru, Indonesia*
**Correspondence author email: apriliaanisa764@gmail.com*

ABSTRACT

This study aims to develop Scratch-based learning media on fiber optic material, assess the feasibility of the learning media, and examine students' responses regarding their interest in the designed media. This research uses the Research and Development (R&D) method with the MDLC (Multimedia Development Life Cycle) model by Rickman Roedavan. The research subjects were 32 Grade X TJKT students at SMK Taruna. Data collection techniques included observation, interviews, documentation, and questionnaires. Instrument validation was conducted by subject matter experts and media experts. Product testing involved a practicality test with both teachers and students. This study resulted in Scratch-based learning media on fiber optic material. The research findings revealed that the learning media "Sertic" (Serat Optic) was validated by validators through a rating questionnaire to determine the feasibility of the developed application. The validity score percentage given by the subject matter expert was 82.63%, categorized as "Highly Feasible," while the validity score percentage from the media expert was 82.39%, also categorized as "Highly Feasible." The validated product was then tested with teachers and students, accompanied by a response questionnaire guided by the researcher to determine the level of practicality. The teacher practicality score was 91.58%, categorized as "Highly Practical," and the student practicality score was 82.63%, also categorized as "Highly Practical."

Keywords: *Scratch, design, MDLC*

1. Introduction

Education is a crucial aspect aimed at shaping individuals to be qualified and competitive. In the field of education today, various developments have been carried out in multiple areas, including curriculum design, instructional process planning, and learning media. These developments are intended to achieve the goals of the Indonesian nation as stated in the 1945 Constitution, namely to educate the life of the nation.

Learning multimedia can make the learning process more engaging, create a more interactive classroom atmosphere, shorten the duration of learning, enhance students' reasoning abilities and learning quality, and allow learning to take place anytime and anywhere. The creative use of multimedia can support the achievement of effective and efficient learning objectives [1]. One way to create interactive learning is by using media in the learning process. Therefore, learning must be integrated with technology to develop learning media that utilize technologies such as the internet and computer programming, as well as the use of computers, gadgets, and projectors [2]. The use of technology in education can transform the traditional classroom climate—where students initially only listen, observe, and imitate what the teacher says—into a setting where students can access information through interactive media, enabling them to build more meaningful learning experiences [3].

Interactive media is an example of media that can stimulate students' activeness in participating in learning. Interactive media allows students to interact with the media and provide feedback. According to [4], interactive media has advantages due to the combination of multimedia elements such as text, audio, images, animation, navigation buttons, and video, making it more engaging. Educational media can accelerate students' learning and help them develop broader perspectives beyond merely listening [5]. Learning media is designed to help students understand the material more easily in a shorter amount of time [6]. Good learning media should attract students' attention, foster their interest, suit their characteristics and learning styles, and align with the intended learning objectives [7]. The better the learning media, the better students' ability to absorb and comprehend the lesson [8]. The function of media in learning activities is not limited to being a teaching aid for educators but also serves as a carrier of learning information or messages.

Based on observations conducted at SMK Taruna Pekanbaru in the Department of Computer and Network Engineering (TJKT), the topic of Fiber Optic Networks is included in the subject Fundamentals of Computer and Network Engineering for Grade X. Basic understanding of fiber optic networks includes both theory and practice. When explaining the topic of Fiber Optic Networks, the teacher still lacks variety in using learning media. The media used are limited to textbooks, Microsoft PowerPoint, and the teacher still applies conventional teaching methods. This results in a teacher-centered learning process, where students are less interested in the learning material, leading to reduced learning activity and suboptimal intellectual development [9].

Beyond the school setting, students also use e-books, while textbooks are only occasionally used during teaching and learning. Therefore, to motivate students to be independent, active, and creative, there is a need for learning media that can support students in understanding the subject matter and developing their knowledge and ideas.

A study by [10] titled "Design and Development of Interactive Informatics Learning Media Based on Educational Games Using Scratch at SMPN 7 Bukittinggi" showed that the validity of the educational game-based learning media was 0.83, categorized as "valid." The practicality of the educational game based on teacher

responses was 0.91, categorized as "highly practical." The effectiveness of using the educational game was 0.4, categorized as "moderate."

The study by [11] titled "Development of Mathematics Learning Media Entitled Game Learn with Adventure Using Scratch" found that the Learn with Adventure game on the topic of Linear Equations with One Variable (PLSV) could be very well designed using the Scratch application within the MDLC development model. The results of student response calculations showed an average percentage of 93.3% for positive statements, falling into the "very good" category.

Based on this explanation, it is necessary to conduct a study on "Development of Interactive Learning Media Using Scratch on the Topic of Understanding Fiber Optic Networks for Grade X Vocational School Students." Scratch is an educational application program that can serve as a learning tool and can be used in application development [12]. Therefore, Scratch is used as an interactive learning media for students with the expectation that it will help them more easily receive and understand the subject matter being taught.

2. Methods

2.1. Type of Research

The type of research used in this study is the Research and Development (R&D) method. As stated by [13], Research and Development (R&D) is a research method used to produce a product and test the effectiveness of that product.

The development model used in this research is the Multimedia Development Life Cycle (MDLC) model by Rickman Roedavan. Based on a combination of the strengths and improvements of previous MDLC models, [14] proposed an MDLC model formulated into five stages: initialization, blueprint design, asset preparation, product development, and testing & validation.

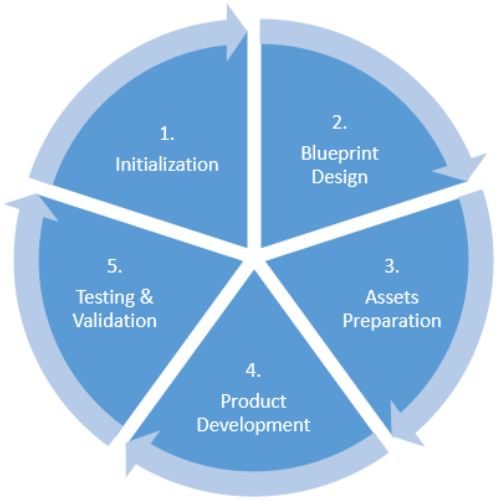

Figure 1: Rickman Roedavan's MDLC Development Model.

2.2. Time and Location of the Study

The research was conducted during the second semester of the 2023/2024 academic year, from January to June 2024. The study was carried out at SMK TARUNA Pekanbaru, located at Jl. Rajawali Sakti, Simpang Baru, Tampan District, Pekanbaru City, Riau.

2.3. Population and Sample

The population in this study was the students of Grade X at SMK TARUNA Pekanbaru in the second semester of the 2023/2024 academic year, consisting of 3 classes. The selection of the sample class in this study used purposive sampling technique. Purposive sampling is a technique for selecting data sources based on certain considerations. The researcher only selected one class, according to the researcher's needs, which required just one class, and was recommended by the vice head of curriculum and the teacher of Fundamentals of Computer and Network Engineering at SMK TARUNA Pekanbaru.

2.4. Data Collection Techniques

- Observation
- Interview
- Questionnaire
- Documentation

2.5. Data Collection Instruments

The scale used is the Likert scale. This instrument uses a Likert scale consisting of five response options. There are three instruments used in this study, namely: 1) the material expert validation instrument, 2) the media expert validation instrument, and 3) the practicality instrument for teachers and students.

Table 1: Questionnaire Outline for Material Expert Validation

Aspect	Indicator
Curriculum	The relevance of the material to the Learning Outcomes (LO)
	The relevance of the material to the Learning Objectives
	The relevance of the material to the Indicators of Achievement of Learning Objectives (IAOLO)
Material	The accuracy of the material
	The use of appropriate language
	The presentation of the material in the learning media is complete, systematic, and easy to understand

Table 2: Questionnaire Outline for Media Expert Validation.

Aspect	Indicator
Media Display	Readability of text
	The use of images supports the learning material
	Use of font type and size
	Appropriateness of image placement
	Composition used in the video
	Selection of colors with appropriate combinations
Operation	The media can motivate students to learn
	Effective video duration for student learning

Table 3: Questionnaire Outline for Student Practicality.

Aspect	Indicator
Media Design	Quality of display
	Use of appropriate animations
	Audio
Material	The material is easy to understand
	Use of appropriate language
	The media used can motivate students
Media Operation	Ease of using the media
	The media can help in understanding the material

Table 4: Questionnaire Outline for Teacher Practicality.

Aspect	Indicator
Media Operation	Ease of operating the media
	Time efficiency
	Easy to interpret
	Attractiveness
Material	The material aligns with learning indicators
	The media makes it easier for students to understand the presented material

2.6. Data Analysis Techniques

The assessment data obtained from the validators are analyzed descriptively and qualitatively, serving as a reference for revising the product to produce a feasible outcome. The data analysis used in this study includes product feasibility testing and product practicality testing of the interactive multimedia learning media using Scratch for the Fiber Optic material.

2.6.1. Media Feasibility Testing

The feasibility testing of the developed product in the form of learning media for fiber optics (Sertic) needs to be conducted to assess the success of the product development. The calculation formula used is as follows:

$$p = \frac{x}{\sum xi} \text{ x } 100\ \%$$

where,

P = The score to be calculated

X = The total sum of respondents' answers for all points

∑xi = The total sum of the ideal values for all points

100% = Constant number

2.6.2. Practicality Testing

The practicality data from the student practicality instrument is calculated using the formula below. The calculation formula used is as follows:

$$p = \frac{x}{\sum xi} \text{ x } 100\ \%$$

3. Results and Discussion

3.1. Results

This research is a type of Research and Development (R\&D) study. The method used in this research employs the MDLC (Multimedia Development Life Cycle) model, version Rickman Roedavan, which consists of five stages: Initialization, Blueprint Design, Asset Preparation, Product Development, and Testing & Validation. The aim of this research is to describe the validity of the learning media based on the Scratch application.

3.1.1. Initialization

In this stage, the concept of the fiber optic learning media is developed in the form of a program, where the media includes both learning materials and a game for learning through play. This media can be accessed online through a website and offline via the Scratch application. The material used in this media is the Fiber Optic Cable Transmission material for class X TJKT.

3.1.2. Blueprint Design

In the blueprint design step, the initial sketch of the learning media is first created by developing a flowchart that illustrates the sequence from one scene to the next. After that, a storyboard is created for the scene displays. The storyboard is made in Microsoft Word and contains the material title, main menu display, indicator display, learning objective display, material menu display, material display, and evaluation menu display.

3.1.3. Asset Preparation

The design stage of this interactive learning media consists of creating the material script, flowchart, and storyboard.

3.1.4. Product Development

The product development stage involves transforming the design draft into the actual display using Scratch software.

3.1.5. Testing & Validation

This testing is conducted after the interactive learning media is created. The testing stage involves running the application and checking whether any errors are present. The goal of the testing is to assess the feasibility of the media that has been designed. The trial is carried out at SMK Taruna Pekanbaru for class X TJKT. The trial is conducted by using the application in classroom teaching by the teacher. During the media usage, the researcher observes its application. After using the media, the teacher is interviewed for feedback, suggestions, and comments about the developed interactive learning media, followed by the distribution of a questionnaire.

3.2. Validation Results

3.2.1. Results of Content Expert Validation

Based on the results verified by the Content Expert, the interactive learning media based on Scratch for the fiber optic subject can be developed with a proportion of 91.25%. According to the content expert, the interactive learning media based on Scratch for the fiber optic subject falls under the category "Suitable and does not require revision." Therefore, no revisions are necessary. Below is a comparison diagram of the validation results from the content expert for phase one and phase two.

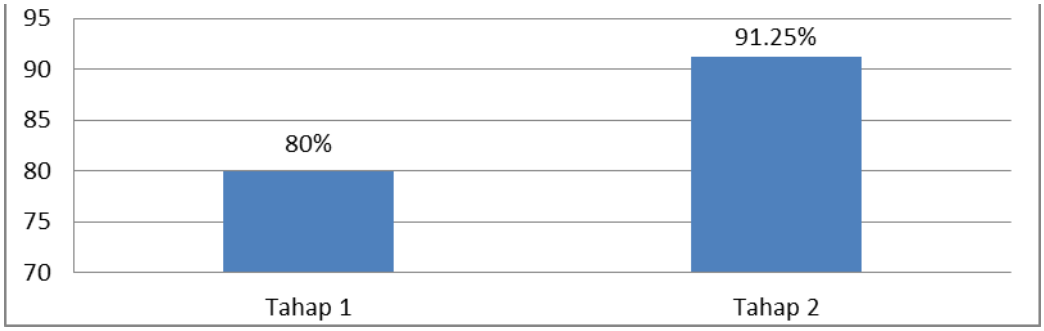

Figure 2: Diagram of the Content Expert Validation Results for Phase I and II.

3.2.2. Media Expert Validation Results

According to the results provided by the Media Expert, the interactive learning media based on Scratch for the fiber optic subject can be developed with a proportion of 88.57%. According to the media expert, the interactive learning media based on Scratch for the fiber optic subject is categorized as "Eligible and does not require revision." In this case, the researcher does not need to make revisions. Below is a diagram comparing the media expert validation results for phases one and two.

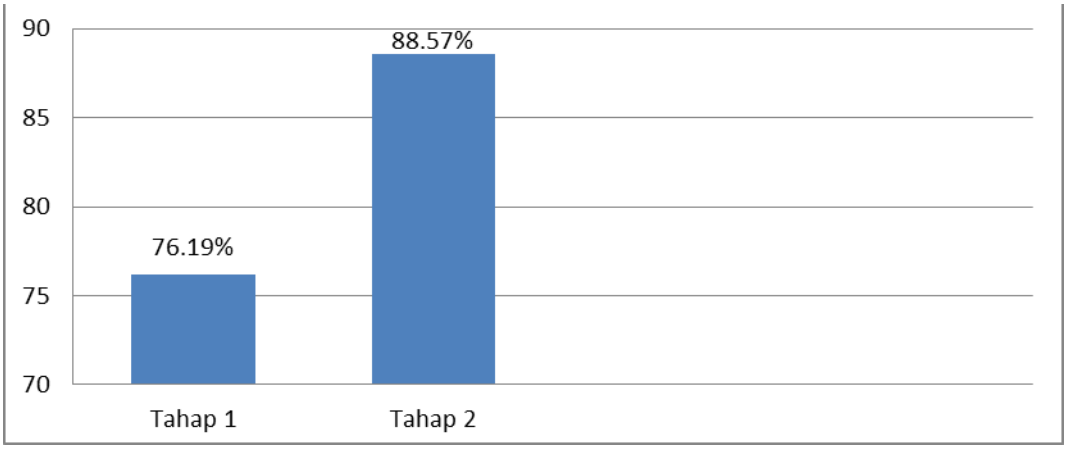

Figure 3: Diagram of Media Expert Validation Results for Phase I and II.

3.2.3. Results of the Trial

The trial was conducted to assess the feasibility of the interactive learning media for fiber optic based on the feedback and responses of the TJKT teacher and students from SMK Taruna Pekanbaru. The trial was carried out at SMK Taruna Pekanbaru in Class X TJKT. The number of respondents was 1 TJKT teacher and 32 students.

Observation Results

a. The learning media Sertic (Fiber Optic) helps students focus more on the lesson. This was evident from the students' attention when using the media.
b. The Sertic (Fiber Optic) learning media encourages students to actively participate in the lesson, as seen from their involvement in answering questions.
c. The Sertic (Fiber Optic) learning media is able to motivate students.
d. The Sertic (Fiber Optic) learning media helps students improve their understanding of basic fiber optic concepts. This was reflected in the students' comments and responses regarding the interactive fiber optic learning media.
e. Students understood the material presented through the Sertic (Fiber Optic) media. This was evident from their ability to answer the questions presented.

Teacher Interview Results

a) The Sertic (Fiber Optic) learning media developed uses communicative language.
b) The material presentation, animations, and games in the Sertic (Fiber Optic) media are clear.
c) The Sertic (Fiber Optic) learning media helps the teacher in delivering the material, minimizing misperceptions about what the teacher presents.
d) The Sertic (Fiber Optic) learning media presents the material clearly and attractively, making it easy to understand.

e) The use of Sertic (Fiber Optic) media creates a fun and varied learning atmosphere, making students more interested in the lesson.

Student Interview Results

a) The presentation of material, animations, images, and games in the Sertic (Fiber Optic) learning media is clear and more engaging to play with.
b) The material is presented clearly, attractively, and is easy to understand.
c) The Sertic (Fiber Optic) learning media uses communicative language that is easy for students to understand. The media also uses terms that are easy for students to grasp.
d) The use of Sertic (Fiber Optic) learning media creates a fun atmosphere and sparks students' curiosity.
e) The Sertic (Fiber Optic) learning media helps improve students' basic understanding, especially in fiber optic subjects.

Survey Results

a. Teacher Practicality Results

Table 5: Teacher Practicality Assessment Results.

No	Aspect	Score
1	Media Operation	46
2	Material	41
Total	**87**	
Average	**91.58%**	

b. Student Practicality Results

Table 6: Student Practicality Assessment Results.

No	Aspect	Score	Percentage (%)
1	Media Design	562	87.81
2	Material	641	80.12
3	Media Operation	648	81.00
Total	**1851**	**82.63**	

3.2.4. ***Evaluation Results***

At this stage, the researcher conducted an evaluation of the developed learning media based on the feasibility assessment results provided by the subject matter expert and the media expert. Based on the validation results, the subject matter expert gave an average score of 85.63%, and the media expert gave an average score of 82.39%. The combined average score from both experts was 84%. Based on these validation results, the Sertic (optical fiber) learning media falls into the "Highly Feasible" category. Therefore, it can be concluded that the interactive learning media for achieving learning outcomes on the topic of fiber optics is highly feasible for use.

3.3. Discussion

3.3.1. Research and Development Results

The result of this research and development is the learning media *Sertic* (Fiber Optic). The researcher used the Scratch application to create the *Sertic* learning media for the fiber optic topic. Scratch was chosen because it has several advantages: it is free to download, has a relatively small file size, and uses a drag-and-drop scripting method instead of typed commands, which minimizes errors. This application allows users to build programs by arranging command blocks, each color-coded according to its function.

The initial product of the *Sertic* (Fiber Optic) learning media was validated by both a subject matter expert and a media expert. The subject matter expert performed two rounds of validation because the average score from the first round was 80%, which fell into the "Feasible with Revisions" category and did not meet the standard for testing. Similarly, the media expert also validated the product twice, with the first round scoring an average of 76.19%, also in the "Feasible with Revisions" category.

The *Sertic* learning media was revised according to the suggestions and feedback from both the subject matter expert and the media expert. After revision, the product was validated again. The second validation by the subject matter expert showed an average score of 91.25%, which, according to Akbar [15], falls within the 85.01%-100.00% range and is considered “Very Valid.” The second validation by the media expert resulted in an average score of 88.57%, placing it in the “Feasible without Revision” category. Based on these results, the *Sertic* (Fiber Optic) learning media was deemed ready for testing.

The researcher conducted a practicality test at SMK Taruna Pekanbaru using class X TJKT as the subject. The trial involved implementing the *Sertic* learning media during classroom instruction by the teacher. During the session, the researcher observed the use of the media. Afterward, the teacher was interviewed to provide feedback, comments, and suggestions about the developed media.

In addition to the teacher interview, student interviews and a practicality questionnaire were conducted. The questionnaire was distributed to 32 students. According to the teacher’s evaluation, the *Sertic* (Fiber Optic) learning media achieved a practicality percentage of 91.58%. The TJKT teacher at SMK Taruna Pekanbaru rated the media as “Highly Practical.” Student responses indicated a practicality score of 82.63%. According to [16], this percentage also categorizes the Scratch-based *Sertic* (Fiber Optic) learning media as “Highly Practical.”

Based on validation results from both the subject matter and media experts, with average scores of 85.63% and 82.39% respectively, the final average score was 84%. Therefore, the *Sertic* (Fiber Optic) learning media is categorized as “Feasible.” This indicates the success of the researcher in designing Scratch-based learning media for the fiber optic topic, demonstrating the feasibility of Scratch-based media for SMK-level learning—especially for Grade X—and showing student interest in using such media. The website for the *Sertic* (Fiber Optic) Scratch-

based learning media at the SMK level for fiber optic material is: https://scratch.mit.edu/projects/1057147939

The *Sertic* (Fiber Optic) Scratch-based learning media has both strengths and weaknesses.

Strengths:

It can be used by teachers during the learning process.

It can be used individually or in groups.

It promotes active and enjoyable learning.

It increases student motivation and attention toward the learning material.

It includes fiber optic learning materials enhanced with images, animations, and engaging quiz games [17].

Weaknesses:

It can only be used in schools with supporting facilities like computers.

It only covers one learning topic: fiber optics.

4. Conclusion

Based on the research findings in Chapter IV, the researcher concludes that the product developed using the Scratch application is a Sertic (Fiber Optic) learning media design for the fiber optic topic, developed using the MDLC model through its five stages. The design of the Sertic learning media based on Scratch at the vocational high school (SMK) level was evaluated by media and content experts. The results of these evaluations declared the media as "valid." The media expert evaluation yielded a score of 82.39%, and the subject matter expert evaluation yielded 85.63%, which are categorized as "Highly Feasible." This confirms that the media is suitable for implementation in the learning process. The interactive Scratch-based learning media has been shown to enhance students' motivation to learn, help them stay focused during lessons, and encourage active participation. This is evident from the students' engagement in answering the presented questions, as reflected in the practicality test results with a score of 82.63%, placing the media in the "Highly Practical" category.

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