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Design and Development of Interactive Multimedia Based on Didactical Design for Basic Programming Subject: Branching Material

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ABSTRACT

Basic Programming is subject that being learn by Engineering Computer's students. The branching material is proven difficult for students to understand and implement it. Learning obstacle in Basic Programming can occur due to inaccurate teaching materials and learning models used, resulting in students do not understand and interested in learning it deeply. This study aims to determine impact of the use of interactive multimedia based on didactical design to respond the learning obstacle based on student learning outcomes. This research was conducted with Pre-Experimental with One-Group Pretest-Post-test design and multimedia research Lifecycle Method in class XI Software Engineering Vocational High School 2 Cimahi. The results of this study can be concluded: 1) Didactical design that is implemented into interactive multimedia consists of explanations any kind of branching in basic programming and exercises designed to respond to students' learning obstacle on branching material; 2) Based on the gain value obtained after implementing interactive multimedia based on didactical design on branching material of 0.59 is interpreted as "Medium" it can be stated that interactive multimedia can minimize students' learning obstacle; 3) Students give a pretty good response by obtaining an average multimedia assessment of 4.31 which can be interpreted as "Very High Acceptance".

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1. INTRODUCTION

The subject of Basic Programming is often considered unfamiliar and challenging for students, as it differs from the subject they have studied in previous levels such as Elementary School (SD) and Junior High School (SMP). This assertion is supported by the findings of a study conducted by Rahmat (2011), stating that in the subject of Basic Programming, student needs to have multiple skills, such as problem-solving and logical thinking. These skills will be needed especially in learning Branching materials.

The difficulties faced by students in learning Basic Programming may arise from their understanding. The students at the Vocational High School (SMK) are expected to have the ability to think abstractly, logically, and draw conclusions based on available information. The fact is, many individuals do not reach this stage, causing them to lack the thinking skills. This can trigger learning obstacles in the Basic Programming subject, as learning obstacles are a natural occurrence during the learning process due to each student constructing knowledge in their unique way.

Students typically aren't aware of or knowledgeable about the causes of these learning obstacles. This is due to the abstract nature of the Basic Programming subject, leaving students confused about identifying the sources of their learning obstacles (Lahtinen, E., Ala-Mutka, K. & Järvinen, H-M, 2005). Generally, lesson plans designed by teachers are not prepared to anticipate diverse student responses based on didactic situations, resulting in suboptimal learning processes for individual students and a lack of appropriate response to emerging learning obstacles by the teacher, or no response at all, preventing effective learning processes for students.

One of the teacher's efforts to enhance teaching quality involves evaluating the alignment between lesson plan design and the actual teaching process, followed by designing a new lesson plan based on the evaluation results. This process enables teachers to respond to learning obstacles that arose from the previous lesson plan, ensuring optimal learning experiences.

In various educational levels, the use of instructional multimedia is necessary to help teachers achieve teaching objectives. The selection of suitable instructional multimedia can be based on evaluations conducted by teachers (Amalia, 2014). Instructional multimedia can create an enjoyable and engaging learning environment by combining visuals, sound, and motion. Multimedia can be used as a tool to address learning obstacles faced by students. Furthermore, multimedia provides advantages in conveying and receiving information, as it offers communicative elements making information absorption easy to understand, facilitates easy modifications when additional information or development is required, and promotes interactivity through feedback between multimedia and users.

2. METHODS

This study employs the pre-Experimental research method with quantitative approach. The chosen research design is the One-Group Pretest-Post-test design, involving a pretest, treatment, and then a post-test administered to the participants. The sample is selected using Purposive Sampling, where the researcher establishes specific criteria for selecting the sample to be studied.

For multimedia development, the Comprehensive Life Cycle Model is utilized, consisting of five stages: 1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation.

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2.1. Research Procedure

The research procedure conducted by the researcher can be seen through the flowchart in the following Figure 1.

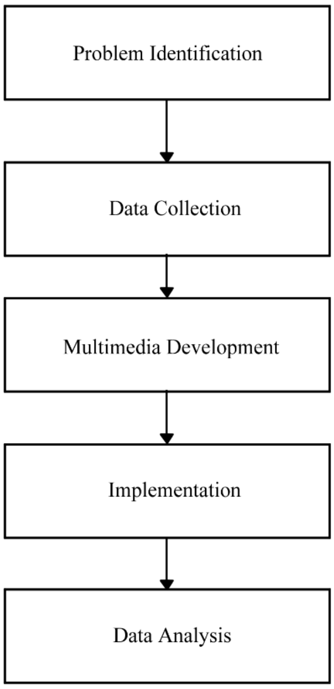

Figure 1. Research Procedure

Figure 1 can be presented as follows:

(i) Problem Identification and Formulation

In this stage, a literature study is conducted with the aim of collecting data, including theories and previous data related to the thesis, dissertations, and journals that are relevant to Interactive Multimedia in the learning process, Didactical Design Research for the preparation of didactic designs, and Branching material. Furthermore, a field study is conducted by interviewing subject teachers with the purpose of understanding the teaching and learning activities that take place and the common difficulties experienced by the students.

(ii) Data Collection Stage

In the data collection stage, the development of pretest and post-test instruments is carried out. Once the instrument development is completed, the instruments are validated by expert professors. After being deemed appropriate by the expert professors, the researcher administers the pretest to the students.

(iii) Multimedia Development Stage

In the multimedia development stage, the procedure is carried out using the Comprehensive Life Cycle (CLC) approach. The analysis phase involves analyzing user criteria and device requirements for developing instructional multimedia. The design phase involves creating interactive multimedia flowcharts and storyboards based on the previously created didactic design and integrating the didactic design into the multimedia. The assessment phase involves validation by instructional multimedia experts. The final outcome of this stage is an interactive multimedia based on the didactic design for the branching material.

(iv) Implementation Stage

In the research process stage, the implementation of interactive multimedia is carried out with the students to gather their perspectives regarding the interactive multimedia for

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learning the branching material, after it has been deemed suitable for use by expert professors. After the students engage in learning using the interactive multimedia, they will then be given a post-test to measure their understanding, as well as a questionnaire to provide feedback on the interactive multimedia they have used. Subsequently, the researcher analyze the pretest and post-test results and identifies the learning obstacles experienced by the students.

(v) Data Analysis Stage

In the research data analysis stage, data collected from the use of interactive multimedia are processed. There is also a review of the assessment of the created multimedia to understand its strengths and weaknesses. The results of this assessment will be used to provide suggestions and recommendations for the development of future interactive multimedia.

2.2. Research Design

The research design utilized is Pre-Experimental Design using the One-Group Pretest-Post-test Design format. The One-Group Pretest-Post-test Design was chosen because it includes a pretest before the treatment is administered to the students. The pretest enhances the accuracy of treatment outcomes, as it enables the comparison between results before and after the treatment.

Based on the explanation provided, the One-Group Pretest-Post-test design can be illustrated as follows:

$$O_1 > X > O_2$$

Figure 2. One-Group Pretest-Post-test Design

Where:
O1: Pretest score (measurement before treatment)
X: Treatment administered
O2: Post-test score (measurement after treatment)

2.3. Sample and Population

The population involved in this research consists of the 70 students in the 11th grade of the RPL (Software Engineering) class at SMK Negeri 2 Cimahi. The sample used in this study was determined using a non-probability sampling method with the Purposive Sampling technique. The sample was not selected randomly because the researcher specifically chose students who had pretest scores below the minimum passing grade (KKM) and students who had already studied the subject of Basic Programming with branching material. A total of 23 students were selected as the sample for the study.

2.4. Research Instrument

The research instruments were used by the researcher to measure the variables under investigation. The instruments used in this study include questionnaire items, field study instruments, multimedia expert assessment instruments, and student responses to the multimedia instruments.

2.5. Instrument Analysis

The data analysis conducted in this research includes: (1) Analysis of the field study instrument is performed by reanalyzing the interview results. (2) Analysis of the multimedia

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expert assessment instrument is conducted by referring to the "Instrumen Penilaian Media Pembelajaran" developed by Sriadhi (2019). (3) Analysis of student responses to the multimedia is carried out using the "Instrumen Penilaian Media Pembelajaran" developed by Sriadhi (2019). (4) Analysis of the test items involves validity testing using the product-moment correlation technique (5) Analysis of the influence of multimedia is performed using the Wilcoxon Rank Sum Test. (6) Analysis of learning outcome data is conducted using the N-Gain test developed by Hake (1998).

3. Result and Discussion

3.1. Research Result

(i) Stage of Problem Identification and Formulation

In the stage of problem identification and formulation, a field study was conducted involving interviews with several teachers of the Basic Programming subject to understand how they teach and the issues that arise with the Branching material at SMK Negeri 2 Cimahi. Based on the interviews with the Basic Programming subject teachers and discussions with the students, the common problems identified in the Branching material include: (1) Students having difficulty understanding the flow of branching. (2) Students struggling to differentiate between different types of branching. (3) Students facing challenges in comprehending problems presented in pseudocode or programming code. (4) Students finding it challenging to interpret problems presented in flowchart form. (5) Students struggling to grasp the intention behind the given problems.

(ii) Data Collection Stage

In the data collection stage, a pretest consisting of 40 multiple-choice questions was administered, revealing learning obstacles faced by the students, which include: (1) Learning obstacle related to the definition of Nested-If and Switch-Case branching. (2) Learning obstacle concerning determining the general form of pseudocode algorithms for If-Then, If-Then-Else, and Switch-Case branching. (3) Learning obstacle involving determining the general form of flowchart algorithms for If-Then branching. (4) Learning obstacle concerning the appropriate usage timing of If-Then and If-Then-Else branching. (5) Learning obstacle related to the students' ability to implement problems into the forms of If-Then, If-Then-Else, and Nested-If branching. These learning obstacles serve as a reference for the didactic design that will be implemented into the interactive multimedia.

(iii) Multimedia Development Stage

In the multimedia development stage, the process involves creating a flowchart of the didactic design that has been planned. This flowchart depicts a process that begins with displaying an opening screen consisting of a main menu, which includes options like "New Game," "Continue Game," and "Options." Users can then choose "New Game" and decide whether to explore the "Material" or proceed directly to "Practice." In the "Material" section, students are asked to identify a character shown in the welcome message and follow the instructions provided by that character. Upon completing the Material section, users can exit the menu and move on to the "Practice" section. If users manage to complete all the questions, they are declared successful, and the game ends. The storyboard stage involves visualizing the interactive multimedia's process flow based on the designed flowchart. The interface design phase is also conducted during this stage. Below is the attached flowchart of the interactive multimedia based on the didactic design for the branching material in **Figure 3.**

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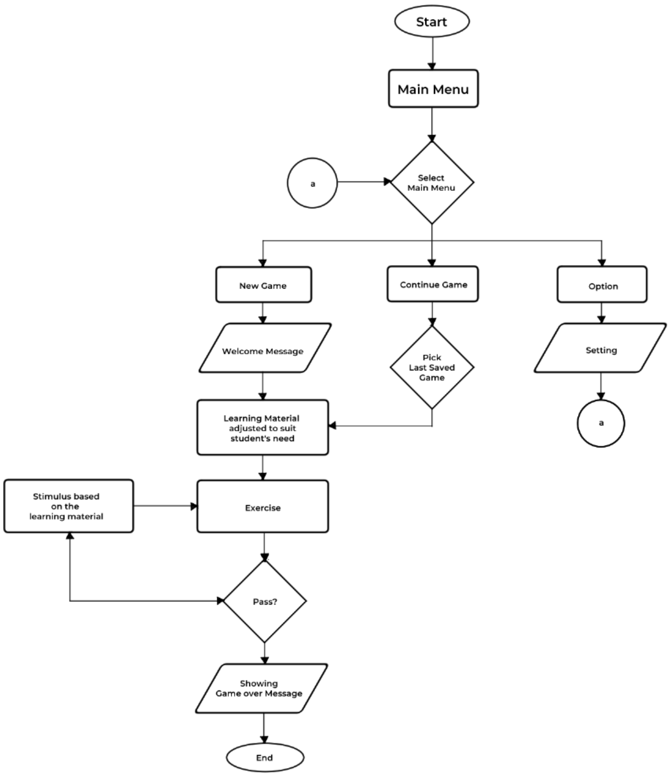

Figure 3. Flowchart of Multimedia Learning Based on Didactic Design in Branching Material

Next, the development of interactive multimedia is carried out based on the didactic design, referring to the created flowchart, storyboard, and interface in the design phase. Below is a segment of the image from the developed interactive multimedia in **Table 1**.

Table 1. Didactic Design in Interactive Multimedia Based on Didactical Design for Basic Programming Subject - Branching Material

No.	Page	Explanation
1.		On the initial page of the multimedia, there are three menu options: "New Game" to start a new game, "Continue" to resume a previously played game, and "Options" for adjusting the sound settings in the multimedia.
2		Introduction page to provide instructions to the students on how the game mechanics of the utilized multimedia work.

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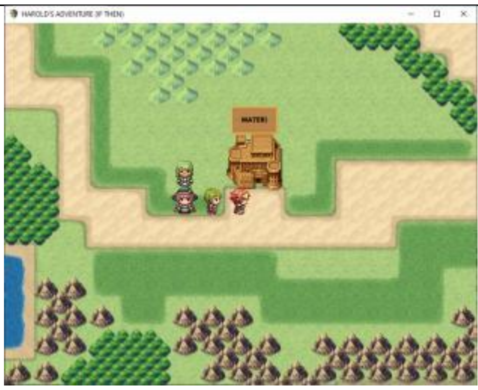
No.	Page	Explanation
3		Welcome message page for introducing the characters that will be used by the students throughout their interaction with the multimedia.
4		On the map page, students can choose to directly go to the "Material" or "Practice" sections, following the earlier instructions.
5		On the introductory material page, a description is provided regarding the material that the students will receive. This material includes definitions, pseudocode notation, flowchart notation, appropriate timing for using branching, and examples of branching implementation. The material is presented gradually, starting from the definition of branching and progressing to examples of branching implementation. Each Non-Player Character (NPC) available will provide instructions for each stage.
6		In the first instruction, the NPC asks if the student is already familiar with the concept of branching (didactic design for the first material section). If the student understands the concept of branching, the NPC will provide further instructions. If the student is not yet familiar with the concept of branching, the NPC will guide them to find an explanation of branching's definition. Once the student has obtained an explanation of the concept of branching, they will receive instructions to proceed to the next material section.

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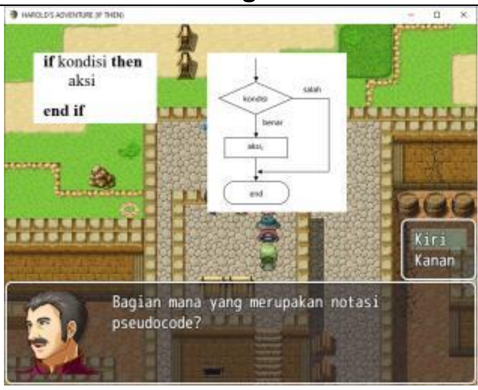
No.	Page	Explanation
7		In the next NPC interaction, the pseudocode notation material will be provided. Before proceeding to the next material section, it is ensured that students have a clear understanding of branching's definition (didactic design for the second material section). If the student has a good understanding, a question related to branching's definition will be posed.
8		In the following NPC interaction, the flowchart notation material will be presented. Before moving on to the next material section, it will be ensured that students have a clear understanding of branching's pseudocode notation (didactic design for the third material section). If the student has a good understanding, a question related to branching's pseudocode notation will be posed. If the student answers incorrectly, they will be prompted to return to the previous instruction.
9		In the subsequent instruction, students are asked to locate the green-colored box, inside of which there will be material about examples of branching implementation in both pseudocode and flowchart notations, along with explanations (didactic design for the fifth material section). After this, students are directed to proceed to the practice section.
10		On the first practice page, a welcome message is given, and the number of exercises will depend on the learning obstacles identified in the previous stages. Each correctly answered practice question earns the student 25 points. If a student answers a practice question incorrectly, a stimulus will be provided (as part of the didactic design in the first practice section), and the student will be asked to try answering the question again. If the student continues to answer the question incorrectly, they will be directed to return to the material section and review the content once again.

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3.2. Research Discussion

(i) Improvement of Student Learning Outcomes Based on Learning Obstacles

Through the utilization of interactive multimedia based on didactic design, an increase in the number of students correctly answering questions categorized as learning obstacles was observed. For Learning Obstacle 1 related to the definition of Nested-If and Switch-Case branching, the average percentage of students answering correctly during the pretest was 43%, which significantly increased to an average of 78% in the post-test. In Learning Obstacle 2, which involves determining the general form of pseudocode algorithms for If-Then, If-Then-Else, and Switch-Case branching, the average percentage of students answering correctly in the pretest was 19%, rising to 86% in the post-test. For Learning Obstacle 3, which entails determining the general form of flowchart algorithms for If-Then and Nested-If branching, the average percentage of students answering correctly during the pretest was 35%, which improved to 89% in the post-test. Similarly, in Learning Obstacle 4, focusing on the appropriate timing for using If-Then and If-Then-Else branching, the average percentage of students answering correctly during the pretest was 22%, which increased to 76% in the post-test. In Learning Obstacle 5, centered on implementing problems into the forms of If-Then, If-Then-Else, and Nested-If branching, the average percentage of students answering correctly during the pretest was 32%, increasing to 82% in the post-test.

Hence, it can be concluded that interactive multimedia based on didactic design for the branching material effectively reduces the learning barriers faced by the students.

(ii) Influence of Multimedia on Improving Student Learning Outcomes

After conducting the pretest and post-test, the researcher categorized the student data into high, middle, and low groups. The highest gain value occurred in the middle group with a gain score of 0.64, which can be interpreted as "Moderate." Following that, the second highest gain value was observed in the low group with a gain score of 0.61, also interpreted as "Moderate." Lastly, the high group achieved a gain score of 0.47, interpreted as "Moderate." The average gain score was calculated to be 0.59, also interpreted as "Moderate."

Attached below are the gain score results after implementing the interactive multimedia in **Table 2**.

Table 2. Gain Score Results

$\bar{x}$ *Gain* Upper Group	$\bar{x}$ *Gain* Middle Group	$\bar{x}$ *Gain* Lower Group	$\bar{x}$ *Gain*
0,47	0,64	0,61	0,59

(iii) Student Responses to Interactive Multimedia

After the implementation of interactive multimedia, students provided favorable responses. The interactive multimedia that was used received scores for various aspects: guidance and information aspect obtained a score of 4.25, multimedia aspect received a score of 4.39, evaluation aspect scored 4.30, design and media facility aspect received a score of 4.29, and pedagogical effect aspect scored 4.33. The average score for the interactive multimedia was 4.31.

Based on Table 3, the scores obtained are higher than 4.17, which falls under the category of "Very High Acceptance." Therefore, it can be stated that the interactive multimedia based on didactic design received a very high acceptance response from students in terms of guidance and information, content, evaluation, design and facilities, as well as the

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pedagogical effects contained within the interactive multimedia. The summarized scores obtained from the students are presented in **Table 3** as follows.

Table 3. Summary of Student Responses

No	Assessment Aspects	Average Scores
1	Guidance and Information	4,25
2	Multimedia Content	4,39
3	Evaluation	4,30
4	Design and Media Facilities	4,29
5	Pedagogical Effects	4,33
Overall Average Score		**4,31**

4. CONCLUSION

The interactive multimedia is designed based on didactic design to address the learning obstacles faced by students. The interactive multimedia is deemed effective in minimizing the learning obstacles faced by students, as evidenced by the average gain score of 0.59. Furthermore, the interactive multimedia based on didactic design for the branching material received an average score of 4.31 from students, which falls under the category of "Very High Acceptance."

Based on the percentage of students correctly answering questions related to learning obstacles and the assessment provided by students, a recommendation can be made for the development of interactive multimedia based on didactic design for future branching materials. This could involve incorporating a gameplay logic that aligns with the algorithmic thinking of branching, allowing students to understand the learning process through their own experiences rather than solely relying on theoretical foundations.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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