PILLAR OF PHYSICS EDUCATION
Vol. 17 (3), 2024, page.225-232
ISSN (Print) : 2337-9618
ISSN (Online) : 2684-8880

Creation of Interactive Multimedia Based on the Double Loop Problem Solving Model to Improve Students' Problem-Solving Skills on Dynamic Fluid Materials

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ABSTRACT

The development of Interactive Multimedia based on the Double Loop Problem Solving model utilizes iSpring Suite software which is intended to provide one of the answers to learning media that does not support learning in schools. This research aims to produce Interactive Multimedia that is valid and practical to use in improving students' problem-solving skills with F1 phase research subjects. The 4D development model consists of 4 stages, namely Define, Design, Development, and Disseminate. The assessment instrument consists of two, namely the validity instrument of content/material and media and the instrument of practicality. The data in this study are needs analysis data, validity data, and practicality data. The data obtained were analyzed using the Aiken's V formula and the Likert Scale. Based on the analysis of validity data, a validity score with an average of 0.81, 0,78, 0,80, and 0,86 was obtained with a valid category. The analysis of teacher and student practicality data was obtained on average 97%, 96,5%, 92.4%, and 91,3% with the practical category. Therefore, it can be concluded that interactive multimedia based on the Double Loop Problem Solving model developed is valid and practical.

Keywords : Interactive Multimedia; Double Loop Problem Solving; Problem Solving Capabilities; Spring Suite

I. INTRODUCTION

An important part of modern education is the need for innovation to develop and assess students' abilities [1]. One of them is problem-solving skills. This ability is very important in daily life because each individual is faced with a problem that must be solved. Problem-solving skills are defined as the ability in the form of sequential steps needed to find a solution to a question[2].

Problem-solving skills are defined as the ability in the form of sequential steps needed to find a solution to a question [3]. Students who are able to identify, analyze, and solve problems effectively will be better prepared to face future challenges, whether in further education, career, or daily life. Research Khalifah [4], emphasizes that to face future challenges, every individual must have good problem-solving skills. This ability is considered very important because it can facilitate a creative and effective approach in facing and overcoming various issues that arise. Problems or issues that arise are solved with their own theories, meaning that students are able to formulate their own theories and then test them, test their friends' theories, and discard inconsistent theories [5].

Problem-solving assessment can be done by measuring students' abilities based on problem-solving indicators. Polya conveying indicators of problem-solving ability including: 1) Understanding problems by identifying known data, data questioned, data adequacy for problem solving; 2) Planning a solution or identifying a strategy that can be taken; 3) Solving a problem or mathematical model with a reason; and 4) Re-checking, i.e. checking the correctness of the solution obtained[6].

Submitted: 2024-08-25 Accepted: 2024-09-10 Published: 2024-09-30

The low problem-solving ability of students is also caused by the search for solutions to problems with shortcuts, such as using internet media only[7]. This also affects students' critical attitudes in analyzing a problem. In addition, the lack of student problem-solving skills is also due to the low level of student learning independence, so they only use the teaching materials provided by the school [8]. Students also have difficulty solving physics problems, caused by learning media that are not supportive enough and tend to use verbal communication. This media is less effective for discussing calculation problems.

This problem was also found in MAN 1 Bukittinggi City. The results of interviews with physics teachers at MAN 1 Bukittinggi City showed that students found it difficult to solve problems with the level of analysis. As many as 74% of students experienced difficulties in solving problems because their conceptual problem-solving skills were relatively low. Most students are only able to identify problems and solve mathematical equations [9]

Another cause of students' low problem-solving ability is based on an observation questionnaire given to 62 students of Madrasah Aliyah Negeri 1 Bukittinggi City, the media used by teachers is not enough to support physics learning. This is corroborated stated that of the 8 schools in West Sumatra, there are still many teachers who have not used learning media, especially IT-based ones, in learning activities, namely around 37.5% of teachers use power point and 62.5% of teachers do not use any media other than blackboards [10]. Based on this, it is necessary to use good learning media because, the use of learning media is effective in improving physics problem-solving skills [11], [12].

The results of the media needs questionnaire, around 73% of students are proficient in using technology (smartphones), of course this supports the use of technology-based media in schools. In addition, 57.1% of students prefer to learn using digital media accompanied by videos, 50,8% of students prefer to learn using digital media accompanied by animation. From these results, it can be seen that MAN 1 Bukittinggi City students tend to like learning media accompanied by videos. Thus, the results of the questionnaire show that teachers and students need media in the teaching and learning process.

The use of learning media will allow students to be more actively involved in the learning process, so that they can develop analytical and logical skills. In addition, the learning media also provides a variety of simulations and challenging situations, which allow students to try various approaches in solving problems. Thus, the use of learning media not only makes the learning process more interesting, but also trains students' ability to face and solve problems.

Research by Yenti [13] stated that the concept of dynamic fluids is one of the concepts that students consider difficult. This is because Dynamic fluid materials that experience the most misconceptions caused by books and teaching methods, and the learning of dynamic fluid physics that takes place in schools is still informative and abstract, tends to be more emphasized on the formulation of mathematical equations, and does not involve students in directly interacting with real phenomena. This is why there is a need for media with a learning model that can develop student concepts and theoretically can affect the improvement of students' problem-solving skills.

The selection of media with a certain learning model can improve students' ability to transfer concepts to new problems, concept integration (reasoning), interest in learning, self-directed learning and problem solving. One of the problem-solving-based learning models is Double Loop Problem Solving. DLPS emphasizes dual reflection, where students not only seek solutions but also evaluate and revise their approach to problems. The DLPS model focuses more on finding the cause of a problem [14]. In line with this, DLPS learning can emphasize for students to become active individuals in the classroom and aim to be able to facilitate problem-solving skills.

The DLPS model has been proven to have a good impact on students' thinking skills and problem-solving skills [15]. We need a practical teaching tool that’s visually engaging and helps with the reasoning process. This will improve how well the Double Loop Problem Solving (DLPS) model works in boosting students’ problem-solving skills. Good learning media can make the model more effective and help students reach their learning goals. [16].

Through the selection of the right learning media, abstract things can be conveyed clearly. Basically, dynamic fluid materials are mostly in the form of real phenomena that are difficult to convey through words or writing, so it is necessary to try to use learning media equipped with audio-visual media to explain practical things through the display of images, writings and sounds. An alternative solution that can be provided is to develop digital learning media in the form of interactive multimedia with the DLPS model. The multimedia in this study was made using iSpring Suite.

The powerpoint-based software produced by Ispring Solutions allows users to create media such as slides, quizzes with various forms of questions, and videos[17]. The software in the ispring suite is also quite easy to learn and provides quite complete features and various facilities that can be used to develop interactive multimedia. Interactive multimedia based on the DLPS model is expected to be able to easily understand the learning material due to students' interest in the learning media, so that it can motivate students in learning and will foster the spirit of learning physics. The use of interactive multimedia based on the DLPS model is also expected to be a solution to students' learning problems and be able to improve physics problem-solving skills

II. METHOD

This study aims to develop a specific product and evaluate its performance. It follows the 4D model proposed by Thiagarajan, Semmel, and Semmel in 1974, which involves four main stages: define, design, develop, and disseminate. The research was conducted at MAN 1 Bukittinggi City, involving 9 students categorized into high, medium, and low levels. The participants include expert validators, teachers, and Phase F students. The expert validators are 3 lecturers specializing in material and media. The research focuses on an interactive multimedia product based on the Double Loop Problem Solving model, intended as a physics teaching aid and a resource for guiding educational activities.

The instruments used for feasibility analysis are expert validation sheets and practicality sheets for interactive multimedia products based on Double Loop Problem Solving and learning tools that have been prepared. The data testing techniques carried out in this study are in the form of feasibility and practicality analysis products. The products analyzed include interactive multimedia based on Double Loop Problem Solving. The instrument sheet is arranged using the Likert scale. The data obtained were analyzed with a validity index using Aiken's V formula [20]

$$V = \frac{\sum s}{n(c-1)} \qquad (1)$$

$$s = r - l_0 \qquad (2)$$

Information:
V = Rater deal index
I_0 = The lowest validity rating (in this case it is 1);
c = The highest validity rating (in this case, it is 5);
r = Numbers given by respondents
n = Number of raters

After obtaining the rater agreement index, the category of the index value is decided. The results of the category decision are based on the Aiken's V index as shown in Table 1.

Table 1. Validity Scor Criteria

Score	Criterion
V ≥ 0,6	Valid
V < 0,6	Invalid

(Source: Azwar [20])

A product is said to be feasible if the result of its validity obtains a criterion of ≥ 0.6 with valid criteria[20]. The data obtained from the practicality analysis is searched with percentages formula’s:

$$\text{Percentage Value } = \frac{Total\ Score}{Max\ Score} x\ 100\% \qquad (3)$$

The assessment of practicality is determined based on the interpretation criteria in the following Table 2 below

Table 2. Practicaly Scor Criteria

Score	Criterion
81%-100%	Very practical
61%-80%	Practical
41%-60%	Quite Practical
21%-40%	Impractical
0%-20%	Very impractical

(Source: Riduwan [21])

A product is said to be practical if the results of the analysis of the observation sheet by the teacher and the questionnaire of students responses to the use of the product meet the level of practicality criteria, namely "practical" or "very practical" or the range of practicality values obtained is equal to or more than 61% [21].

III. RESULTS AND DISCUSSION

The creation of interactive multimedia based on the Double Loop Problem Solving model uses a 4D model. The results of this study are limited to 3D consisting of three stages, including, (1) Define; (2) Design; and (3) Develop. The following describes the stages of creating interactive multimedia based on the Double Loop Problem Solving model to improve students' problem-solving skills with the results obtained.

Define

The definition includes in front-end analysis, student analysis, assignment analysis, and concept analysis. The results of this analysis are explained as follows.

a. In front – End Analysis

At this stage, the researcher interviewed physics teachers that even though schools have started using media, the use of media still does not support the learning process. In addition, it was found that students' problem-solving skills were still low as seen from the students' practice answer sheets where students worked on problems directly applying the formulas they knew without identifying the information needed first. Therefore, it shows that students have not applied problem-solving indicators properly. This condition is the reason for the need for the development of interactive multimedia according to needs so that it can improve students' physics problem-solving skills.

b. Student Analysis

The student analysis process was carried out by distributing a questionnaire at Madrasah Aliyah Negeri 1 Bukittinggi City in the Phase F class. This supports the application of technology-based multimedia in schools. In addition, 57.1% of students prefer to learn using digital media equipped with videos, and 50.8% of students prefer digital media accompanied by animation. From these results, it can be seen that students at Madrasah Aliyah Negeri 1 Bukittinggi City tend to prefer media that combine video elements. Thus, the results of this questionnaire show that there is a need from teachers and students for media in the teaching and learning process.

c. Assignment Analysis

Assignment analysis identifies tasks and content of dynamic fluid teaching materials that are in accordance with the independent curriculum based on Learning Outcomes, Learning Objectives Flow, and Learning Goal Achievement Indicators. Based on the Phase F Learning Objectives Flow, dynamic fluid materials include ideal fluids, continuity equations, and Bernoulli equations.

d. Concept Analysis

The analysis of concepts is conducted by assessing the key ideas within the dynamic fluid material being taught. The dynamic fluid material concept is part of the merdekacurriculum and is based on the learning objectives of Phase F. Analyzing this concept involves studying materials such as ideal fluids, continuity equations, and Bernoulli's equations.

e. Specifying Instructional Objectives

This stage produces learning objectives derived from the Learning Outcomes in the independent curriculum. The purpose of learning on dynamic fluid material is that students can apply fluid concepts and principles in daily life.

Design

The results of the analysis at the define stage are the basis for multimedia design at the design stage. The multimedia created has the following steps for learning the Double Loop Problem Solving (DLPS) model: 1) Identifying the problem, which is this stage begins with the presentation of the problem to identify everything that is the cause factor; 2) Detecting the initial cause, 3) Evaluating temporary solutions; 4) Determine if root cause analysis (solution consideration) is needed; 5) Detecting higher causes; 6) Determine the final solution[22].

These multimedia parts are adjusted to the Interactive Multimedia components according to Herman Dwi Surjono's Book[23], It consists of an introduction, a body and a closing. One of the introductory parts, namely the cover, contains a general identity that aims to provide information about the description of interactive multimedia content. The cover on the interactive multimedia is designed using a combination of green and black colors. The cover on the multimedia can be seen in Figure 1.

Fig 1. *Cover*

The content of the multimedia consists of learning activities arranged with the Double Loop problem Solving model. Here's a preliminary look at the continuity equation material in the step of identifying the problem shown in Figure 2.

Fig 2. Learning Activity

Develop

The development phase involves analyzing the validity and practicality of the interactive multimedia that has been prompted.

a. Validity Results

The multimedia that has been designed is then validated by expert lecturers. One of the main criteria to determine whether or not a learning tool is good or not is the result of validation by experts. Experts are required to validate the resulting product. Suggestions and Comments from validators are used as material for consideration and product improvement.

The components in the validation instrument are the content aspect, the construction aspect, the appearance and language aspects. The results of the Interactive Multimedia validation for 4 components, can be seen in the following Figure 3.

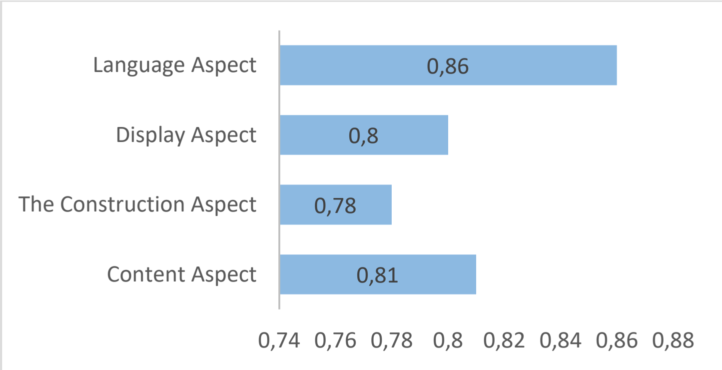

Fig 3. Multimedia Validation Results

Figure 3 shows that the validation results for each aspect are above 0.6, which means that the interactive multimedia based on the Double Loop Problem Solving model is considered valid. The language aspect, in particular, scored the highest, indicating that the content is presented clearly and without confusion, and the language used is easy to understand. Overall, with an average validity score of 0.81, the multimedia meets the validity criteria across content, construction, display, and language aspects.

b. Practicality Test Results

The practicality of the interactive multimedia was evaluated by 2 physics teachers and 9 students from MAN 1 Bukittinggi City. Among the students, 3 rated it as high, 3 as medium, and 3 as low. The evaluation involved a questionnaire completed by both teachers and students, which assessed how practical the multimedia is. This questionnaire covered 4 key areas: ease of use, attraction, efficiency, and benefits.

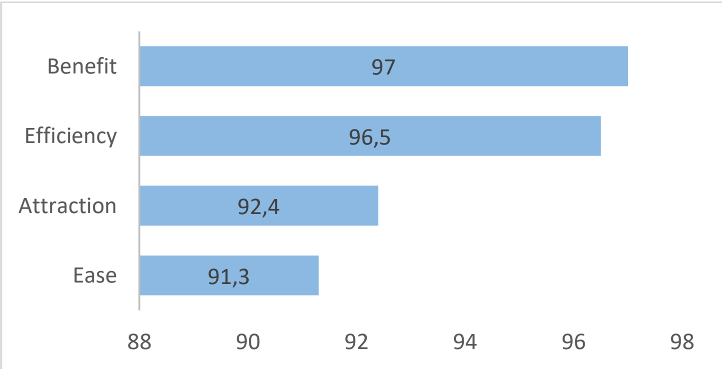

Fig 4. Teachers and Students Practicaly Result

Figur 4 above shows that the average results of practicality in each aspect are in the range of 90%-100%. This shows that interactive multimedia is in the very practical category. Efficiency and benefits aspects gain the highest value, this is related to the effective and flexible use and utilization of interactive multimedia. The Ease aspect has a smaller value than other aspects. This relates to several stages in multimedia, students need help in carrying out activities.

Results from the feasibility and practicality assessments indicate that interactive multimedia can address issues related to learning resources in the educational process. This technology benefits both students and teachers by simplifying how educators present material. Multimedia's advantages include enabling faster and more efficient delivery of content, as well as overcoming constraints of space, time, and sensory limitations [24]. Using media in the teaching and learning process can lead to new interests and enthusiasm among students, enhance their motivation and participation, and even influence their psychological state. [25]. This study's effectiveness tackles a specific issue related to learning resources, contributing to increased and renewed motivation for students.

IV. CONCLUSION

The conclusion is that interactive multimedia, based on the double loop problem-solving model, is deemed suitable for use. This assessment is supported by expert validation results, which indicate a validity score of 0.81, 0,78, 0,80, and 0,86. The multimedia, designed for dynamic fluid materials and grounded in double loop problem-solving, proves to be practical for enhancing students' problem-solving abilities. This practicality is confirmed by the multimedia practicality evaluation conducted by physics teachers and students, who rated it as highly practical with a score of 97%, 96,5%, 92.4%, and 91,3%.

ACKNOWLEDGMENT

The author thanked the principal and teachers at MAN 1 Bukittinggi City School for their permission and support during the research. Additionally, the author extends her thanks to Mrs. Prof. Dr. Ratnawulan, M.Si for her valuable input, which greatly assisted in the completion of this article.

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