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Development of Interactive Multimedia to Overcome Difficulties in Isomorphous Binary Phase Diagram Learning Materials

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Abstract

This research is motivated by the difficulties faced by students in the learning process of the Engineering Materials subject, which is shown by preliminary data that 63% of 30 students have difficulty in learning the subject of phase diagrams, of 63% of students by 50% have difficulty in mastering the material for the calculation of phase diagrams, as many as 30% of students have difficulty in drawing phase diagrams, and 20% have difficulty in others. This is due to the difficulty of understanding abstract, complex and dynamic concepts, so that it impacts on the low student learning outcomes due to the ineffective mastery of concepts. The purpose of this research is to produce interactive multimedia that is suitable to be used as learning media for Isomorphous Binary Phase Diagrams to facilitate students in overcoming the difficulty of concept mastery. Interactive Multimedia development method uses the DBR method and the research method used was a quasi-experimental research method with one group pretest-posttest design. The sample used in this study was 45 students as an experimental class. The results showed that interactive multimedia was feasible to use and could overcome the difficulty of mastering the concepts of students in Isomorphous Binary Phase Diagramsh.

Keywords: *DBR, Isomorphous binary phase diagrams, interactive multimedia, engineering materials, concept master*

1. Introduction

Engineering Materials is a scientific discipline that studies the knowledge of the structure, properties and abilities of metal and non-metal materials and their application [1]-[2]. Engineering Materials is a subject of expertise in the Department of Mechanical Engineering Education - Universitas Pendidikan Indonesia given to students in semester 1 with a load of 2 credits.

Concept mastery improvement in this material is necessary because the knowledge of this material will support the next course as basic knowledge for the field of mechanical engineering [3]. However, this subject in some subjects is considered difficult to understand. The level of difficulty can be seen by conducting initial research on students who have taken Engineering Materials courses. Based on the results of interviews conducted with 30 students of the Department of Mechanical Engineering Education who have received Engineering Material courses, the difficulties encountered in the learning process of this Engineering Material course is vary. The difficulty faced by students is in the phase diagram material as much as 63%. In this phase diagram material studies the types, phase diagram drawings, phase changes, phase types that occur, phase percentages and images of each alloy in each phase change caused by the temperature and composition of the alloy. Then as much as 17% had difficulty in the shear plane material and as much as 20% had difficulty in the crystal structure material.

Based on 63% of students who experienced the difficulty of the material on the phase diagram, 50% of its students had difficulty in mastering the calculation of the phase diagram, as many as 30% of students had difficulty in the regions of the phase diagram, and 20% of the difficulty in the micro structure change. According to [4], the difficulties experienced by students in understanding the concept of Engineering Materials are due to abstract, complex and dynamic characteristics, with the difficulties faced by students impacting on the low learning outcomes of students due to students not being optimal in mastering concepts in problem solving [15].

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According to [5], mastery of concepts is one aspect in measuring the results of a learning. In addition, it was shown by the previous research conducted by [6] about the use of multimedia animation on the subject of phase diagrams in engineering material courses, classes that use multimedia animation have a higher increase in learning outcomes compared to classes that do not use multimedia animation [16].

In general, humans can remember the messages conveyed through writing by 10%, audio messages 10%, visual 30%, audio visual 50% and when added by doing thing, it will reach 80%. Based on the results of Francis M. Drawer's research, interactive multimedia-based learning media has enormous potential in helping the learning process [7].

The purpose of this study is to produce Interactive Multimedia that is suitable for use as learning media for Isomorphous Binary Phase Diagrams in Engineering Material courses to facilitate students in overcoming the difficulty of mastering concepts and to produce Interactive Multimedia implementation data that can overcome the difficulty of mastering the concept of Ishomorpous Binary Phase Diagrams.

2. Methodology

Research conducted using pre-experimental method, with the type of one group pretest-posttest design, using a quantitative approach, so that by using this research design the effect of interactive multimedia implementation can be identified [8]. In this design, the population or sample is given a pretest to find out the initial condition, then proceed with giving treatment (by using interactive multimedia on learning). At the final stage, the sample is given a posttest to find out the condition after getting treatment. The research design used in this study can be seen in the following figure.

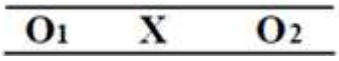

Figure 1. One group Pretest-posttest Design

Explanation:

O1 = Pre-test activity.

X = Treatment activity (Interactive Multimedia implementation).

O2 = Post-test activity

The population in this study were students of the Department of Mechanical Engineering Education who contracted an Engineering Material course. For the research sample used are Class A DPTM 2018 students totaling 45 people with simple random sampling technique, said to be simple because the member sampling of the population is done randomly [8].

The instrument in this study as a measuring tool to assess the feasibility of multimedia by material experts and media experts. This process aims to find out the weakness that exist in multimedia through indicators that have been prepared, so that improvements can be made to find the results of assessments that are otherwise suitable for use as learning media. At this stage, material experts and media experts fill out the assessment questionnaire using a rating scale as in Table 1.

Table 1. Rating Scale Guide

Score	Explanation
0	Strongly Disagree
1	Disagree
2	Neutral
3	Agree

4	Strongly Agree

Measurement of students' concept mastery in this study using the questions in pre-test and post-test. The measurement data is then analyzed to determine changes in student learning outcomes that occur after pre-test and post-test. Before being implemented, this instrument was first consulted and judged with the lecturer of Engineering Materials course.

Analysis of the Validation Results data aims to determine the percentage level of achievement of Interactive Multimedia as a learning media. The ideal score is first determined. The ideal score is a score set with the assumption that each respondent on each question gives the answer with the highest score. The formula for analyzing the validation data is as follows [8]:

$$P = \frac{Skor\ hasil\ pengumpulan\ data}{skor\ ideal} \times 100\%$$

Explanation:

P: Percentage

Skor hasil pengumpulan data: Actual Score

Skor ideal: Ideal Score

The N-Gain Test in this study was used to measure improvement in student learning outcomes after using interactive multimedia in learning and increasing scores on each indicator. The formula used for the N-Gain Test according to [9] is as follows:

$$\langle g \rangle = \frac{T_2 - T_1}{Sm - T_1}$$

Explanation:

<g> : Normalized Gain

T1 : Pre-test Score

T2 : Post-test Score

Sm : Maximum Score

3. Results and Discussion

Interactive Multimedia Program for Isomorphous Binary Phase Diagram material developed by the method of Design Based Research (DBR) Reevers model using Adobe Flash CS3 Professional as a main software. This software is used to process images, sounds, videos that have been processed using supporting software and give it a command / coding using Actionscript 2.0. Figure 2 is a display of the Interactive Multimedia program that was developed.

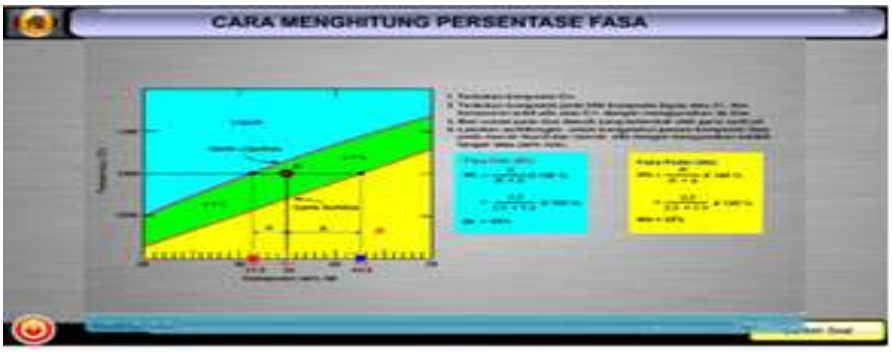

Figure 2. Interactive Multimedia Program

The feasibility study of Interactive Multimedia products is done by judge by media experts and material experts. Based on judge to media experts and material experts, interactive multimedia products are declared feasible without revision with an average percentage obtained is 94.31% and included in the qualification is very feasible. The results of testing of media experts and material experts are shown in Table 2.

Table 2. Judge Result of Interactive Multimedia Program

No.	Interactive Multimedia Judge	Average Percentage
1	Judge by Material Expert	95,14 %
2	Judge by Media Expert	93,48%
Average		**94,31%**

This Isomorphous Binary Interactive Multimedia Program can describe the conditions of the phase changes that occur in each part that cannot be reached by the eye become more real, so learning with real experience is no longer abstract. In addition, the characteristics possessed by Interactive Multimedia not only displaying moving images, but also have interactions that are built between multimedia and students, because multimedia adds to the impression of realism, can stimulate training exercises and so on [10]. Real depictions on the learning process have a better impact, referring to the use of moving images can convey complex concepts [11], the same opinion expressed which states that "Media in the form of live images have a high relationship towards learning concepts" [12].

Interactive Multimedia of Isomorphous Binary Phase Diagrams are used during the treatment process. Based on student learning outcomes obtained before use and after use in the treatment process in the sample, the Table 3 addresses the tabulation of the pre-test and post-test scores obtained by students.

Table 3. The Result of Pretest and Posttest

	Pretest	*Posttest*	N-Gain	
			Score	Category
Maximum	80	100	1	High
Minimum	10	75	0.44	Medium
Average	38.89	89.78	0.82	High

The results show that Interactive Multimedia can overcome the difficulty of mastering the concept shown by the increase in student learning outcomes and is categorized in the very high category, based on an average N-Gain value of 0.82. Figure 3 shows the distribution of the N-gain category obtained in the sample.

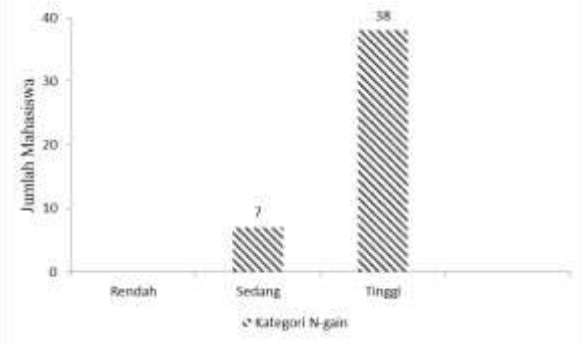

Figure 3. N-gain Category Distribution Data

Based on Figure, it can be seen that there are 38 students who get an increase in the high category, although there are students who get an increase in the medium category that is as many as seven people, but the value of students who are in this medium category shows a better increase.

The use of Interactive Multimedia causes what is learned tends to be remembered longer [13], which is because the learning process involves many aspects. This is because Interactive Multimedia has aspects of sound, images, animation, and interactive that students can operate independently for each concept they want to learn, so learning outcomes obtained using interactive multimedia will be mastered more deeply because it involves long-term memory [14], [17].

4. Conclusion

Based on studies that have been conducted, the conclusion of this research is that Interactive Multimedia is appropriate to be used as a learning media for Isomorphous Binary Phase Diagrams on students in overcoming the difficulty of mastering concepts, with the average results of tests that have been conducted to learning material experts and media experts included in the category very feasible without revision. Interactive Multimedia produces test data that can overcome the difficulty of mastering the concepts shown by student learning outcomes improvement.

The development of interactive multimedia can overcome the difficulty of mastering concepts in the Isomorphous Binary Phase Diagram material, because it can describe abstract conditions into a realtime learning experience and be able to create independent learning conditions according to different ability, understandings and learning styles. This Interactive Multimedia product is very possible if it is used as a learning media in engineering material courses.

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