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Multimedia Animation Learning on Based-Centered Cubic (BCC) Slip Plane Subject for the Prospective Teacher's Critical Thinking Skills

Ariyano*, Mumu Komaro, Yayat, F Falah, Bambang Darmawan

Universitas Pendidikan Indonesia
*Email: ariyano_iyan@upi.edu

ABSTRACT
Difficulties of students in engineering material courses are known from the results of preliminary research including those that occur in material related to the micro atomic structure. The difficulty in understanding this material is due to its abstract nature. On the other hand, this material is very important because it precisely determines the material properties. Theoretical learning in the form of verbal symbols is not representative enough to explain the concept of the system as needed so that the possibility is inaccessible by students which impact on the lack of learning experience. This issue has implications for errors in the construction of a whole system of engineering material, both micro-atomic structural systems and material properties and phase change according to their real application. This research is closely related to efforts to improve the quality of learning in engineering material subjects, especially critical thinking skills in the field of based-centered cubic (BCC) Slip Plane. This study aims to determine the increase in the critical thinking ability of prospective teachers using multimedia animation. The research method is a pre-experimental method with a one-group pretest-posttest design. The results showed a significant increase in the critical thinking ability of prospective teachers who use multimedia animation. This happens due to the long-term memory resulting from learning using animated multimedia.

Keywords: Engineering, Based-centered cubic (BCC), Critical thinking skills, Animated multimedia.

1. INTRODUCTION

Prospective teachers are not only equipped with pedagogical and professional knowledge [1], [2], but also need to master the competencies of the subjects to be taught during teaching [3]. Weaknesses of prospective teachers are a challenge that occurs globally everywhere, due to the limitations of humans who have separate visual and verbal information processing systems [4],[5]. The capacity of visual and auditory working memory systems is very limited, so learning that only involves visual and verbal information does not last long, and is not effective to receive a lot of information [6], [7]. Weaknesses in learning certainly occur in all fields. In this case, which is related to the weaknesses of prospective teachers/students in the subject of engineering materials, where all material properties are determined by the structure of the atoms or determined by the microstructure. Explanations of these concepts are represented in drawings and theories which generally describe an abstract event because they cannot be seen with the naked eye due to the small size of the atoms. The difficulty of understanding an abstract, complex and dynamic concepts is a problem in the learning process of engineering materials subject [8].

Based on the facts, prospective teachers must be able to master the engineering material courses that are considered difficult. Efforts should be made to improve their lectures, which are no longer difficult, although not immediately understandable, at least it is not boring if they are repeated or studied by themselves so that they can eventually be mastered. One technology that can be utilized to overcome this problem is information and communication technology (ICT) [9], with the consideration that current students can generally access easily to computers to be used in learning or lectures. Among the alternative uses are in the form of e-learning, virtual reality, and interactive multimedia (MMI).

2. EXPERIMENT

Participants in this study were Semester 1 students (Class A) of Mechanical Engineering Education from Universitas Pendidikan Indonesia. Participants were 30 students consisting of 28 men and 2 women who had studied the Slip Plane subject in previous lectures. The research method used in this study was Pre-Experimental Designs with One-Group Pretest-Posttest Design.

The study was conducted in a classroom with a laptop and LCD projector provided for learning using multimedia animation. First, the participants were given questions in the form of essay material based on the Based Centered Cubic (BCC) Slip Plane subject which had been studied previously, participants were given 30 minutes to complete the problem. An essay test (pretest) is given to determine the participants' initial critical thinking skills. After completing these questions, participants are required to pay attention to the learning process (treatment) using multimedia animation in BCC Slip Plane subject material. Multimedia animation learning is given with the guidance to make it easier for students to understand the material.

Figure 1. Sub-chapter Material on Multimedia Animation

Secondly, students are given multimedia animation learning in BCC slip plane subject material. The animation depicts a brown atom shifting on a blue plane and at the end of the atom shift, there are questions to students like in Figure 2. After the question is answered, students pay attention to the next animation.

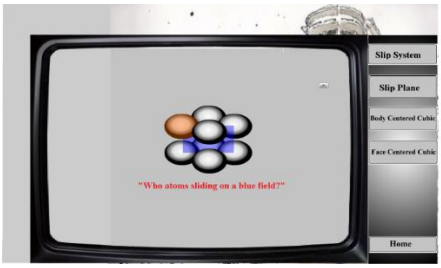

Figure 2. Multimedia Animation of BCC Slip Plane

Furthermore, the animation explains why the atom shifts in the green-coloured field like Figure 3. At the end of the animation, there is a question to start the question and answer session between participants and supervisors to better understand what has been given and bring out the nature of students when to ask and when to answer, as shown in Figure 4.

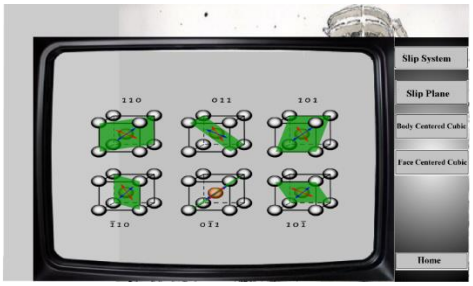

Figure 3. Animation of Atomic Slip in BCC Unit Cells

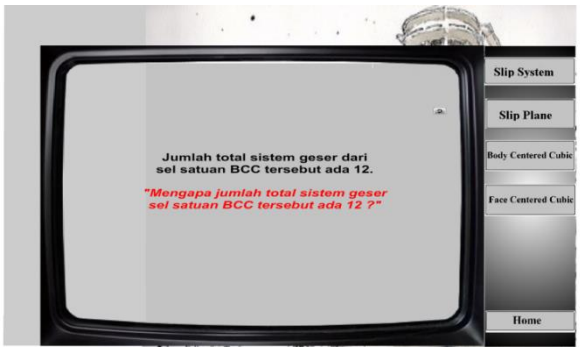

Figure 4. Final Display of the BCC Slip Plane Animation

After all, participants followed the learning process using multimedia animation, all participants were given the same essay test (posttest) as the questions given before learning (pretest) using multimedia animation. Essay test questions as a measuring tool for BBC Slip Plane learning using multimedia animation. Participants are given 30 minutes to fill out the questions.

3. RESULT

Based on the results of pretest and posttest data of class A prospective teachers at Mechanical Engineering Education in Universitas Pendidikan Indonesia who have been conducted in this study, there was an increase in students' critical thinking skills after using multimedia animation in the learning process. This increase is shown by the average results of the pretest-posttest (1,017). This is proven by the *p-value* (0.00) smaller than α (0.05).

Tabel 1. Pretest and posttest data processing

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 pretest - postest	-1.01667E1	4.63929	.84701	-11.89901	-8.43433	-12.003	29	.000

The development of learning science aims to understand how students learn. In an effort to apply learning science, the challenge of education is the instructional science development that aims to understand how to present material in ways that help students to learn [10]. To achieve the objectives, education experts make various educational media with different emphases, along with the appropriate principles. For multimedia design, Mayer made seven principles of multimedia design: multimedia, spatial, temporal, coherence, modality, redundancy and individual differences [11].

Meanwhile, the special principle characteristic of E-books based on multimedia animations for engineering material subject is accessible or affordable by students' reasoning. This is the main emphasis relating to the characteristics of engineering materials subject which are determined by the properties of the microstructure, such as atomic structure, and the abstract and dynamic movement of atoms. The microstructure size which is very small and abstract requires appropriate media to understand it, and for that, the E-MMA is a media that can meet these requirements. The E-MMA development procedures include several common steps, such as analysis, initial development, expert validation, limited trials, and final product testing.

The basic principle of E-MMA design as a result of research findings is the involvement of students in giving opinions and reasoning simulation. E-MMA for engineering material is created for active learning that produces the student-centered media, although it has not been made for all material. Narratives are made in the form of questions to be answered by students, by giving a time gap for thinking. This is intended to involve students in giving opinions and is expected to get a learning outcome of 70%. Then the answers are displayed in the form of animation as a correction to the results of their reasoning. It is also intended to involve students in reasoning simulations so that learning outcomes increase with the expectation of reaching 90% as a result of involving in simulations. The basic principles of E-MMA products and design make better and memorable learning outcomes, which combine verbal text, audio, and still and moving images or animation. The learning outcomes are better and deeper because of long-term memory involvement as stated by Mayer [10], [12].

4. DISCUSSION

The results of this study indicate an increase in the critical thinking ability of the slip plane material by using multimedia animation. This is indicated by the average results of the pretest-posttest (1,017). This is proven by the p-value (0.00) smaller than α (0.05).

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