Optimizing Multimedia Animation on the Improvement of Problem Solving in Crystal Defects Material in Engineering Material Course in Terms of Upper and Lower Group

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Abstract: **Difficulties in understanding abstract concepts, complexity and dynamics are the obstacles encountered by students when learning engineering materials, especially in the materials about Crystal Defects. The most recent data from the lecturer of engineering materials indicates that only 41.6% of the students could solve problems related to Crystal Defects. Therefore, this research was conducted on the implementation of multimedia animation on the material about Crystal Defects. This study aims to obtain information on the ability of concept mastery and response of the students after experiencing the learning process using multimedia animation on the material about Crystal Defects in engineering material course. The research method used is pre-experimental design in the form of one group pretest posttest design. Data collection was conducted using pretest posttest. The results after comparing the pre and post test showed that the students from lower group who used MMA in the learning of material about Crystal Defects in Engineering Material course are better than those from upper group. The implementation of MMA helps the students to better understand the material content and facilitates their learning process. The respones from the questionaires showed students' positive reactions to the use of MMA.**

1. INTRODUCTION

Difficulties in understanding abstract, complex and dynamic concepts are the problems in the learning of Engineering Materials. The most recent data of the students who managed to solve the problems related to atomic crystal structure, atomic structure changes, and atomic interaction that causes the changes in the properties of metal, only reached 41.6%. It can be seen that many students expressed difficulties in studying atomic crystal structure. The difficulties appear because the learning media used are still abstract, so it is hard for the students to describe, illustrate and imagine the movement of atoms in the crystal defects.

Given the importance of the Engineering Material course, and based on the data showing that the students experience difficulties in Crystal Defects material, an improvement effort is required to make the process easier to understand. An attempt that can be conducted is using media that is not only theoretical, but also practical, economical, accessible and teachable, thus allowing the material to be studied repeatedly. The efforts to meet the practical, economical, accessible and teachable criteria will be performed by manipulating theoretical model (pictures) into realistic model in the form of multimedia animation (MMA). Because multimedia animation has manipulative characteristic, that is, being able to transform theoretical model into realistic model (animation), so it can draw attention in the learning process and make it easier to understand the learning materials.

In order to master the engineering materials course, which is considered difficult, it is necessary to do an improvement of the lecture so it is no longer difficult, although it would not be immediately understandable, but at least it would not be boring if it is repeated or studied alone so it could eventually be mastered. One technology that could be used for this purpose is information and communication technology (ICT), considering that nowadays generally students can easily operate computers to be used in learning. One of the alternative utilizations is in the form of e-learning, virtual reality and interactive multimedia (MMI).

E-learning research had been done, in which browser training-based e-learning media using program content management system (CMS) JOOMLA had been tested with good results when being used in the learning of training course about maintenance/manual transmission service and components at vocational schools. Web-based E-learning does not only improve efficiency but also inspire the students to gain strong interest in learning (Huang et al., 2011).

Researches on the implementation of interactive multimedia (MMI) had been shown to be able to improve the quality of learning. Interactive multimedia-based

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 01, January-2017

learning is proven effective in increasing the achievement of concept mastery of elementary school student teachers, improving the ability to read the projected image among vocational students, and improving learning outcomes competence in assembling and installing the brake system among vocational students.

Multimedia animation on engineering materials has been created by Callister but the animation is still limited to: 1) the crystal structure in the form of unit cells, but not including the characteristics of each unit cell, which actually determine the mechanical properties of the material; 2) field and the direction of crystal, but not including phase diagram, which actually determines whether or not the material is easily molded, or determine the hardness of the material (Callister, 2004).

Generally, this research aims to create learning media, while specifically, this research aims to understand the improvement of concept mastery in engineering materials course by implementing multimedia animation (MMA) for vocational school student teachers in production machine competence program.

2. METHOD

Two groups are required to see the extent of the improvement of concept mastery in learning using multimedia animation. The first group is lower group, consisting of students who have low pretest results and the second group is upper group, consisting of students who have high pretest results. The division of this thinking groups is determined by the results of the initial pretest conducted on the students before the treatment is given. The research design used in this study is Pre-Experimental Designs in the form of One-group pretest-posttest design. The underlying reason for the selection of this research design is because the sample is not selected randomly, so this research design is suitable with the author's research.

Stated that in this design there is pretest before treatment, so the results of the treatment can be known more accurately because it can be compared with the situation before being treated. The design pattern used in this study can be seen in Table 1.

Tabel 1 One-Group Pretest-Posttest Design

Group	Pre-test	Treatment	Post-test
Lower	O_{L1}	X	O_{L2}
Upper	O_{U1}	X	O_{U2}

Information:
O_{L1} = Result/condition of concept mastery of lower group
O_{U1} = Result/condition of concept mastery of upper group.
X = Treatment using multimedia animation.
O_{L2} = Result of lower group after being given treatment X
O_{U2} = Result of upper group after being given treatment X

In this research design patterns, there are two groups consisting of lower group and upper group that are not chosen randomly. These two groups are divided through a pretest to determine differences in the ability in the population. After being given a pretest, they are divided into two groups: lower group and upper group, which are subsequently given treatment, which is the learning using multimedia animation. Furthermore, they are given posttest to determine the differencess in learning outcomes between the two groups. The questions in pretest and posttest are the same.

The difference of two averages of two samples is used to determine whether the lower group and the upper groups have any difference in N-Gain (normalized gain) based on Hake (2002), namely:

$$(N - Gain) \quad = \frac{\%\,actual\ gain}{\%\,potential\ gain} = \frac{\%\,skor\ postes - \%\,skor\ pretes}{100 - \%\,skor\ pretes}$$

In this study, descriptive analysis of N-Gain was also performed using N-Gain criteria based on Hake (2002), namely: 1) The increase with "high-gain", if (N-Gain)> 0.7; 2) increase with "medium-gain ", if 0.7 ≥ (N-Gain) ≥ 0.3; and 3) increase with "low-gain ", if (N-Gain) <0.3.

3. RESULT AND DISCUSSION

The result of preliminary studies shows that the students who took engineering materials course encountered difficulties on the material about abstract calculation and movement of atoms. Considering the importance of engineering materials course, and based on the data showing that students have difficulties at the material about Crystal Defects, an effort of improvement is required in order to make the process easy to understand. One attempt to do it is using media that is not only theoretical, but also practical, economical, accessible, and teachable, thus allowing a material to be studied repeatedly. The efforts to meet the accessible criteria will be performed by manipulating the theoretical model (pictures) into realistic model in order to be teachable in the form of multimedia.

Multimedia animation of atomic Crystal Defects is created so that learning is sufficiently representative to explain the concept of a system realistically so it becomes accessible for learners, therefore causing learning experience. Meanwhile the data from pretest and posttest on the control and experimental class was used to calculate the value of N-Gain, which is the increase of students' ability. N-Gain Values are presented in Table 2.

Table 2. Results of the calculation of pretest, posttest, and N-Gain of Concepts Mastery on Crystal Defects.

Class Group		*Pretest*	*Posttest*	*N-Gain*
Upper	Highest	65	95	0,91
	Lowest	45	75	0,50
	Average	55,71	85,71	0,68
Lower	Highest	40	95	0,93
	Lowest	10	80	0,71
	Average	29,12	87,94	0,83

The increase of Concept Mastery ability on crystal defects material using MMA in the lower group achieved an average of 83% or high category. This is higher than the average increase of Concept Mastery ability in the upper group, which is 68 %% or moderate category.

Development of science aims to understand how students learn. In the effort to apply the science of learning, the challenge in education is the development of instructional science that aims to understand how to present materials in a way that helps students to learn (Mayer, 2008). The educational experts created various educational media with different emphasis according to the type of the media, like the principles used for multimedia, namely: multimedia, spatial closeness, temporal closeness, coherence, modalities, redundancy, and individual differences (Mayer & Mayer, 2001).

Meanwhile the specific principle which characterizes the multimedia animation of atomic crystal defects is accessible, or affordable by students' reason. This becomes a major emphasis related to the characteristics of Engineering Materials course whose characteristics are determined by its micro properties, namely: structure of atoms, dynamic movement of atoms, and the abstract property. The micro size that is extremely small and abstract requires an appropriate media to understand, and for that, MMA has become a medium that can meet these needs.

MMA about engineering materials is created to produce media that is student-centered. It is intended to engage learners in simulations of thought, in order to increase learning outcomes as a result of engagement in the simulation (Fadel 2008). The basic principles of MMA-making produce better learning outcomes and leave mark. This better results are also explained by the notion that the relationship between media in the form of live or animated image has a high correlation to the learning outcomes. It is also better because the students do not only read, with the achievement of 10% getting increased by 60% with multimedia, which combines text read, voice heard, still and moving images or animation seen. The learning outcomes are deeper because there is Long-term Memory, as stated by Mayer (2008), and Berk (2009).

4. CONCLUSION

The increase of Concept Mastery ability on Crystal Defects material in the lower group using MMA reached an average of 83% or high category. This is higher than the increase of Concepts Mastery ability using MMA in the upper group, which reached the average of 68% or moderate category. Therefore, the MMA about atomic Crystal Defects has been proven to increase the Concepts Mastery ability on atomic Crystal Defects material to a high level or category. Students' concept mastery in the lower group is higher than those in the upper group, this is indicated by the value of N-Gain in lower group (83%) and upper group (68%).

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