Using Android-based Learning Media to Facilitate Students Critical Thinking Skills

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ABSTRACT

Critical thinking skills are one of the abilities that must be owned by a candidate of teacher, especially in relation to the demands of a teacher in the industrial era 4.0. To develop these skills, students must be trained by providing subject materials that are conceptual in nature, and have abstract, complex, and dynamic characteristics. The shear plane teaching materials is one of the teaching materials with these characteristics. The latest data is based on the results of an initial study of 30 students, showing that around 67% had difficulty understanding the teaching materials. The cause is thought to be due to their critical thinking skills which still need to be improved and the lack of learning media that can help them understand the materials. Therefore, the existence of learning media that is able to facilitate students in understanding the teaching materials is very necessary. The aims of the development of learning media using the DBR (Design By Research) method is to produce Android-based learning media that can facilitate students' critical thinking skills. The results of experimental research using a one-shot case study research design show that the learning media that was developed responded positively by students and can facilitate students in understanding teaching materials.

Keywords: *Learning Media, Critical Thinking Skills.*

1. INTRODUCTION

Entering the era of the industrial revolution 4.0, educational institution in Indonesia, including college, is required to prepare graduates who master 21st century learning skills, namely critical thinking, creative and innovative, communication, and collaboration [1]. Critical thinking skills are skills that are needed now and in the future, because society is faced with challenges such as increasing complexity and uncertainty [3] which requires a person to make wise decisions in order to get good results [4], [6]. Critical thinking skills can also be used to develop new solutions to meet community needs [5]. Critical thinking is the art of analyzing and evaluating thinking [2]. Critical thinking skills is a form of higher order thinking ability, because it implies thorough knowledge about the discipline in which a person works [7].

Critical thinking skills can be trained in students through a learning process with material that has abstract, complex, and dynamic characteristics. Shear plane materials, crystal structures, and crystal defects in the Engineering Materials Course are subjects matter that have these characteristics. The shear plane subjects matter consists of sub matter: (a) Crystal Plane (Miller index) which is an imaginary plane in the unit cell and is formed by the atoms present in the crystal, and (b) Shear Plane which is the plane where the atoms shift crystal structure in both BCC and FCC units. Higher-order thinking skills are needed to be able to understand the characteristics of such material, because should be able to visualize it in a more realistic form.

Preliminary research through interview techniques was conducted on 30 Mechanical Engineering Education students who had attended Engineering Materials lectures. The results showed that the level of difficulty experienced by students in understanding the subjects matter varied (Table 1).

Table 1. Level of Difficulty of Students in Engineering Material Courses

No	Material	Number of Students	Percentage (%)
1	Slide Field	20	67
2	Crystal Structure	7	22
3	Crystal Defect	3	11
Amount		30	100

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The data in Table 1 shows that in general students experience difficulties in Shear Plane Materials. The Shear Plane Materials with its two sub-materials is very important to master because it is basic knowledge that can be used, among others, in analyze the strength of the material, heat treatment, and material processing. This Shear Plane Material is very important, but there are still many students who have difficulty understanding it. For this reason, an effort is needed to overcome these problems through the use of learning media that are practical, economical, easily accessible, and can visualize the abstract, complex and dynamic characteristics of materials to be more realistic so that it is easier to understand. The rapid development of computer and Internet technologies has made e-Learning become an important learning method [26]. Online resources can be helpful for students and can augment the content presented in learning environments [27]. The media is Android-Based Multimedia via smartphone which contains theoretical material, animated shows, and is integrated with assessment tools.

Previously, this multimedia has been made in the form of other reports [8], but it is still computer-based and has not been integrated with assessment tools. Compared to computers, Android Smartphones are easier to access anytime and anywhere, because they can be taken anywhere. Currently, Android Smartphone is an item that is needed for daily communication purposes. A smartphone is a communication tool that can be used like a computer [9], so it has the opportunity to be used in developing learning media by utilizing Android [10], [11], [16]. Android is an operating system that has open source properties, which gives freedom for developers to create applications on smartphones [12]. Android is the most popular operating system in society, and can be utilized in the education sector to become an interactive learning medium [13],[17]. Learning media that utilize mobile phone technology are intended to provide opportunities for students to relearn materials that is not mastered anywhere and anytime [14].

The purpose of this study is to produce Android-Based Multimedia that can facilitate students' critical thinking skills about the Shear Plane Subject Maters in the Engineering Materials course. The use of android applications in media development is a novelty from this multimedia, because this application is an application that is currently widely used as an operating system [15]. With this application, this media is easy to access anytime and anywhere. Each student can practice according to their individual learning needs, freely repeating the material according to their interests. Through an integrated assessment tools, students can quickly determine their level of understanding of the material they have learned. The formulation of the problem in this study is Can the use of Android-based learning multimedia facilitate students' critical thinking skills in Shear Plane Materials? The objectives of this research are: (1) producing android-based learning media that can facilitate students' critical thinking skills about the shear plane material in engineering materials courses, and (2) knowing students' mastery of shear plane material in engineering materials courses after using android-based learning media.

2. METHOD

The interactive multimedia development process is carried out using the DBR (Design Based Research*)* method Reeves' model (Figure 1).

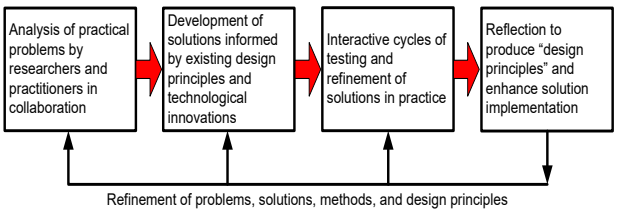

Figure 1 Four Steps of Reeves' DBR Model [18]

The steps for developing interactive multimedia are:

1. Analysis of practical problems by researchers and practitioners in collaboration.
2. Development of solutions informed by existing design principles and technological innovation.
3. Interactive cycles of testing and refinement of solutions in practice.
4. Reflection to produce "design principles" and enhance solution implementation.

Android-Based Multimedia was applied in research using a One Shot Case Study Pre-Experimental Design (Table 2). The treatment carried out was observed and measurements were made of the treatment. In this study a control group was not used so that the effect of the treatment used could be observed for the dependent variable.

Table 2. One Shot Case Study Research Design [19]

X Treatment	O Observation Dependent Variable

The feasibility level of this multimedia was measured through expert judgment (material and media), as well as user responses. The aims of this process are to determine the advantages and disadvantages of multimedia so that improvements can be made so that multimedia learning is feasible to use. Material experts, media experts, and users filled out an assessment questionnaire which was developed adapting from LORI (Learning Objects Review Instrument) v1.5 [20] using a rating scale as shown in Table 3.

Table 3. Rating Scale Guide

Explanation	score
very suitable	5
in accordance	4
neutral	3
not suitable	2
very inappropriate	1

The aims of the data analysis from the expert assessment are to determine the feasibility level of the multimedia created as a learning medium. In conducting this data analysis, the ideal score must be determined first [21], namely the maximum score obtained if each respondent gives an answer to each question with the highest score. The equation used is:

$$Percentage = \frac{Riil\ Score}{Ideal\ score}\ x\ 100\%$$

The above equation is also used to analyze user response data.

The level of mastery of the material and students' critical thinking skills are measured using a assessment tools that is validated by experts. This process is carried out to determine whether assessment tools are feasible or not to be used. Descriptive analysis using the average and standard deviation was carried out to categorize students' mastery to Shear Plane Teaching Materials. The categorization uses the Norm Reference Assessment standard (PAN) [21]. There are five categorizations used, namely very low, low, medium, high, and very high.

Mechanical Engineering Education Study Program students taking part in Engineering Materials courses are the subjects used in this study. The number of sample members used was 67 students from the 2018, 2019, 2020 and 2021 classes which were taken using a simple random sampling technique.

3. RESULT AND DISCUSSION

Android-Based Multimedia products are produced through a development process using the DBR method Reeves' model . In accordance with the DBR method, the first step taken is to analyze the Shear Plane Teaching Materials that must be mastered and the problems experienced by students. There are Shear Plane Teaching Materials that students must be mastered, namely: (1) definition of crystal plane, miller index, plane group, shear plane, and shear system; (2) determining the miller index, and the total number of sliding systems; (3) comparing the shear plane of the unit cell according to the type of unit cell; and (4) the effect of heat treatment on the mechanical properties of the material (Fe) according to the type of unit cell. There are two main problems that students experience in understanding the shear plane material, namely the difficulty in visualizing the atomic structure in a crystal plane and the atomic shifts that may occur.

Based on the results of the analysis then develop the media as a solution to overcome these problems. The making of this media refers to the storyboards that have been prepared and the Material Engineering Textbook. Based on the story board, the appearance of this multimedia consists of: (a) opening page, (b) instructions for use, (c) main menu/material menu (crystal plane, shear plane, and the effect of shear plane), (d) evaluation menu, and (e) information menu.

The multimedia feasibility test is carried out through expert judgment, until an Android-based multimedia product is produced that is suitable for use in research. The testing process is carried out by material experts and media experts using an assessment instrument in the form of a rating scale. The next step is the reflection stage which is the evaluation stage which is also the determining stage whether the media made is feasible or not to be used. Trials were carried out on users to find out their response to the Android-based multimedia that was made. Students are asked to install an Android-based multimedia application and use it themselves then fill out a user response form to see the feasibility of multimedia from the user's point of view. The results of the media feasibility test can be seen in Figure 2.

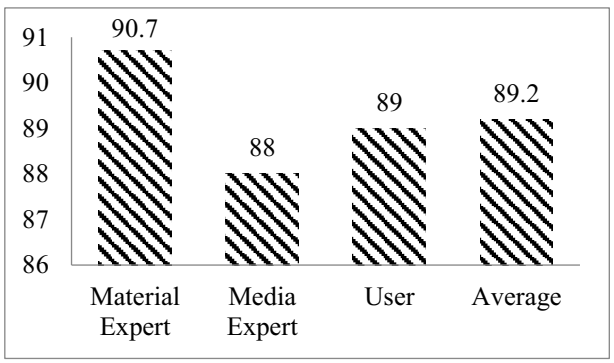

Figure 2 Media Rating Score

Based on the results of expert and user assessments as shown in **Figure 2**, this multimedia was included in the very feasible category for use in learning, especially for Shear Plane Teaching Material. After then, the Android-Based Multimedia is assessed, it is applied to the learning process of the Shear Plane Teaching Materials. Each student is asked to install this Android-Based Multimedia Application on their smartphone and run it to study Shear Plane Teaching Materials. After finishing studying the Shear Plane Teaching Materials in Multimedia, they were asked to complete a test sheet which was also included in Multimedia. This test is used to see the level of student mastery of the teaching materials after using Android-Based Multimedia. The test results can be seen in Figure 3.

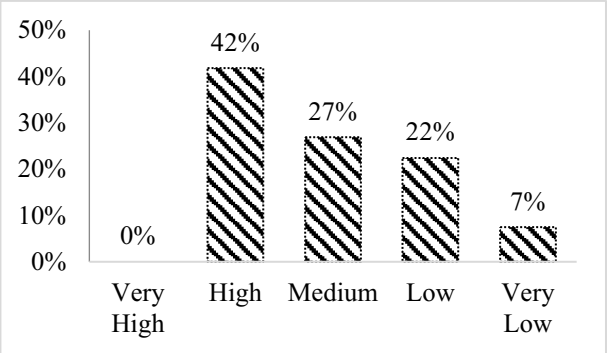

Figure 3 Level of Mastery of Teaching Materials

Based on Figure 3, it can be seen that there are no students whose level of mastery of the teaching materials is included in the very high category, and only 42% are included in the high category. The remaining 58% are in the medium, low and very low categories. There are around 58% of students whose test results are above average, and around 42% are still below average. This shows that the use of Android-Based Multimedia in learning Shear Plane Teaching Materials has been able to overcome their difficulties in understanding the material, because the number of students who have difficulty understanding Shear Plane Teaching Materials has decreased from 67% to 42%. This shows that the existence of the media used in the learning process has fulfilled the benefit aspect because it makes learning more interesting, material is easier to understand, methods are varied, and students are more actively involved in learning [22]. In addition, based on the results of expert and user assessments which show the results that this media is in a category that is very feasible to use. This shows that the media made has met the criteria of being presented attractively, according to the needs and skills of students, according to the material displayed, easy to use, related to learning objectives [23].

Even so, these results still show that the use of Android-Based Multimedia has not fully been able to help overcome students' difficulties in understanding the shear plane subject material. This implies that the media produced still has weaknesses, because according to the results of expert and user assessments, even though it is in the very feasible category, the assessment score obtained has not yet reached perfect (100). This means that there are several aspects of the media that still need to be improved, including from on the material side, several things that still need to be improved are content quality, learning goal alignment, feedback and adaptation. As for the media, several things that still need to be improved are interaction usability, accessibility, and standard compliance. Meanwhile, from user assessments, several things that still need to be improved are content quality, learning goal alignment, feedback and adaptation.

An overview of the level of student mastery of the Shear Plane Teaching Materials for each Competency Achievement Indicator (GPA) can be seen in Figure 4.

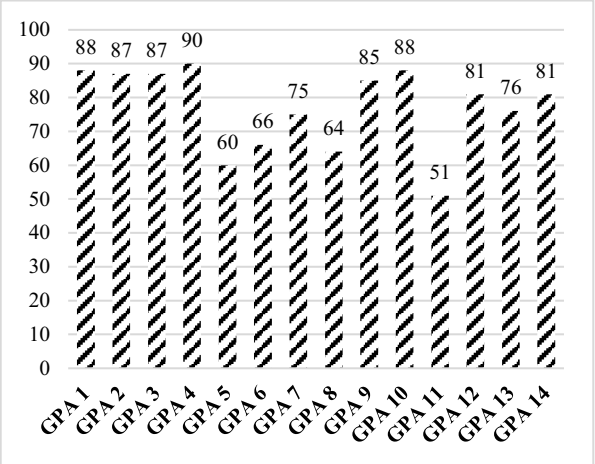

Figure 4 Level of Material Mastery for Each Indicator

Based on Figure 4, it turns out that the student's ability to master the Shear Plane Teaching Materials is based on GPA, it turns out that the grades above the average (77) only have 9 GPA out of 14 GPA. This means that only 64% of the GPA has been mastered by students and 36% is still not mastered. Based on the GPA, materials that have not been mastered include: (1) how to determine the inverse value on each axis based on the intersection value, (2) how to write the Miller index, (3) definition of a group of crystal planes based on the characteristics of the unit cell, (4) definition shear planes based on the characteristics of the arrangement of atoms, (5) how to find out the number of shifts and the direction of the shifts that occur in the shear planes based on auxiliary imaginary lines, (6) comparing the unit cell shear planes based on the type of unit cell.

The difficulties that students still experience in mastering the material of the Shear Plane Teaching Materials, do not only come from the quality of the material, but possibly come from the quality of the assessment tools used, because the quality of the assessment tools prepared is part of the technical quality of a media [24]. If this is related to the problem of critical thinking skills, the assessment aspect is one of the keywords that must be considered, because in assessing critical thinking skills it is better not to use multiple choice assessments [25].

4. CONCLUSION

Research conducted on students of the Mechanical Engineering Education Study Program (PTM) FPTK UPI managed to reveal about: (1) the feasibility level of Android-Based Multimedia both from the material and media aspects (2) the level of student mastery of the Shear Plane Teaching Materials in the Engineering Materials Course after using Android-Based Multimedia

that is integrated with the assessment tools, (3) positive response from users towards Android-Based Multimedia. These three findings have shown that this multimedia is feasible for use in learning Shear Plane Learning Materials in Engineering Material Courses in the Mechanical Engineering Education Study Program (PTM) FPTK UPI. The reduced number of students who have difficulty understanding Shear Plane Teaching Materials (although not yet significant), indicates that this media has been able to facilitate students' critical thinking skills in learning the Shear Plane Teaching Materials.

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