The Effect of Tutorial Multimedia on the Transformator Learning Outcomes Based on the Students' Visual Ability

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Abstract. The low learning outcomes have a negative impact on the quality of graduates. This study is aimed at revealing the effect of multimedia exploratory tutorial model on the learning outcomes of Basic Competence (BC) and Advanced Competency (AC) based on the students' visual ability differences in the course of Transformator. The research was conducted in State University of Medan using quasy experiment. Samples of 82 students were divided into three groups: Visual High (V_H), Visual Medium (V_M) and Visual Low (V_L). The comparison of research results was analyzed by Anova. The result shows that at the BC level the students' learning outcomes in the V_M and V_H groups were higher than V_L while the V_M and V_H did not differ significantly. At the AC level the three student groups differ significantly, the V_H group is higher than the V_M and the V_M is higher than the V_L. This study concludes that multimedia exploratory tutorials are effective for V_M and V_H student groups but not for V_L. Therefore exploratory multimedia should be used for V_M and V_T students to obtain optimal BC and only for V_H group to obtain optimal AC. However, this multimedia is not recommended for students with low visual abilities (V_L). It is advisable to prepare a special exploratory media for high visual ability students, while for students with low visual ability need to do further research to find effective learning media used.

1. Introduction
Technology and vocational education in Indonesia have played an important role in the transition of science and technology that enable graduates to prepare themselves before entering the mid-level workplace. Nevertheless, the facts show that vocational technology education graduates have not properly reached the standard competency [1, 2]. Learning outcomes in the Transformator field which is one of the main areas in vocational technology education is considered low so that it affects the low competence of graduates. Several studies revealed that low learning outcomes in electricity field was mainly caused by the lack of learning media [1, 3, 4, 5]. This weakness needs to be addressed so that the decreased quality of education would not trigger the low competence of graduates. The problem now is how to improve students' learning outcomes with the aforesaid problems, lack of learning media and the level of visual ability among different students.

Visual ability is the ability to manipulate an object in a rotational perspective that includes intelligence in rotation operations, manipulation of 2-D and 3-D forms of an object [6]. The instructional medium developed is an exploratory tutorial model [7] with the design as shown in Figure 1.
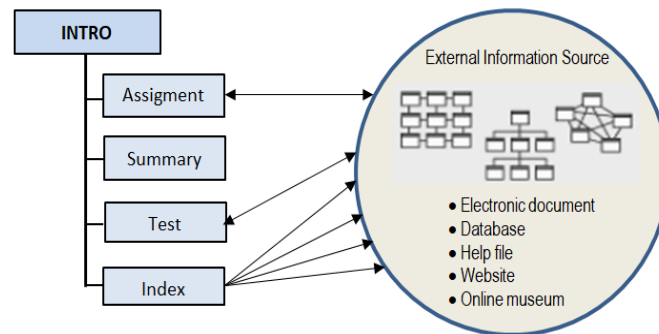
Figure 1. Exploratory tutorial design.

The use of instructional multimedia as an effort to improve learning outcomes is based on problem analysis and research studies that multimedia-based learning is an alternative to improve learning outcomes in electricity [1, 2, 8]. In addition, Kora kakis, et al. [9] found that the use of 3-D multimedia is becoming an enhancement of science learning. Moore [4] also revealed that multimedia learning tutorials become solutions to improve the quality of electromagnetic learning. Similarly, Hsiu [10] who proved the benefits of multimedia-assisted learning, Jenkins and Burtner [5] developed visualization of measurement technology in mechanical engineering using computer-aided learning modules, and Höhne and Henkel [11] who developed multimedia applications in technological education design. The results of these studies proves the contribution of instructional multimedia for learning outcomes improvement in science and engineering, particularly in electricity.

Instructional multimedia has many advantages such as being able to visualize abstract and conceptual events into easily understood concepts [12], and to improve students' learning motivation [1, 13, 14]. Multimedia will be effectively applied if its development follows the rules of multimedia design [15], and is oriented on students' cognitive loads [16]. It is in line with the theory of information processing systems in the human brain [17]. Multimedia-based learning is expected to improve learning outcomes which are distinguished in two levels, namely Basic Competencies (BC) and Advanced Competencies (AC). Basic competencies are competencies used to master theory and usage of Transformator subject, while Advanced Competencies are competencies to planning and problem solving of Transformator subject.

The purpose of this study is analysis the effect of multimedia-based learning on the transformator learning outcomes for students with different visual ability. The data were analyzed by using descriptive statistics and inferential statistics, i.e. one way Anova.

2. Research Methodology
The research was carried out in the form of quasy experiment, by means of multimedia Exploratory Tutorial model in the Transformator subject. The sample of 82 students were divided into three groups of abilities: Visual High (V_H), Visual Medium (V_M) and Visual Low (V_L) determined based on the measurement result using The Purdue Visualization of Rotation Test [6]. Learning outcomes are measured using test instrument in two levels, namely Basic Competencies (BC) and Advanced Competencies (AC). Data analysis for comparative study of learning outcomes was conducted with Anova after the requirements test [18].

3. Results and Discussion
The results showed that most of the respondents had medium-level visual abilities, n=18 (58.54%), the rest were Visual Low, n=48 (21.95%) and Visual high n=16 (19.51%). The ability of students who are generally at the middle level and only a small part of high visual ability becomes an obstacle factor in the learning process of students to understand the subject is abstract and conceptual. This fact also evidenced by the measurement data that show the relevance of the level of visual ability with learning outcomes as shown in Table 1.

Table 1. Learning outcomes of Basic Competencies.

Visual Abilities	n	Learning Outcomes (mean)		
		Basic Competencies	Advanced Competencies	Total
V_H	18	75.89	69.78	72.83
V_M	48	81.25	76.67	78.96
V_L	16	82.13	81.63	81.88
Total	82	80.24	76.12	78.18

Overall learning outcomes of Basic Competencies (BC) is higher than Advanced Competencies (AC). This analysis proves that students' competence is generally only at the level of understanding of teaching subjects while application competence and creativity for further development and problem solving are still low.

Differences in learning outcomes based on group ability were done by comparative analysis with Anova was conducted after passing the requirements test. The data distribution for the Basic Competencies variable is normal, and Levene's Test of Equality of Error Variances produces F $(2.79) = .574$; p= .565 so that the variant is homogeneous. Anova for Test of Between-Subject Effects obtained F $(2,79) = 7.83$; p = .001 which shows significant differences between sample groups based on visual ability level. Similarly, the Advanced Competencies variable, the price F = 0.972; p = .383 indicates homogeneous variance, and the Test of Between-Subject Effects yields F = 19.58; p = .00.

Thus the requirements have been met to perform comparative analysis using Anova.

Table 2. Pairwise Comparison for Basic Competencies.

| Visual Abilities		Mean Different	Std. Error	Significant [b]
(I)	(J)	(I – J)		
V_L	V_M	-5.36[*]	1.48	.001
	V_H	-6.25[*]	1.84	.003
V_M	V_L	5.36[*]	1.48	.001
	V_H	-.88	1.54	1.000
V_H	V_L	6.25[*]	1.84	.003
	V_M	.88	1.54	1.000

Table 2 indicates that there is a difference in learning outcomes of Basic Competencies between groups of students with low visual abilities (V_L) with students of medium visual skills (V_M) and high visual abilities (V_H). There is no significant difference between V_M and V_H. The result of the data analysis means that the learning result of Basic Competencies of V_L group is lower than V_M and V_H, but is not significantly different between V_M and V_H groups. This implies that visual abilities affect the achievement of learning outcomes in Basic Competencies especially in low visual groups. This finding is in line with previous research results that visual ability determines student learning outcomes [1, 5]. Multimedia that is loaded with visualization of learning content will be easily understood by students with high visual abilities. This is in line with information processing theory, work memory [17], cognitive load theory [16], and multimedia cognitive learning theory [19]. In the dependent variable of Advanced Competencies, there are significant differences between the three sample groups as shown in Table 3.

Table 3. Pairwise Comparison for Advanced Competencies.

Visual Abilities		Mean Different	Std. Error	Significant [b]
(I)	(J)	(I – J)		
V_L	V_M	-6.89[*]	1.55	.000
	V_H	-11.85[*]	1.92	.000
V_M	V_L	6.89[*]	1.55	.000
	V_H	-4.96[*]	1.61	.009
V_H	V_L	11.85[*]	1.92	.000
	V_M	4.96[*]	1.61	.009

The result of data analysis proves that there are learning outcomes differences in Advanced Competencies between the three group of students which is indicated by significant value $p<0.05$. This result shows that visual abilityis directly proportional to the learning outcomes of Advances Comptencies, while groups mean $V_H > V_M > V_L$.

This findings reinforce that ability to plan and problem solving in transformer subject require visual ability which linearly affects the learning outcomes. Therfore, the result of study is appropriate with the previous studies as well as proving the suitability of processing theory, process of thinking and multimedia learning cognitive [16,17,19]. The graph of learning outcomes is briefly shown in figure 2.
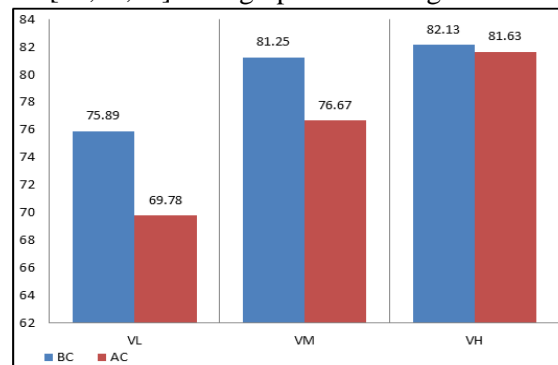
Figure 2. Comparison of Learning outcomes.

In the group of students, the visual abilities of low and medium gaps occur in the achievement of Basic Competencies and Advanced Competencies, but not so in the high visual ability group. This indicates that high visual ability positively influences achievement of Basic Competencies and Advanced Competencies and for students of medium and low visual ability is more difficult to achieve Advanced Competencies than Basic Competencies. This supports the results of previous studies [1, 4].

Multimedia Exploratory Tutorial model developed with the rules of teaching materials structure in parallel gives the opportunity for students to choose the lesson material according to their ability. This parallel pattern will be easily understood by students with high visual abilities but difficult for students with low visual abilities. It supports the theory of principles of multimedia form [15] and the rules of the preparation of multimedia tutorials [7]. At the level of Basic Competencies, students with medium visual abilities are parallel to high-ability visual students, but not so at the Advanced Competencies level, where high-ability visual students are able to achieve higher learning outcomes from the two underlying groups.

The results of this study are in line with previous research that the visual ability has a positive effect on the learning outcomes of engineering [20]. This study also supports research that proves students' learning outcomes of electrical power generation is determined by the level of spatial (visual) abilities [21]. However, the academic service system should also be improved to support learning outcomes. This is in line with Sriadhi's research [22] suggesting improving academic services including the integrated information system to support the teaching-learning process.

4. Conclusions

The development of media in accordance with the rules of design and structure of the content of teaching materials will determine the feasibility of tutorial media. This study proves that multimedia-based learning model Exploratory Tutorial, visual abilities have positive and linear effect on student learning outcomes. At the level of Basic Competencies V_L students achieve learning outcomes lower than the V_M and V_H groups, but the learning outcomes of the V_M group were not different from the V_H group. While at the Advanced Competencies level the visual ability more significantly determines the learning outcomes as evidenced by the learning outcomes of the V_H group of students higher than the V_M group and higher than the V_L group. Therefore exploratory multimedia tutorials are effective for V_M students for the Basic Competencies level and V_H students for the Basic Competencies and Advanced Competencies levels, but are not effective for V_L students for both the Basic Competencies and Advanced Competencies learning achievement levels.

Acknowledments

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