INFLUENCE OF LEARNING MEDIA BASED ON ADOBE FLASH PROFESSIONAL TO PSYCHOMOTOR DOMAIN LEARNING OUTCOMES ON PLC COURSES VIEWED FROM LEVEL OF CREATIVE THINKING STUDENT

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Abstract

This study uses adobe flash professional based learning media for experimental class while in control class using CourseLab media. Learning media based on adobe flash professional designed in the form of applications for smartphones and computers or notebooks. This study aims to determine the interaction and differences in learning result for students who have low and high creative thinking level who learn by using adobe flash professional media than students who use the media CourseLab. This research was conducted in department D3 mechatronic class of 2015 at State University of Trunojoyo Madura (UTM) on PLC course and using factorial design 2 x 2, with total of students in the experimental class as much as 44 people and total of students in the control class as many as 26 people. Data Processing Technique for hypothesis testing, used two-independent-samples test technique. If the prerequisite test of normality and homogeneity is not met, we will use the mann-whitney u test technique. Research finds: (1) for students who have a low level of creative thinking, who learn by using adobe flash professional learning media, psychomotor domain learning outcomes is significantly higher than students who learn by using instructional media CourseLab; (2) for students who have a high level of creative thinking, who learn by using adobe flash professional learning media, psychomotor domain learning outcomes is significantly higher than students who learn by using instructional media CourseLab; and (3) there is a significant interaction between the level of students' creative thinking and learning media, to psychomotor domain learning outcomes. Research suggests: (1) research subjects used at least more than 150 students, to obtain better data (normal distributed data); and (2) the preparation of tools and materials must be in accordance with the needs to be used, so that the quality of learning is increasing.
Keywords: *learning media, adobe flash professional, level of creative thinking, and programmable logic controller (PLC)*

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INTRODUCTION

Education has a very important position in the development of a country. Good and quality education can create competent and quality human resources. Based on Law no. 20 of 2003 on National Education System (Presiden Republik Indonesia, 2003), article 3 explained that "National education aims to develop the potential of learners to become human beings who believe and cautious to God Almighty, have a noble character, healthy, knowledgeable, capable, creative, independent, and responsible". Thus to achieve a stable economy requires great attention to the achievement of a competitive position in the world market. It's important to look at the ways, how creative thinking can enrich the economic potential. Expected through education, human resources Indonesia has a creative thinking to be ready to compete in the world of work.

National education standards require creative learning models and media, so that lecturers as educators play an important role in implementing the learning process in universities, in order to develop the potential and creativity of students. In relation to this, the learning process needs to be designed and implemented in such a way, including the use of instructional media. One of the facilities and infrastructure that can be used for creative learning process, namely interactive multimedia and e-learning. According to Daryanto (2010, p. 51) interactive multimedia is a multimedia equipped with user-operated controller tools, so the user can choose what is desired for the next process. Learning media based on e-learning is also very needed by students in doing learning activities. Furthermore Daryanto (2010, p. 168), explained that, E-learning is a learning system that utilizes electronic media as a tool to help learning activities. One of the interactive multimedia and e-learning that can be used for PLC courses that is adobe flash professional-based media. Adobe flash professional software is one of the software that can make learning media based on animation, game and simulation.

Students need media support in lecturing process, so that instructional media become an important foundation in influencing student learning outcomes. The facts so far indicate that most of the media used in universities, is still one way. In connection with this, it is necessary to do research about the utilization of adobe flash professional based media. The first step, made initial observations at the University of Trunojoyon Madura (UTM) on the D3 Mechatronics Engineering. The lecturer concerned argued that: (1) in the learning process of PLC courses using CX-Programmer simulation media, has not fully optimized the learning process for the students, because the CX-Programmer software developed by omron is a heavy software in its use and requires computer with high specification; (2) the students do not all have a computer, so it needs supporting media that can cover the weakness of the software CX-Programmer easy in its use, in order to happen interactive learning process; and (3) to optimize the CX-Programmer software required support animation-based media and simulation, so as to create efficient, meaningful and interactive learning.

Based on the results of these initial observations, media required with the following specifications: (1) made with adobe flash professional software; (2) generated media in the form of dot html (.html), dot swf (.swf), and dot apk (.apk); (3) completed with a file material that can be downloaded online; (4) has an easy-to-use menu and submenu; and (5) equipped with accompanying music. When compared with previous research, this research has novelty that include: (1) difference of adobe flash professional learning media influence compared to learning media of CourseLab; and (2) the interaction between the level of creative thinking with learning media.

Based on the above description of the background, the formulation of the problem in this research are: (1) is there any difference of psychomotor domain learning result between students who have low level of creative thinking, learning by using adobe flash professional learning media compared to students learning by using instructional media CourseLab ?; (2) is there a difference in psychomotor domain learning outcomes between students who have high level of creative thinking, learning by using adobe flash professional learning media compared to students learning by using CourseLab? (3) is there an interaction between the level of creative thinking and learning media, to the learning outcomes of the psychomotor to programmable logic controller courses?.

Based on the formulation of the problem, the purpose of this study is to: (1) analyze

difference of learning result of psychomotor domain for student who have low level of creative thinking learning by using adobe flash professional learning media compared to student learning by using learning media Course-Lab; (2) analyze the difference of psychomotor domain learning result, for students who have high level of creative thinking that learn by using adobe flash professional learning media compared to student learning by using learning media CourseLab; and (3) analyzing the interaction between the level of creative thinking and learning media, to the learning outcomes of psychomotor in the subjects of programmable logic controller.

Media

Heinich & Russell (1982, p. 15) states that the media is functioning as an intermediary that delivers information between the source and the recipient. Television, films, photographs, radios, audio recordings, projected images, printed materials, and the like are media used as a medium of communication. Meanwhile, according to Kozma (1991, p. 8), that the media is a technology that facilitates students in learning, so it can affect the learning outcomes. While Munadi (2013, p. 7), considers that the media is anything that can deliver and deliver messages from sources in a planned manner, so as to create a conducive learning environment in which recipients can make the learning process efficiently and effectively.

Munadi thought, in line with: (1) the results of the research by Nopriyanti & Sudira (2015, p. 234) who found that interactive multimedia learning basic competencies in the installation of lighting systems and electrical wiring was very effective for improving student learning outcomes; (2) the results of Mantasia & Jaya (2016, p. 290) research which found that Augmented Reality technology for productive subjects with the scientific approach, can improve learning outcomes in the cognitive, affective and psychomotor domains; and (3) the results of the research by Wirawan, Indrawati, & Rahmanto (2017, p. 85), who found that the use of digital archival learning media, effectively improved student learning outcomes.

Futhermore Munadi (2013, p. 153), explains that to design and produce interactive multimedia program, please note the following

matters: (1) the criteria of ease of navigation, where the program should be designed as simple as possible, so students do not need to learn computer first; (2) criteria of cognitive content, in which the content of the program must provide the learning experience of the cognitive domain required by the student; (3) knowledge and information criteria; (4) criteria of media integration, in which the media must integrate several other aspects and skills to be learned; (5) interactive learning should place emphasis on integrating various language skills, listening, speaking, writing and reading; (6) to attract students, the program must have an artistic appearance, then aesthetics is also a criterion; and (7) the last performance criterion is the overall function. The program developed should give the students the desired learning in its entirety, so that when a person finishes running a program he / she will feel he has learned something.

In multimedia presentation, according to Green & Brown (Munir, 2013, p. 112) there are several methods used: (1) paper-based, eg books, magazines, brochures; (2) light-based, eg slide shows, transparencies; (3) sound-based (Audio-based), eg CD Players, tape re-corders, radio; (4) Moving-image-based, for example: television, VCR (Vidio cassette recorder), film; and (5) digital based (Digitally-based), eg computer. The process flow interactivity between multimedia as shown in Figure 1.
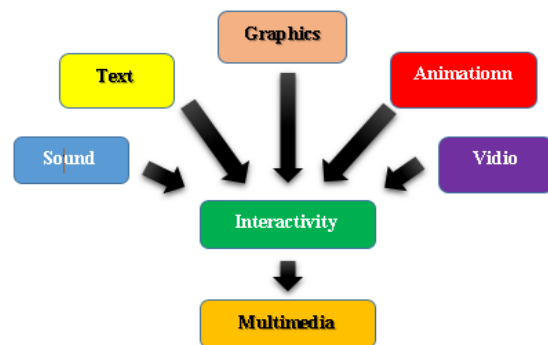

Figure 1. Multimedia Interactivity Process

In terms of understanding, Huddleston (2010, p. 33) explains that "Flash Professional" is a full-featured vector-based design tool. The program includes a set of tools for drawing and creating animations with the help of timeline. Meanwhile, according to Wahana Komputer (2012, p. 2) adobe flash professional is an animated object maker, making presentation, animation ads, games, supporting animation web

page, so it can be used for animated film making.

The latest features in adobe flash professional are: (1) provide support for HTML 5; (2) rapid export of symbols and animation sequences to generate sprite sheets to enhance gaming experience, workflow, and performance; (3) provide support for Android and iOS with the latest adobe flash player; and (4) perfomanya gives the loading of large images to be faster. This is realized thanks to the adobe mercury graphics engine that is able to minimize rendering time.

Learning Outcomes

Anderson & Krathwohl (2010, p. 31) have successfully developed a taxonomy of learning outcomes by revising the taxonomy into a teaching-learning and assessment taxonomy. Taxonomy includes two dimensions of the cognitive process dimension (cognitive processes) and the dimension of knowledge (knowledge). The learning outcomes of the cognitive domain includes 6 (six) levels: (1) remembering; (2) understand; (3) apply; (4) analyze; (5) evaluating; and (6) create. Furthermore, Anderson & Krathwohl (2001, p. 32) suggest five hierarchies in the affective domain learning result of receiving, responding, give valuing, orgating, and characterizing a value. Accepting is the ability to pay attention to an activity or event at hand. Responding is the provision of reactivity to an activity by involving themselves or participating in it. Values are strongly related to the act of accepting or rejecting the values or norms encountered through an expression of positive or negative attitudes. Organizing means identifying, selecting, and deciding on the value or norm to be applied. Giving character to value means believing, practicing, and demonstrating behavior that is consistent with the values and norms learned. Assessing the competence of skills can be done through observing activities, asking, trying, and reasoning, tasting, and creating. Psychomotor domains, according to Krathwohl, Bloom, and Kibler (Tomei, 2005, p. 58), consist of five ranks: (1) imitation; (2) manipulating; (3) precision; (4) articulation; and (5) naturalization.

Level of Creative Thinking

According to Torrance (1965, p. 9), that creativity is: (1) as a process of feeling and dealing with a problem; (2) it is necessary to make an assumption about the answer to a problem; (3) to identify difficulties in finding answers to a problem; (4) finding solutions and making conjectures, or formulating hypotheses in response to a problem; (5) assess and test such allegations or hypotheses; (6) then change the hypothesis and test it again, so find the answer or the result. This definition describes as a natural process and the human needs involved at each stage of problem resolution.

Accordingly, Silver (1997, p. 182) describes that creative people in high-order thinking seem to have a creative character and orientation to their activities. Meanwhile, according to Marrapodi (2003, p. 28), that creativity is often defined as an idea parallel to intelligence, but different from intelligence. Creativity is, not limited to cognitive or intellectual function or behavior. Conversely, creativity relates to a mixed condition of complex motivation, personality factors, environmental conditions, accidental factors, and even products. Creativity is a meeting of six different components, but is interrelated, including intellectual ability, knowledge, thinking style, personality, motivation, and environment (Sternberg, 2006, p. 43).

In contrast to the above three opinions, Paul & Elder (2008, p. 21) describe that creative implies an important component (eg "owning or displaying imagination and artistic or intellectual inventiveness"). Creativity is high-quality thinking contextually in an environment and can produce products (European University Association, 2007, p. 7). Siswono (2008, p. 6) explains that creative thinking is a process that is used when we come up with a new idea. It combines previously unheard of ideas, while Munandar (2014, p. 19) considers that creativity is a way of life, a way of perceiving the world.

Measurements on creativity are numerous, including in this study in order to measure the level of students' creative thinking. One tool used to measure the level of one's creative thinking is to use Torrance Tests of Creative Thinking that have been created by Torrance. Kaufman & Sternberg (2010, p. 53) revealed that there are seven verbal subtes including: (1) Asking; (2) Guessing Causes; (3) Product Improvement; (4) Unusual Uses; (5) Unusual Questions; and (6) Just Suppose. Meanwhile, according to Munandar (2014, p. 43), the creativity scoring scheme used in composing in-

volves four criteria of creative thinking: fluency, flexibility, originality (orosinality), and elaboration. Each of the four criteria consists of five components, so that there are 20 items that need to be assessed. For each eligible item, a score of 1, so the maximum score a person can get is 20.

While Silver (1997, p. 76) agrees with Torrance, that creativity judgments can use "The Torrance Tests of Creative Thinking (TTCT)". The creativity assessment used on TTCT is based on three key components including fluency, flexibility, and novelty.

RESEARCH METHODE

This research uses experimental research method. According to Sukardi (2012, p. 179) experimental research method is the most productive research method, because if the research is done well can answer the hypothesis that primarily related to causality. In addition, experimental research is also one form of research that requires relatively more stringent conditions when compared with other types of research. This is in accordance with the intent of the researchers who want a certainty to obtain information about which variables cause something to happen and the variables that result from the change in an experimental condition. The research design used intact-group comparison with the factorial model as shown in Figure 2.
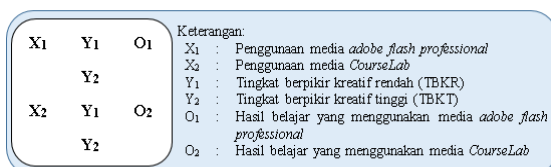

Figure 2. Intact-group comparison with factorial model

Montgomery (2013, p. 233) explains that a complete design requires a $2 \times 2 \times ... \times 2 = 2^k$ design called the factorial design 2^k. Accordingly, Suryabrata (2013, p. 111) explains that the simplest factorial random is that using two factors, and each factor uses two categories. This stage is a measure of the presence or absence of differences in learning outcomes between students who have high and low creative thinking levels taught by using adobe flash professional-based learning media, and students who are taught by using CourseLab media, and the presence or absence of interaction between the level of thinking creative with adobe flash professional based learning media on student learning outcomes in the course of Programmable Logic Controller (PLC).

Table 1. Design of Research Analysis

Learning Media (B)	Level Creative of Thinking (A)	
	High Level of Creative Thinking (A_1)	Low Level of Creative Thinking (A_2)
Learning media based adobe flash professional (B_1)	Learning Outcomes (B_1) (A_1)	Learning Outcomes (B_1) (A_2)
CourseLab Media (B_2)	Learning Outcomes (B_2) (A_1)	Learning Outcomes (B_2) (A_2)

Description:
1. $B_1 A_1$ is the result of student learning that has a high level of creative thinking who learned by using adobe flash based professional learning media.
2. $B_1 A_2$ is the result of studying students who have a low level of creative thinking who learned by using adobe flash based professional learning media.
3. $B_2 A_1$ is the result of student learning that has a high level of creative thinking that is learned by using CourseLab media.
4. $B_2 A_2$ is the result of student learning which has low creative thinking level which is learned by using CourseLab media.

To test the hypothesis required data analysis techniques. The data analysis technique used is parametric statistic if assumption test is met, and if assumption test not fulfilled, must use non parametric statistic which can be explained as follows: (1) Test Prerequisites, in this study used Levene test as data homogeneity test and Kolmogorov-Smirnov test as data normality test; (2) Test Hipotesis, If the preconditions are met, then hypothesis testing uses Independent-Samples T-Test and if not met then, using Mann-Whitney U Test.

RESEARCH RESULTS AND DISCUSSION

The result of interview with Head of Department of Mechatronics D3, Trunojoyo University of Madura (UTM) as shown in Table 2.

Table 2. Interview Result with Head of Department of Mechatronics D3, Trunojoyo University of Madura (UTM)

No.	Questions Researcher	Respondents Answer	Description
1	What learning media is used in the learning process in the course of PLC in D3 Mechatronics Study Program?	Software CX-Programmer	Respondents' answers are clear
2	How is the media deficient?	Software pretty heavy and requires a computer / notebook with a pretty good specification	Respondents' answers are clear
3	What problems arise if using the media?	Because the software CX-Programmer is a heavy software in its use and requires a computer / notebook with a pretty good specification, so it still needs learning media to equip it	Respondents' answers are clear
4	Whether in the learning process in the PLC courses in D3 Mechatronics requires other media, if need how the specifications?	Yes it requires, (1) there is animation; (2) media can be opened computer, notebook, and smartphone; (3) the medium is not heavy in its operation; (4) has a menu and sub menu that is easy to use; (5) can be accessed online	Respondents' answers are clear

Assessment of the level of creative thinking of students is done once each time in the experimental class and control class, by giving test question description characterized by multiple solution task. The assessment includes fluency, flexibility, and renewal. The results of the assessment are shown in Table 3.

Table 3. Criteria of Student Creative Thinking Level (LOCT)

Catagory LOCT		Total of Student	
		Experiment Class	Control Class
Students who have HLOCT	LOCT 4	16	7
	LOCT 3	3	5
Students who have LLOCT	LOCT 2	16	2
	LOCT 1	6	9
	LOCT 0	3	3
Total N		44	26

Table 3 shows that the students in the experimental class who get the criteria of high creative thinking level amounted to 19 students and the control class were 12 students. For the criteria of students who have low creative thinking level in the experimental class is 25 students and the control class is 14 students. Furthermore, these criteria, processed into groups for testing the hypothesis. The average grade of students' creative thinking level is shown in Table 4.

Table 4. Average Score of Student Creative Thinking Level

Learning Outcomes	Class	Mean
Psychomotor domain learning outcomes for students with LLOCT	Experiment	88,28
	Control	85,00
Psychomotor domain learning outcomes for students with HLOCT	Experiment	85,64
	Control	80,50

Against the psychomotor domains of learning result, assumption test (normality test and homogeneity test). The result of normality test and homogeneity test of psychomotor domain learning result, as shown in Table 5.

Table 5. Test Results of Normality and Homogeneity

Research Data	Normality Test Results	Homogeneity Test Results
Data of psychomotor domain learning outcomes	The data is not normal	Homogeneous data
Data of psychomotor domain learning outcomes for student with LLOCT	The data is not normal	Homogeneous data
Data of psychomotor domain learning outcomes for student with HLOCT	The data is not normal	Homogeneous data

Because the data is not normally distributed, the hypothesis testing is performed using nonparametric statistics, ie by using Mann-Whitney U Test and Friedman Test. Hypothesis testing is done as follows.

Hypothesis Testing 1

$H_0: \mu_{B_1A_2} \leq \mu_{B_2A_2}$
$H_1: \mu_{B_1A_2} > \mu_{B_2A_2}$

Table 6. Statistical test[a] of Psychomotor Domain Learning Outcomes for Students with LLOCT

	Psychomotor Domain Learning Outcomes for Students with LLOCT
Mann-Whitney U	68.500
Wilcoxon W	159.500
Z	-3.057
Asymp. Sig. (2-tailed)	.002
Exact Sig. [2*(1-tailed Sig.)]	.003[b]

a. Grouping Variable: Class used research

b. Not corrected for ties.

Sources: Software SPSS v.23

Table 6 shows that the probability value for the two-sided test (sig-2-talled) based on the Mann-Whitney U statistic is $\rho = 0.002$, which means value $\rho < 0,05$ with a very significant status. Therefore H_0 rejected, and $H_1: \mu_{B_1A_2} > \mu_{B_2A_2}$ which reads, "Psychomotor domain learning outcomes for students who have low level of creative thinking, who learn by using adobe flash professional learning media, significantly higher than students learning by using CourseLab learning media", are accepted.

Hypothesis Testing 2

$H_0: \mu_{B_1A_1} \leq \mu_{B_2A_1}$
$H_1: \mu_{B_1A_1} > \mu_{B_2A_1}$

Table 7 shows that, the probability value for the two-sided test (sig-2-talled) based on the Mann-Whitney U statistic is $\rho = 0.016$, which means value $\rho < 0,05$ with significant status. Therefore H_0 rejected, and $H_1: \mu_{B_1A_1} > \mu_{B_2A_1}$ which reads, "Psychomotor domain learning outcomes for students who have high

level of creative thinking, who learn by using adobe flash professional learning media, significantly higher than students learning by using CourseLab learning media", are accepted.

Table 7. Statistical test[a] of Psychomotor Domain Learning Outcomes for Students with HLOCT

	Psychomotor Domain Learning Outcomes for Students with HLOCT
Mann-Whitney U	58.000
Wilcoxon W	136.000
Z	-2.409
Asymp. Sig. (2-tailed)	.016
Exact Sig. [2*(1-tailed Sig.)]	.023[b]

a. Grouping Variable: Class used research

b. Not corrected for ties.

Sources: Software SPSS v.23

Hypothesis Testing 3

$H_0: \mu_A = \mu_B$
$H_1: \mu_A \neq \mu_B$

Table 8. Statistical test[a] of Interaction between LOCT and Learning Media to Psychomotor Domain Learning Outcomes

N	26
Chi-Square	21.476
df	3
Asymp. Sig.	.000

a. Friedman Test

Sumber: Software SPSS v.23

Table 8 shows that the probability value for the test based on Friedman Test statistics is equal $\rho = 0.000$, which means value $\rho < 0,05$ with a very significant status. Therefore H_0 rejected, and $H_1: \mu_A \neq \mu_B$ which reads, "There is a significant interaction between the levels of creative thinking and learning media on psychomotor domain learning outcomes "is accepted.

Furthermore, about the interaction between the independent variable and the moderator variable to the dependent variable, as shown in Figure 3.
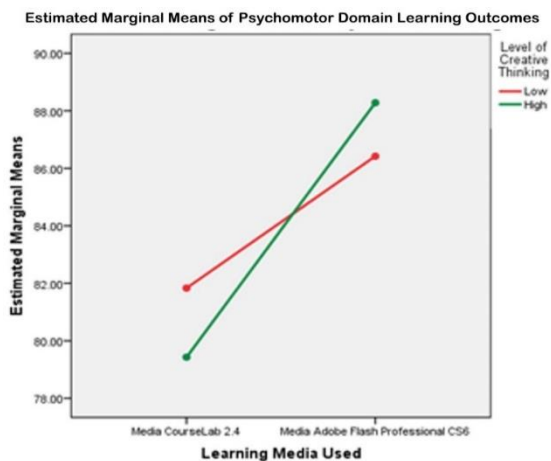
Figure 3. There is a very significant interaction between the level of creative thinking and learning media to the psychomotor domain (SPSS v.23)

The results showed that: (1) psychomotor domain learning outcomes, for students who have low level of creative thinking, learning by using adobe flash professional learning media, significantly higher than students learning by using CourseLab learning media with $\rho = 0.002$; (2) psychomotor domain learning outcomes for students who have high level of creative thinking, learning by using adobe flash professional learning media, significantly higher than students learning by using CourseLab learning media with $\rho = 0.016$; and (3) there is a very significant interaction between the level of students' creative thinking and learning media, to psychomotor domain learning outcomes with $\rho = 0.000$.

The results of this study, similar to the results obtained by Zhang (2015, p. 122) through his research entitled "Interactive Multimedia-Based E-Learning: A Study of Effectiveness", found that students in the learning environment use interactive multimedia based e-learning, fully achieve better performance and higher levels of satisfaction than students in the traditional classroom, which in their learning environment is less interactive with e-learning.

The findings of this study are consistent with the findings of Sun & Cheng (2007, p. 182) through his research entitled "The design of instructional multimedia in e-Learning: A Media Richness Theory-based approach", which found that in the learning process there

was an increase in outcomes significant learning for students using multimedia e-Learning.

The findings gained through this study, similar to the findings of Nazir, Rizvi, & Pujeri (2012, p. 77) through his research entitled "Skill development in the Multimedia Based Learning Environment in Higher Education: An Operational Model", which found that when creative education based issues that are packed with interactive and targeted multimedia will help learners so that: (1) skills are improved; (2) the learning time is reduced; and (3) its performance increases.

The results of this study, in parallel with the results obtained by Leow & Neo (2014, p. 53) through his research entitled "Interactive Multimedia Learning: Innovating Classroom Education in A Malaysian University", found that: (1) there was an increase which is significant in the psychomotor community learning outcomes of the students; and (2) students also exhibit positive attitude changes, so they become more active and motivated in the learning process.

The findings of this study are similar to Surjono's (2015, p. 98) findings through his research entitled "The Effects of Multimedia and Learning Style on Student Achievement in Online Electronics Course", which found that students whose multimedia preferences and learning styles corresponded to the way the material was presented in an online electronic course, students have significantly higher psychomotor domain learning outcomes than other learning models.

CONCLUSION

From the research that has been done found that: (1) psychomotor domain learning outcomes for students who have low level of creative thinking, learning by using adobe flash professional learning media, significantly higher than students learning by using CourseLab learning media; (2) psychomotor domain learning outcomes for students who have high level of creative thinking, learning by using adobe flash professional learning media, significantly higher than students learning by using Course-Lab learning media; and (3) there is a very significant interaction between the students level of creative thinking and learning media, to the students' psychomotor domain learning

outcomes in the programmable logic controller course.

REFERENCES

Anderson, L. W., & Krathwohl, D. R. (2010). *Pembelajaran, pengajaran, dan asesmen*. Yogyakarta: Pustaka Pelajar.

Daryanto. (2010). *Media pembelajaran*. Yogyakarta: Gava Media.

European University Association. (2007). *Creativity in higher education*. Belgium: EUA.

Heinich, R., & Russell, J. D. (1982). *Instructional media*. Amerika: Miriam Seda.

Huddleston, R. (2010). *Adobe flash catalyst CS5 bible*. Hoboken: Wiley Publishing Inc.

Kaufman, J. C., & Sternberg, R. J. (2010). *The cambridge handbook of creativity*. New York: Cambridge University Press.

Kozma, R. B. (1991). Learning with Media. *Review of Educational Research*, *61*(2), 179–211. https://doi.org/10.3102/00346543061002179

Leow, F. T., & Neo, M. (2014). Interactive multimedia learning: innovating classroom education in a malaysian university. *TOJET: The Turkish Online Journal of Educational Technology*, *13*(2), 99.

Mantasia, M., & Jaya, H. (2016). Pengembangan teknologi augmented reality sebagai penguatan dan penunjang metode pembelajaran di SMK untuk implementasi Kurikulum 2013. *Jurnal Pendidikan Vokasi*, *6*(3), 281. https://doi.org/10.21831/jpv.v5i3.10522

Marrapodi, J. (2003). Critical thinking and creativity an overview and comparison of the theories. In *Partial Fulfillment Of the Requirements of ED7590 Critical Thinking and Adult Education*. Providence.

Montgomery, D. C. (2013). *Design and analysis of experiments*. United States: John Wiley & Sons, Inc.

Munadi, Y. (2013). *Media pembelajaran*. Jakarta: GP Press Group.

Munandar, U. (2014). *Pengembangan kreativitas anak berbakat*. Jakarta: Rineka Cipta.

Munir. (2013). *Multimedia dan konsep aplikasi dalam pendidikan*. Bandung: Alfabeta.

Nazir, M. I. J., Rizvi, A. H., & Pujeri, R. V. (2012). Skill development in multimedia based learning environment in higher education: an operational model. *International Journal of Information and Communication Technology Research*, *2*(11).

Nopriyanti, N., & Sudira, P. (2015). Pengembangan multimedia pembelajaran interaktif kompetensi dasar pemasangan sistem penerangan dan wiring kelistrikan di SMK. *Jurnal Pendidikan Vokasi*, *5*(2). https://doi.org/10.21831/jpv.v5i2.6416

Paul, R., & Elder, L. (2008). *Critical & creative thinking*. The Foundation for Critical Thinking.

Presiden Republik Indonesia. Undang-Undang Republik Indonesia nomor 20 tahun 2003 tentang sistem pendidikan nasional (2003). Indonesia.

Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *Zentralblatt Für Didaktik Der Mathematik*, *29*(3), 75–80. https://doi.org/10.1007/s11858-997-0003-x

Siswono, T. Y. E. (2008). Implementasi teori tentang tingkat berpikir kreatif dalam matematika. In *Seminar Konferensi Nasional Matematika XIII dan Konggres Himpunan Matematika Indonesia* (pp. 1–16). Semarang: Jurusan Matematika FMIPA Universitas Negeri Semarang.

Sternberg, R. J. (2006). The nature of creativity. *Creativity Research Journal*, *18*(1), 87–98. https://doi.org/10.1207/s15326934crj1801_10

Sukardi. (2012). *Metodologi penelitian*

pendidikan kompetensi dan praktiknya. Jakarta: PT. Bumi Aksara.

Sun, P.-C., & Cheng, H. K. (2007). The design of instructional multimedia in e-learning: a media richness theory-based approach. *Computers & Education*, *49*(3), 662–676. https://doi.org/10.1016/j.compedu.2005.11.016

Surjono, H. D. (2015). The effects of multimedia and learning style on student achievement in online electronics course. *TOJET: The Turkish Online Journal of Educational Technology*, *14*(1), 116–122.

Suryabrata, S. (2013). *Metodologi penelitian*. Jakarta: Rajawali Pers.

Tomei, L. A. (2005). *Taxonomy for the technology domain*. United States of America: Idea Group Inc.

Torrance, E. P. (1965). Scientific views of creativity and factors affecting its rowth. *Daedalus*, *94*(3), 663–681.

Wahana Komputer. (2012). *Buku shortcourse series: Adobe Flash CS6*. Yogyakarta: Andi Offset.

Wirawan, A. W., Indrawati, C. D. S., & Rahmanto, A. N. (2017). Pengembangan media pembelajaran kearsipan digital untuk meningkatkan hasil belajar siswa SMK Negeri 3 Surakarta. *Jurnal Pendidikan Vokasi*, *7*(1), 78–86. https://doi.org/10.21831/jpv.v7i1.12879

Zhang, Y. (2015). Sustaining lesson study in schools with positive peer leadership. *International Journal for Lesson and Learning Studies*, *4*(2), 140–154. https://doi.org/10.1108/IJLLS-07-2014-0018