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THE EFFECT OF ANIMATION IN MULTIMEDIA COMPUTER-BASED LEARNING AND LEARNING STYLE TO THE LEARNING RESULTS

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ABSTRACT

The effectiveness of a learning depends on four main elements, they are content, desired learning outcome, instructional method and the delivery media. The integration of those four elements can be manifested into a learning modul which is called multimedia learning or learning by using multimedia. In learning context by using computer-based multimedia, there are two main things that need to be noticed so that the learning process can run effectively: how the content is presented, and what the learner's chosen way in accepting and processing the information into a meaningful knowledge. First it is related with the way to visualize the content and how people learn. The second one is related with the learning style of the learner. This research aims to investigate the effect of the type of visualization—static vs animated—on a multimedia computer-based learning, and learning styles—visual vs verbal, towards the students' capability in applying the concepts, procedures, principles of Java programming. Visualization type act as independent variables, and learning styles of the students act as a moderator variable. Moreover, the instructional strategies followed the Component Display Theory of Merril, and the format of presentation of multimedia followed the Seven Principles of Multimedia Learning of Mayer and Moreno. Learning with the multimedia computer-based learning has been done in the classroom. The subject of this research was the student of STMIK-STIKOM Bali in odd semester 2016-2017 which followed the course of Java programming. The Design experiments used multivariate analysis of variance, MANOVA 2 x 2, with a large sample of 138 students in 4 classes. Based on the results of the analysis, it can be concluded that the animation in multimedia interactive learning gave a positive effect in improving students' learning outcomes, particularly in the applying the concepts, procedures, and principles of Java programming. The difference of students' learning styles—visual or verbal, it can also gave the different effect in students' learning results acquisition. There was no interaction effect between the factors of visualization type and learning styles.

Keywords: **Multimedia learning, animated visualization, static visualization, learning styles, learning result, java programming.**

INTRODUCTION

With the publication of the regulation of the Minister of education and culture Number 109 in 2013, about the organization of distance education in higher education, then the Universities/Institutes and Privates certainly have to prepare for everything that concerns the infrastructure. One of these is the availability of infrastructure facilities-based

electronic learning (e-learning) are expected to meet the principles of learning that are effective, efficient and attractive (Merrill, 2009).

Multimedia is one of the e-learning component that acts as a medium of delivery information/messages/instructions. The multimedia technology continues to evolve and has increased in usage (Ganesan, 2009; Lau, et al., 2013). The development of the technology, both in terms of hardware and software, has allowed techniques or good teaching practice in traditional classes (face-to-face instruction or chalk-and-talk) can be realized in learning through multimedia or multimedia learning (computer-based). Multimedia learning has been instrumental in increasing (enhancing) and learning experience of learners or a higher understanding in solving problems and or his attitude towards teaching material, as expressed by Mbarika et al. (2010) and Stanwick (2010). According to Clark (2008), there are four main elements to be aware of in order to be an effective learning, namely the existence of a learning outcome (product knowledge), the type of content, learning methods and media of delivery (delivery medium). Thus, in the context of learning through multimedia, multimedia learning is said to be effective when managed to integrate the four elements.

In the learning context by using computer-based multimedia, there are two main things that need to be noticed so that the learning process can run effectively: how the content is presented, and what the learner's chosen way in accepting and processing the information into a meaningful knowledge. First it is related with the way to visualize the content (static or animation) and how people learn. The chosen way of how to visualize the content can influence the cognitive process of the learner and furthermore it can influence his/her learning result. This influence can occur because the limited capacity of sensoric memory (which is related with how the information enters visually and/or audio, through sighting/hearing) and the working memory of the learner in processing the information into a meaningful knowledge. The second one is related with the learning styles of the learner. The effectiveness of the learning by using multimedia depends on how far the learning style is accomodated in the learning strategy (Clark & Mayer, 2008; Kassim, 2013). Beside it, the effectiveness of multimedia learning will increase when designing and producing it pay attention to the following matters: the availability of learner control facilities (with stop and play button) in adjusting the learner's cognitive load during the learning process or multimedia interactivity (Hasler et al., 2007; Clark & Mayer, 2008; Tabbers & de Koeijer, 2010); the availability of interactive learning facilities (Schroeder, 2006); the condition of the topic (static or dynamic content type) are presented (Passerini, 2007); and content visualization type (static visualization or animated visualization) (Lin & Dwyer, 2010).

Pay attention to such things, the results of research conducted Rusli et al. (2013), having regard to the intrinsic cognitive load (static or dynamic content types), concluded that the presentation of the animated visualization in multimedia interactive learning (computer-based) and learning content object-oriented modeling (dynamic or procedure content types) is more effective than static visualization, presentation related to the student's capability in the application of the concepts and procedures of object oriented modeling. With respect to the results of research appear a question, what about the other dynamic learning content type (principles type, e.g. mathematical or programming Java)? Whether the presentation with animated visualization in multimedia learning (computer-based) for a dynamic (principles) learning content type also gives the same result?

The results of previous research on multimedia interactive learning with the content of the principles type (i.e. mathematics) carried out by Madar & Buntat (2011) concluded that there was an increase in the effectiveness of teaching and learning mathematics. Likewise conducted by Ogochukwu (2010) about multimedia presentations with the same content showed that multimedia presentations improve understanding, enthusiasm, the presence of the class, and the satisfaction of learner in learning mathematics. However, both these studies have not involved influence the effectiveness of visualization types (static vs

animated) on the multimedia learning and also learning styles of learner towards the learning results.

This research was carried out in order to develop research results conducted Rusli et al. (2013), to accommodate different types of dynamic content, i.e., principle content type (Java programming) and the scope of the broader learning results. This research aims to investigate the effect of different types of visualization (static vs animated) on presentation of multimedia computer-based learning and learning styles (visual vs. verbal) towards the learning results (student's capability in the application of the concepts, procedures and principles of Java programming). The detail description of the purpose of this research is to obtain empirical findings on:

- There are real influence on the visualization type (animated vs static) of multimedia computer-based learning against the students' capability in applying the concepts, procedures, and principles of Java programming,
- There are not real influence on the different learning style (visual vs verbal) against the students' capability in applying the concepts, procedures, and principles of Java programming,
- There are not real influence on the interaction between the visualization type of multimedia computer-based learning and learning style against the students' capability in applying the concepts, procedures, and principles of Java programming.

The results of this research, together with the results of previous research (Rusli et al., 2013), are expected to provide a guide to the importance of the application of animation in multimedia computer-based interactive learning, especially on dynamic learning content (type of procedures and principles), in order to improve student learning outcomes. The Java programming content chosen given the level of complexity and high enough of abstraction in the process of his education. Beside that, this content belongs as core courses in the program of study information system (S1) and computer systems (S1)-STMIK STIKOM in Bali.

METHOD

Research Variables and Experimental Design

This research is quantitative research with quasi-experimental approaches. The goal is to test the influence of the independent variables against the dependent variables. Independent variables are visualization types—on multimedia computer-based learning—with two kinds of treatment i.e. the presentation content with static or animated visualization, and student learning styles (visual or verbal) as a moderator variable. The dependent variables are the students' learning results of the application of the concepts, procedures, and principles Java programming. Design of experiments using factorial multivariate (MANOVA) 2 x 2.

Research Subject

The subject of this research was students of an odd semester of information systems and computer system studies program in STIKOM Bali. The total number of students that involved in this research were 138 people scattered in four classes. Two classes had interactive learning modules with static visualization and the others had interactive learning modules with animated visualization. Determination of a class which had interactive learning modules with static or animated visualization was performed randomly. Data about the number of students from the two groups participating treatment followed the research listed in table 1. The equivalence between the two groups (static class and animated class) tested based on the students' final value of the prerequisite courses (discrete mathematics) that have been obtained by a statistical analysis of non-parametric Mann-Whitney test (table 2), and the results concluded that the two groups (static class and animated class) were equivalent (significant at $\alpha = 0.05$).

Procedure of Treatment

Treatment procedures of this research consist of setting the timetable of implementation of treatment, and performance measurement of learning result. In detail this procedure listed table 3. As for the comparative aspects of the two treatments of multimedia computer-based learning, i.e. learning with multimedia presentations of static visualization and animated visualization described in table 4. Animation used here is an animated pointer type, which have a learning outcome equality with animated content appearance gradually (Rusli, 2015). The examples of slide multimedia presentations with interactive learning visualization animations and static as figure 1a and figure 1b.

Table 1. The number of Student Based Group of Treatment and Classes

Group of Treatment	Classes	n	%
Static Visualization	A	36	
	B	32	
	Sub-Total	68	49.3
Animated Visualization	C	35	
	D	35	
	Sub-Total	70	50.7
	Total	138	100

Note: n = number of students

Table 2. Mann-Whitney Test Result for Two Groups of Static and Animated Class

	Discrete Mathematics
Mann-Whitney U	22205.500
Wilcoxon W	4551.500
Z	-.743
Asymp. Sig. (2-tailed)	.457

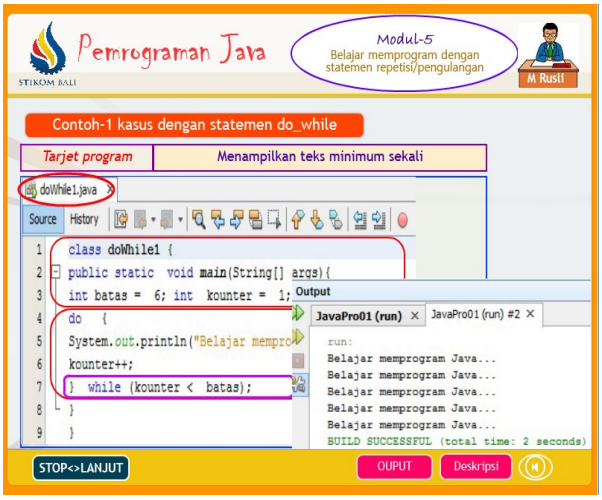

Figure 1a.
Slide with pointer animation

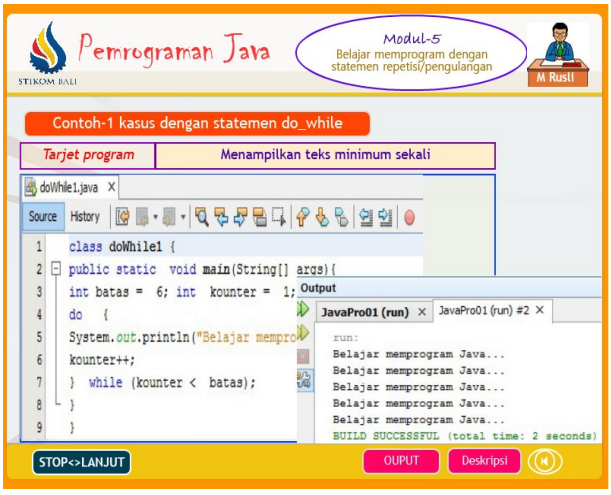

Figure 1b.
Slide with no pointer animation

Measurement of Research Variable

In this study, there were two kinds of variables whose data was obtained through measurements, i.e. the dependent variable and moderator variable:

The dependent variable—performance—was measured by test (final test), using instruments developed by the researchers. There were three kinds of the dependent variable i.e. the capability in applying the concepts, procedures, and principles of Java programming. The instrument of test of the concepts application capability as many as 20 items with fill-in-the-blank type (an example in figure 2a), the procedures application capability as many as 6 items with sequence type (an example in figure 2b), and the principles application capability as many as 7 items with fill-in-the-blank type (an example in figure 2c, more complex than figure 2a). Considering the concepts is subordinate of the procedures, then the final value of the procedures application capability was taken from the average value of test results of the concepts and procedures application capability. Similarly, to the procedures that is subordinate of the principles, then the final value of the principles application capability was taken from the the average value of test results of the concepts, procedures, and principles application capability.

Moderator variable—index of learning style (ILS)—was measured using instruments developed by researchers. These instruments were adapted from instruments to measure learning style appropriate Index of Learning Styles (ILS) of the Felder-Soloman (Litzinger et al., 2007; Graf et al., 2007). ILS is an on-line questionnaire designed to assess the preference of the 4 dimensions of learning style that is active/reflective, sensing/intuitive, visual/verbal, and sequential/global, with each dimension includes 11 items of questions, so the total questions there are 44 items. This instrument has been tested its reliability and validity for students of engineering (Litzinger et al., 2007; Wang & Mendori, 2015; Al-Azawe et al., 2015). In this study all the dimensions of learning style were measured, but used only one dimension of a learning style that was a visual/verbal learning style.

Table 3. Procedure of Treatment

Lecture	Content	Treatment
Week-1	Research and learning plans. Index of Learning Styles Questionnaire. Multimedia learning, module-1.	Learning plan description, the intent/purpose of research, and operational learning modules; an explanation of the Index of learning styles (ILS); measurement of ILS student. Presentation of learning module-1 and exercises.
Week-2	Multimedia learning, module-2. Multimedia learning, module-3.	Presentation of learning module-2 and exercises. Presentation of learning module-3 and exercises.
Week-3	Multimedia learning, modul-4. Multimedia learning, modul-5.	Presentation of learning module-4 and exercises. Presentation of learning module-5 (part of) and exercises.
Week-4	*Final test*	The implementation of the final test and measurement of the learning results.

Data Collection and Analysis Method

The description of average score of capability in applying concepts, procedures, and principles of Java programming listed in table 5. Data measurement results all variables were analyzed further research with Multivariable variance analysis techniques (MANOVA) 2 x 2 with the help of the SPSS statistical program package version 17. However, some statistical assumptions that must be done before doing the MANOVA analysis techniques were, among others, the normality of the data and homogeneity of variance-covariance matrices (Hair et al., 2014).

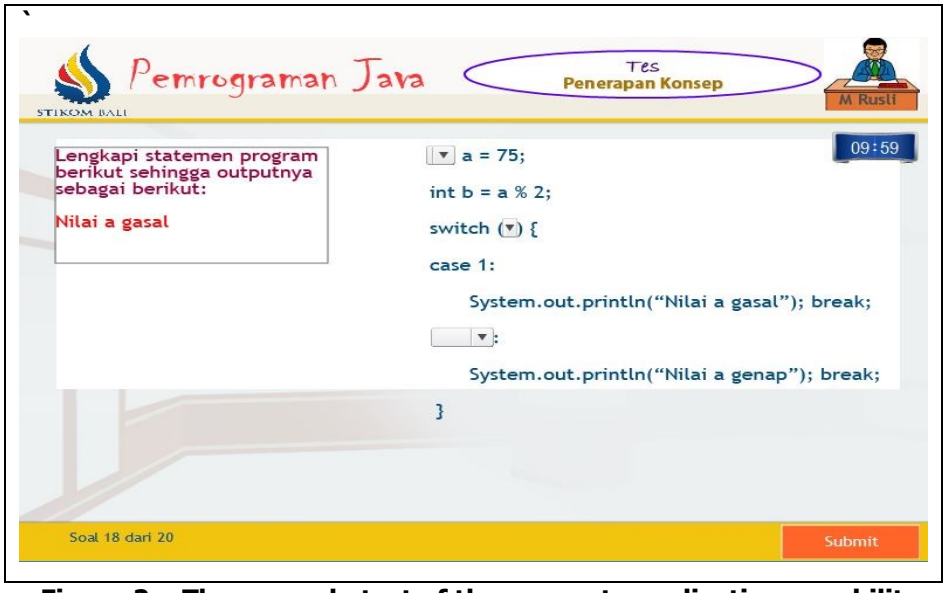

Figure 2a. The example test of the concepts application capability

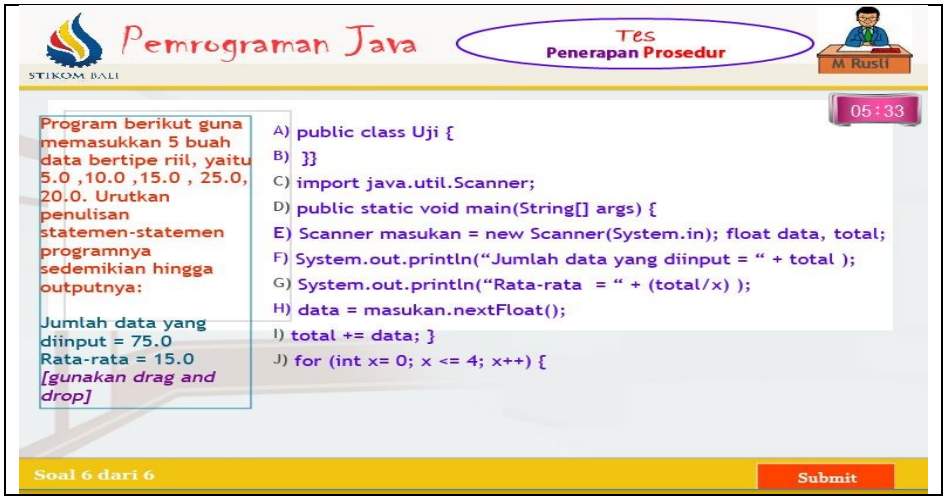

Figure 2b. The example test of the procedures application capability

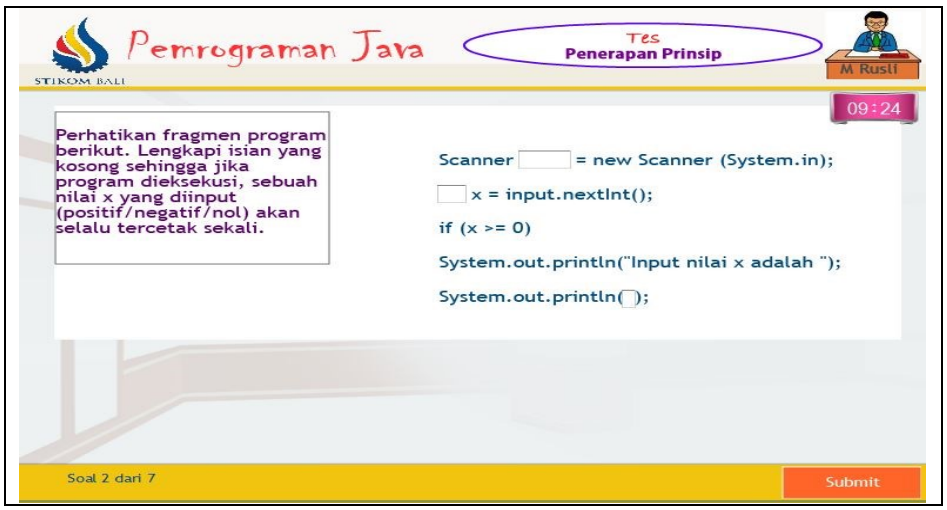

Figure 2c. The example test of the principles application capability

Table 4. The Comparative aspects of the two treatments of multimedia computer-based learning

The Aspects	Multimedia Learning with Static Visualization Presentation*	Multimedia Learning with Animated Visualization Presentation*	Description
Content presentation	Segment content displayed simultaneously on a computer screen followed by a narrative voice that explains the parts of the content	Segment content displayed simultaneously on a computer screen followed by a narrative voice aligned with the appearance of an animated pointer that explains the parts of the content	One part of the content consists of multiple words/sentences or part/whole picture/diagram/table.
Learner control	Availability of STOP and CONTINUE button governing as the emergence of the narration (the voice).	Availability of STOP and CONTINUE button governing as the emergence of the narrative (voice) and animated pointers.	The button handler as a representation of the existence of user interactivity with multi-media learning beside another button.
Practicing	Availability of material practice/workout with some type of question: multiple choice, short answer, fill in the blank, sequence. The material question is displayed on the screen/computer screen without the narration.	Availability of material practice/workout with some type of question: multiple choice, short answer, fill in the blank, sequence. The material question is displayed on the screen/ computer screen without the narration.	Lecturers along with students discussing problems such as exercises/assignment given.

*** The content is adapted from the book: *Belajar Pemrograman Java dengan NetBeans, Sebuah Pengantar (Rusli et al., 2016)***

Table 5. Description average score capability of applying concepts, procedures, and principles

Treatments	Learning Styles	Total of Students (n)	Capability of applying concepts		Capability of applying procedures		Capability of applying principles	
			Average score	Standard deviation	Average score	Standard deviation	Average score	Standard deviation
Static Visualization	Visual	47	51.8	14.46	40.8	12.76	37.5	12.72
	Verbal	21	51.9	16.00	41.9	13.23	37.7	13.03
Animated Visualization	Visual	37	60.3	13.84	48.8	14.64	46.4	15.80
	Verbal	33	56.5	14.76	46.8	15.28	42.6	15.02

FINDINGS

Testing Assumptions in MANOVA

The most critical assumptions relating to MANOVA are the independence of observations, homoscedasticity across the groups, and normality (Hair et al., 2006; Hair et al., 2014). In addition, the issues of significance of intercorrelation between the dependent variables and outliers are tested.

Experimental data obtained from all students actively participated in the current study, that consists of 4 classes. Two classes obtained the treatment with learning modules of animated type, and the other classes obtained the treatment with learning modules of static type. The determination of which classes gain preferential treatment of one type of visualization (animated or static) has been done randomly.

On the results of test of normality against three dependent variables (the capability in the applying the concepts, procedures, and principles of Java programming) with Kolmogorov-Smirnov Statistics test, it can be concluded that the normality assumption of data measurement of the three dependent variables was filled (significant at α = 0.05).

Meanhile, the test results of covariance matrices homogeneity with Box's M test showed the value of 1.247 F test can be filled (significant at the α = 0.01). As for the test results to the variance matrices homogeneity with Levene test was as follows: results of the capabilities measurement of the application of concept, the value of $F_{(3,134)}$ significance was 0.423 (significant at α = 0.05); the application of the procedure, the value of $F_{(3,134)}$ significance was 0.890 (significant at the α = 0.05); and the application of the principles, the value of $F_{(3,134)}$ significance was 1.666 (significant at the α = 0.05). Therefore, it can be said that the assumption of variance matrices homogeneity for the three dependent variables can be filled.

Bartlett's Test of Sphericity to test the intercorrelation between the dependent variables showed that there was an intercorrelation between the dependent variables (significant at the α = 0.01). Beside that, through Boxplots diagrams of all the data measurement results showed that there was no outliers (figure 3a-3f).

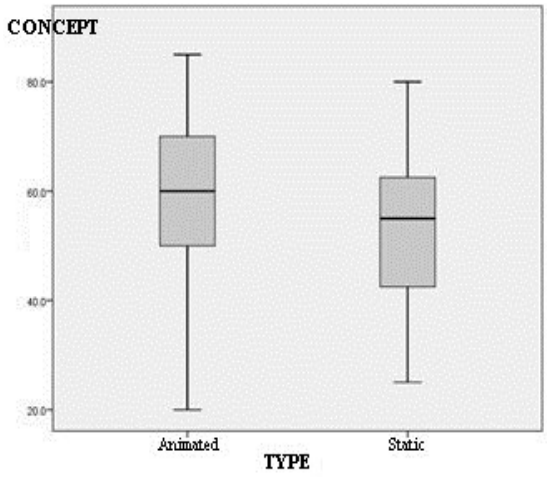

Figure 3a.
Boxplots Diagram of Concept-Type

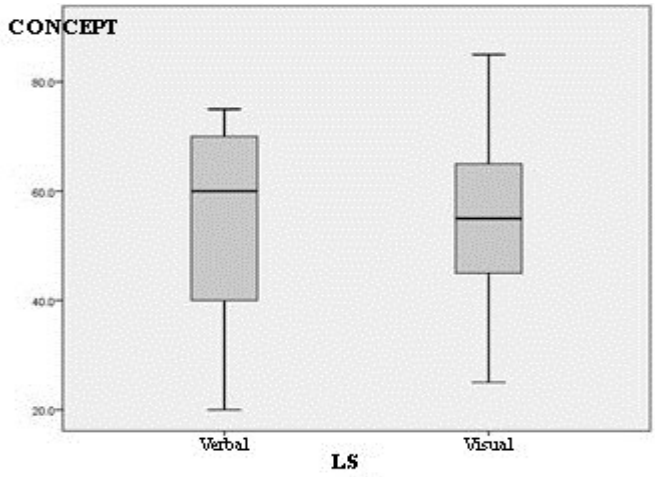

Figure 3b.
Boxplots Diagram of Concept-Learning Style

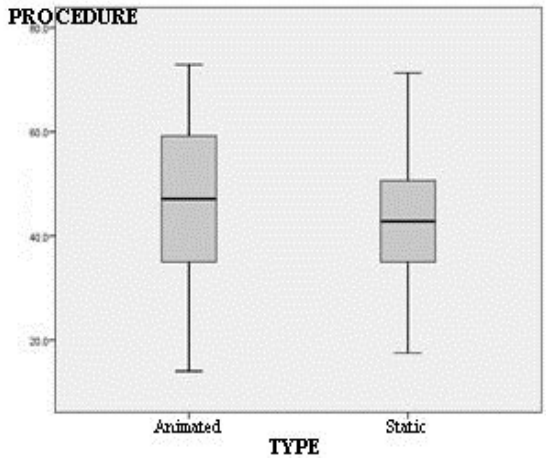

Figure 3c.
Boxplots Diagram of Procedure-Type

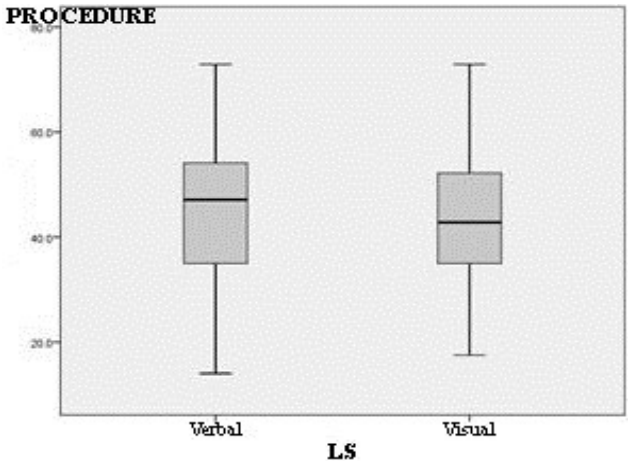

Figure 3d.
Boxplots Diagram of Procedure-Learning Style

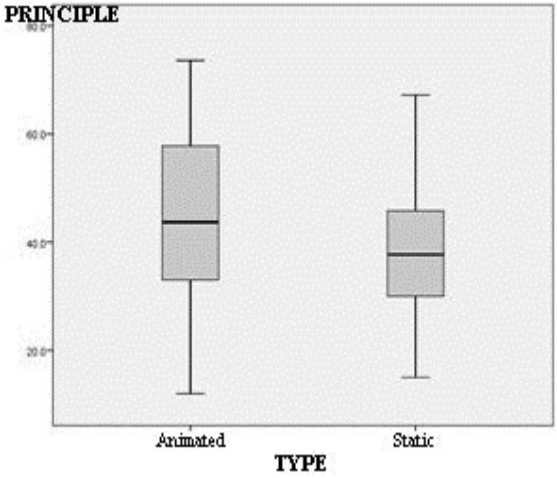

Figure 3e.
Boxplots Diagram of Principle-Type

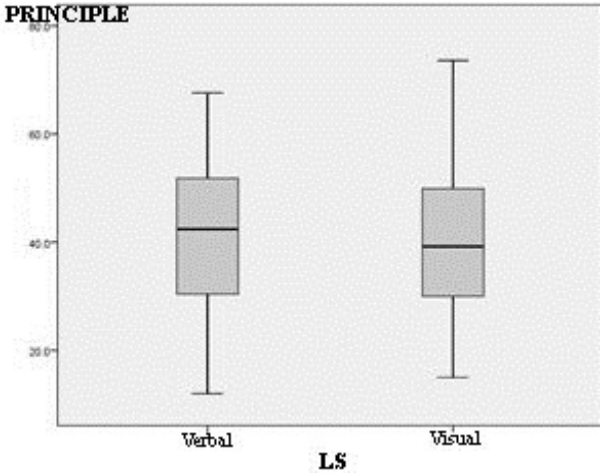

Figure 3f.
Boxplots Diagram of Principle-Learning Style

Analysis Results

Test results/analysis of factor effect of 2 x 2 MANOVA visualization type and learning style against the capability of students in the implementation of the concepts, procedures, and principles of Java programming listed as table 6 & 7.

Based on test results/analysis in table 6 (multivariate test), it can be concluded as follows:

1) **There was a real influence on the type of visualization (animated vs static) against the students' capability in applying the concepts, procedures, and principles of Java programming,**
2) **There was a real influence on the different learning styles (visual vs. verbal) against the students' capability in applying the concepts, procedures, and principles of Java programming,**
3) **There was no real influence on the interaction between the factors of visualization type and learning styles.**

Table 6. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.
TYPE	Pillai's Trace	0.054	2.501	3	132	0.062 ^{s}
	Wilks' Lambda	0.946	2.501	3	132	0.062 ^{s}
	Hotelling's Trace	0.057	2.501	3	132	0.062 ^{s}
	Roy's Largest Root	0.057	2.501	3	132	0.062 ^{s}
LS	Pillai's Trace	0.050	2.298	3	132	0.080 ^{s}
	Wilks' Lambda	0.950	2.298	3	132	0.080 ^{s}
	Hotelling's Trace	0.052	2.298	3	132	0.080 ^{s}
	Roy's Largest Root	0.052	2.298	3	132	0.080 ^{s}
TYPE*LS	Pillai's Trace	0.009	0.391	3	132	0.760 ^{ns}
	Wilks' Lambda	0.991	0.391	3	132	0.760 ^{ns}
	Hotelling's Trace	0.009	0.391	3	132	0.760 ^{ns}
	Roy's Largest Root	0.009	0.391	3	132	0.760 ^{ns}

Notes: TYPE = Visualization Type (Animated VS Static); LS = Learning Style (Visual VS Verbal)
TYPE * LS = Interaction of Visualization Type and Learning Style Factor
S = Significant; NS = Not Significant; α = 0.1

Table 7. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	KONSEP	422533.374	4	105633.344	494.638	0.000
	PROSEDUR	275658.646	4	68914.661	352.605	0.000
	PRINSIP	235635.909	4	58908.977	291.878	0.000
TYPE	KONSEP	1353.774	1	1353.774	6.339	0.013 ^{s}
	PROSEDUR	1312.027	1	1312.027	6.713	0.011 ^{s}
	PRINSIP	1508.464	1	1508.464	7.474	0.007 ^{s}
LS	KONSEP	106.059	1	106.059	0.497	0.482 ^{ns}
	PROSEDUR	6.470	1	6.470	0.033	0.856 ^{ns}
	PRINSIP	101.264	1	101.264	0.502	0.480 ^{ns}
TYPE * LS	KONSEP	117.512	1	117.512	0.550	0.460 ^{ns}
	PROSEDUR	75.887	1	75.887	0.388	0.534 ^{ns}
	PRINSIP	127.395	1	127.395	0.631	0.428 ^{ns}
Error	KONSEP	28616.626	134	213.557		
	PROSEDUR	26189.514	134	195.444		
	PRINSIP	27044.851	134	201.827		
Total	KONSEP	451150.000	138			
	PROSEDUR	301848.160	138			
	PRINSIP	262680.760	138			

Note: S = Significant; NS = Not Significant; α = 0.05

Based on test results in table 7 (univariate tests), it can be concluded as follows:

1) **against the students' capability in applying the concepts of Java programming: there was a real influence on the type of visualization (animated vs static); there was no real influence on the different learning styles (visual vs verbal); There was no real influence on the interaction between the factors of visualization type and learning styles,**
2) **against the students' capability in applying the procedures of Java programming: there was a real influence on the type of visualization (animated vs. static); there was no real influence on the different learning styles (visual vs. verbal); there was no real influence on the interaction between the factors of visualization type and learning styles,**

3) against the students' capability in applying the principle of Java programming: there was a real influence on the type of visualization (animated vs. static); there was no real influence on the different learning style (visual vs. verbal); there was no real influence on the interaction between the factors of visualization type and learning styles.

DISCUSSIONS

The Effect of the Visualization Type (Static vs Animated)

Based on the description of test results/research analysis in table 6 (α = 0.10) and table 7 (α = 0.05), the conclusion that there was a real influence on the presentation type visualization (static vs animated)—on Multimedia Learning—against the students' capability in applying the concepts, procedures, and principles of Java programming. The results were aligned with the results of previous studies conducted by Lin & Dwyer (2010), Pass et al. (2007), and Rusli et al. (2013). They stated that multimedia learning with animated visualization more effective than presentation with static visualization associated with its capability to enhance students' learning outcomes.

In this study, the advantages of multimedia learning with animated visualization (with learner controlled) than static visualization could occur because of the existence of the animation (pointer animation) on the multimedia lesson that followed/accommodated principles guide the presentation of information in multimedia formats—animation (Clark & Mayer, 2008), especially regarding the principle of multimedia, modality, contiguity and the principle of segmentation. Those principles applied to manage the cognitive load of leaner during the learning process. It is related to the limited capacity of working memory and remote memory in cognitive theories of learning with multimedia (Clark & Mayer, 2008).

The Effect of Learning Styles (Visual vs Verbal)

Based on the description of test results/research analysis in table 6 (α = 0.10), the conclusion that the factors of learning style (visual vs verbal) in multimedia computer-based learning, provided a real influence on the students' capability in applying the concepts, procedures, and principles of Java programming (although there was no real influence in table 7). It showed that there were significant differences over the capability of students' learning results in applying the concepts (as a subordinate procedures), procedures (as subordinate principles), and principles of Java programming in multimedia computer-based learning between groups of students that have a visual learning style and verbal learning style.

The precence of the influence of the students' learning styles against the learning result, it could be due to unsuccessful in accommodating the balance of the appearance between images/tables/diagrams/symbols and text/voice narration in multimedia lesson.

The Effect of the Interaction between the Factors of Visualization Type and Learning Styles

Based on the description of test results/research analysis in tables 6 and 7, the conclusion that the interaction between the factors of visualization type and learning styles, provided no real influence on the students' capability in applying the concepts, procedures, and principles of Java programming. Therefore, the conclusions drawn as a result of the analysis over these two factors (related to [1] and [2]), it can be stated explicitly. The results were aligned with the results of previous studies conducted by McCann (2006), and Rusli et al. (2013).

CONCLUSION

The animation in multimedia interactive learning gave a positive effect in improving students' learning outcomes, particularly in applying the concepts, procedures, and principles of Java programming. The differences of students' learning style—visual or verbal, in multimedia interactive learning can gave the different effects in students'

learning results acquisition, particularly in applying the concepts, procedures, and principles of Java programming. There was no interaction effects between the factors of visualization type and learning styles in obtaining the students' learning results.

The importance of the application of animation in learning through interactive multimedia, in particular on the content of principle type.

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BIODATA and CONTACT ADDRESSES of AUTHORS

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