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EFFECTS OF SEGMENTED ANIMATION ON THE LEARNING PERFORMANCE

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Abstract

The aim of this research was to study the effectiveness of segmented animation on the learning performance of students with different visualization ability. Segmented-animation and continues-animation showing cellular signal transmission process were developed for the research purpose. This quasi-experimental study utilized 2x2 factorial design with the independent variables were segmented-animation and continuous-animation. The dependant variable refers to the post-test. Meanwhile, the moderator variables were students' visualization ability whether high or low which was measured using the SVAT test. The research sample consists of 124 Diploma in Education students enrolled in Technology and Innovation in Education course. The data was analyzed by using T-test and Univariate ANOVA. In general, the research finding shows that the segmented-animation was better than continuous-animation in enhancing students' learning performance. Segmented animation was also better in assisting students with low visualization ability in developing perfect mental model of the process implied by the animation. However students with high visualization ability seems benefited from both strategy.

Keywords: segmented-animation, continuous-animation, visualization, mental model

Introduction

Utilization of animation has been a key component of the instructional courseware design nowadays. New advances in software technology had allowed the development of new means in conveying information in animation form. In its best uses, animation presents information in a more interesting and easier to understood and remembered way than static media (Rieber, 1990). Animation is good in indicating process and movement, illustrating changes over time, visualizing three-dimensional objects and attracting attention. Animation is a form of presentation that will simplify complex process and therefore made it easier to understood (Norton & Sprague, 2001). Animation also has strong theoretical foundation towards effective learning (Mayer, 2001). However, even with these advantages and theoretical support, research finding related to the effectiveness of the animation in instructional courseware remains inconsistent (Lin & Dwyer, 2004 ; Aminordin & Fong, 2004). The main reason of inconsistency maybe resulted by improper presentation design of animation (Liu, Jones & Hemstreet, 1998). Improper design may increase the cognitive load of the learners throughout the learning process (Sweller 1994, 1988). This situation will under some condition impede learning.

Animation and Cognition

Mayer's Cognitive Theory (Mayer, 2001) explained that information processed in human memory through two channels, namely verbal channel and visual channel and through three cognitive processes. The first cognitive process is, selecting verbal information to be processed in verbal working memory and selecting visual information to be processed in visual working memory. The second cognitive process is, organizing the selected verbal information into verbal mental model and organizing the selected visual information into visual mental model. The final process is, integrating the verbal mental model and visual mental model developed with prior knowledge to be stored in long-term memory.

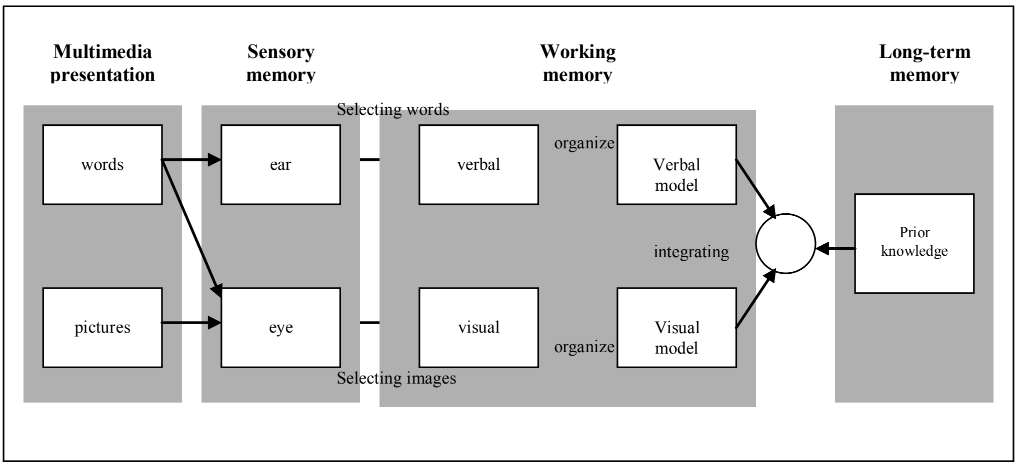

Figure 1:
Mayer's model of memory
(source : Mayer, 2001)

Sweller's Cognitive Load Theory (Sweller, 1994) describes learning structures in term of information processing system involving long-term memory which effectively stores all the information gained on more-or-less permanent basis. Information may only be stored in long-term memory after first being attended to and processed by working memory. Working memory however is extremely limited in both capacity and duration. This limitation will impede learning under some condition. Cognitive Load Theory assumes that information should be structured to eliminate any avoidable load on working memory in order to enhance learning. Quality of instructional design will be raised if greater consideration is given to the role and limitation of this working memory.

User-controllable Animation

Among the reason for failure of animation in assisting learning is, designs that do not provide appropriate time for the learners to focus their attention on the information being presented (Torres & Dwyer, 1991). Segmented animation with features that allow learners to control the segment viewing rather than passively view the whole animation may be a solution for this problem (Ahmad Zamzuri, 2007). Segmented animation with user-controllable navigation will allow appropriate exposure duration on animation that will help learners in interpreting and understanding the animation better (Ahmad Zamzuri, 2007; Fong, 2001).

Visualization Ability

Visualization ability is one competency of visual literacy, the ability to understand and communicate using visual images (Casey & Wolf, 1989). Visualization is a factor in scientific understanding (Earnshaw & Wiseman, 1992). In implying dynamic process, application of dynamic display techniques such as animation have been realized as a potential tool for assisting students in developing their visualization skills (Wiebe, 1991). Furthermore, research findings also indicate that visualization on computers has improved students' learning (Hsieh & Cifientes, 2006). Therefore, this research will investigate the effectiveness of computer displayed animation in assisting students with different visualization ability in developing perfect mental model of the information presented by animation.

Method

Research Objective

Based on the discussion above, the main objective of this research was to study the effectiveness of segmented user-controllable animation on students with high and low visualization ability.

Material

Two different presentation's mode courseware was developed. The first is segmented user-controllable animation mode courseware (figure 2), which consist animation that was chunked into segments and the users could view the segments in sequence using the control button provided. The second is continuous user-controllable animation mode courseware (figure 3), which consist animation that will be viewed continuously when the user clicked the start button. Both user-controllable animation modes will display the same animation that was an animation that shows cellular signal transmission process.

Figure 2:
Segmented user-controlled animation mode courseware

Figure 3:
Continuous user-controlled animation mode courseware

Procedure
This quasi-experimental study utilized a 2x2 factorial design method (table 1) to investigate the effects of different animation presentation mode on students with different visualization ability. The independent variables were the segmented-animation and continues-animation. The dependent variable refers to post-test. Meanwhile, the moderator variables refer to the students' visualization ability whether high or low. The research samples consist of 124 Diploma in Education students enrolled in Technology and Innovation in Education course (table 2).

Table 1:
2x2 factorial design

	Segmented	**Continues**
High	SEG_{high}	CON_{high}
Low	SEG_{low}	CON_{low}

Instruments

Pre-test and Post-test design was employed on two intact classes that viewed two different animation strategies respectively. The visualization ability level was determined through SVAT test instrument. The validity of the SVAT's tasks as measures of spatial visualization ability has been established by research studies (Maizam, Black & Gray, 2002). A week before the commencement of the study, SVAT test was conducted. During the actual study, pre-test was conducted first before the students view the respective animation mode. Post-test was conducted immediately after the animation viewing. T-test and Univariate ANOVA was employed to analyze the data collected statistically.

Table 2:
Statistic of research samples

Mode	**Visualization**	**N**
Segmented	High	25
	Low	39
	Total	64
Continues	High	34
	Low	26
	Total	60
Total	High	59
	Low	65
	Total	124

Results

Consistency of prior knowledge was examined from the pre-test result. From the Independent-Samples T-test (table 4), Levene's test has a probability greater than 0.05 ($p>0.05$) which indicates the population variances are relatively equal. Therefore t-value, df and two-tail significance can be used. The two-tail significance indicates that $t(122)=1.634$, $p > 0.05$ and therefore there was no significant differences between the two group. This result assured there was no pre-existing difference in prior knowledge by group. Mean scores of prior knowledge were also obviously low for students in segmented-animation mode ($M=13.64$, $SD=9.429$) and students in continues-animation mode ($M=16.50$, $SD=10.055$) which was necessary for the study (table 3).

Table 3:
Group statistics of pre-test

Mode	N	Mean	Std. Deviation	Std. Error Mean
Segmented	64	13.64	9.429	1.179
Continues	60	16.50	10.055	1.298

Table 4:
Independent-Samples T-test of pre-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pre	Equal variances assumed	.456	.501	-1.634	122	.105	-2.859	1.750	-6.323	.604
	Equal variances not assumed			-1.631	119.999	.106	-2.859	1.753	-6.331	.612

To examine whether there was any significant difference in the learning performance of students relative to segmented-animation mode and continues-animation mode, Univariate ANOVA was employed on post-test result. Levene's test for homogeneity of variances was not significant ($p>0.05$) and therefore the population variances for each group were approximately equal (table 6). The output shows there was significant difference in the cognitive performance of students relative to segmented-animation mode and continues-animation mode $F(1,119)=15.772$, $p<0.05$ (table 7). Mean scores (table 5) shows that students in segmented-animation mode (M=60.78, SD=16.932) obtains better score than students in continues-animation mode (M=50.00, SD=17.660).

Table 5:
Descriptive statistics of post-test

Mode	Visualization	Mean	Std. Deviation	N
Segmented	Average	60.80	17.776	25
	Low	60.77	16.604	39
	Total	60.78	16.932	64
Continues	Average	53.53	19.677	34
	Low	45.38	13.633	26
	Total	50.00	17.660	60
Total	Average	56.61	19.083	59
	Low	54.62	17.146	65
	Total	55.56	18.047	124

Table 6:
Levene's test of equality of error variances

Dependent Variable:Post

F	df1	df2	Sig.
2.282	3	120	.083

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Pre + Mode + Visualization + Mode * Visualization

Table 7:
Univariate ANOVA of post-test

Dependent Variable:Post

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	6125.017[a]	4	1531.254	5.370	.001	.153	21.478	.969
Intercept	88660.821	1	88660.821	310.903	.000	.723	310.903	1.000
Pre	1548.081	1	1548.081	5.429	.021	.044	5.429	.637
Mode	4497.781	1	4497.781	15.772	.000	.117	15.772	.976
Visualization	443.466	1	443.466	1.555	.215	.013	1.555	.236
Mode * Visualization	276.467	1	276.467	.969	.327	.008	.969	.164
Error	33935.467	119	285.172					
Total	422900.000	124						
Corrected Total	40060.484	123						

a. R Squared = .153 (Adjusted R Squared = .124)

b. Computed using alpha = .05

To examine whether there was any significant difference in the cognitive performance of students with high visualization ability relative to segmented-animation mode and continues-animation mode, Independent-Samples T-test was employed on post-test result of students with high visualization. Levene's test shows $p>0.05$ which indicates the population variance were relatively equal. The two-tail significance indicates that $t(57)=1.460$, $p>0.05$ and therefore there was no significant difference between the two group (table 9). However mean score (table 8) of post-test for students with high visualization ability shows that students in segmented-animation mode (M=60.80, SD=17.776) obtained slightly better mean score than students in continues-animation mode (M=53.53, SD=19.677).

Table 8:
Group statistics of high visualization students' post-test

Mode	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Segmented	25	60.80	17.776	3.555
Continues	34	53.53	19.677	3.374

Table 9:
Independent-Samples T-test of high visualization students' post test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Post	Equal variances assumed	.762	.386	1.460	57	.150	7.271	4.979	-2.700	17.242
	Equal variances not assumed			1.483	54.533	.144	7.271	4.902	-2.555	17.096

To examine whether there was any significant difference in the cognitive performance of students with low visualization ability relative to segmented-animation mode and continues-animation mode, Independent-Samples T-test was employed on post-test result of students with low visualization. Levene's test shows $p>0.05$ which indicates the population variance were relatively equal. The two-tail significance indicates that $t(63)=3.922$, $p<0.05$ and therefore there was significant difference between the two group (table 11). Mean score (table 10) shows that students with low visualization ability in segmented-animation mode ($M=60.77$, $SD=16.604$) obtained better score than students in continues-animation mode ($M=45.38$, $SD=13.633$).

Table 10:
Group statistics of low visualization students' post-test

Mode	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Segmented	39	60.77	16.604	2.659
Continues	26	45.38	13.633	2.674

Table 11:
Independent-Samples T-test of low visualization students' post test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Post	Equal variances assumed	2.747	.102	3.922	63	.000	15.385	3.923	7.546	٢٣,٢٢٤
	Equal variances not assumed			4.080	60.179	.000	15.385	3.771	7.843	٢٢,٩٢٦

Finally, to examine whether there was any significant cognitive performance interaction between high visualization and low visualization students in segmented-animation mode and continues-animation mode, Univariate ANOVA was employed (table 7). The output shows that there was no significant interaction for mode*visualization F(1,119)=0.969, p>0.05. This suggests that students with different visualization ability could not affected by the mode of presentation applied in animation. From the graph plotted (figure 4), shows that segmented-animation mode students obtained better mean score than students in continues-animation mode. Students with low visualization ability in segmented-animation mode gained better mean score than low visualization ability students in continues-animation mode. However, there is no significant difference for students with high visualization ability in segmented-animation mode and continues-animation mode.

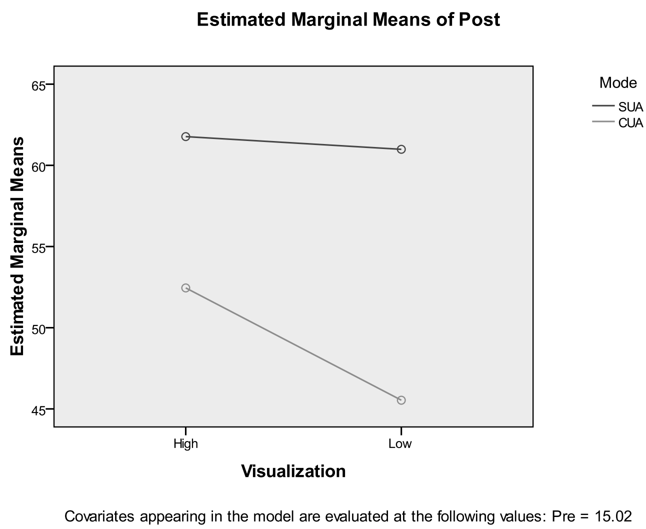

Figure 4:
Interaction between mode and visualization ability

Discussion

The purpose of this research was to study the effects of two animation presentation strategy on students with different visualization ability's learning performance. Overall, the research finding shows that students in segmented-animation mode performed better than students in continues-animation mode. This finding was similar to Ahmad Zamzuri (2007) and Fong (2001). Therefore, this indicates animation that is chunked into segments and allowing students to view these segments in sequence provides ample time for them to extract the information from it to be processed and stored in memory structure. Thus, this method has a potential role in reducing cognitive overload throughout the learning process. Segmented user-controllable animation is also a perfect strategy in assisting students with low visualization ability in developing a better mental model of the process implied by the animation in their memory structure. However, students with high visualization ability seem to be able to develop a perfect mental model of the process implied by the animation in both continuously or segmented user-controllable animation.

Conclusion

To maximize the effectiveness of animation, the instructional designer should ground their design based on the research findings and theories. They should not base their design on their own preferences that may or may not work well. Thus, this research finding suggested segmented user-controllable strategy in displaying animation have advantage in minimizing cognitive overload and improving students' cognitive performance especially for students without prior knowledge of the content and even students with low visualization ability. These findings are expected to be guideline for instructional courseware developers in getting full benefit out of the animation in the instructional courseware.

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