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Procedia - Social and Behavioral Sciences 46 (2012) 5666 – 5671

Procedia
Social and Behavioral Sciences

WCES 2012

Effectiveness of visual animation-narration presentation on student's achievement in the learning of meiosis

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Abstract

The effects of an Animation-Narration (AN) and Animation-Narration-Text (ANT) visual presentation was examined on 250 Matriculation students' achievement in the learning of Meiosis. This quasi-experimental study employed a 2 x 2 factorial design with the presentation mode as the independent variable, students' achievement score as dependent variable, and students' spatial intelligence level (high spatial intelligence, HSI or low spatial intelligence, LSI) as the moderator variable. The finding shows students in the AN group obtained a significantly higher achievement level compared to the ANT group. However, there was a significant difference between the achievement of students' with HSI and LSI after following the two presentation modes. This study implies that the AN presentation enhance learning task that involves abstract concepts and complex processes. Therefore, AN visual can be used to help students' learning, especially for those with LSI who have difficulties in constructing intrinsic visualization without the interference of text that will increase their cognitive load.

Keywords: Visual presentation, Animation-Narration, Animation-Narration-Text, High-Low Spatial Intelligence

1. Introduction

Malaysia is moving towards realizing her vision to be a progressive and fully developed country by year 2020. One of the challenges of Vision 2020 is "to establish a scientific and progressive society that is innovative and forward-looking, one that is not only a consumer of technology but also a contributor to the scientific and technological civilization of the future" (Information Department of Malaysia, 1997). As such, multimedia was introduced as one of the delivery systems in schools to emphasize the science and technology thrust.

With the advent of the knowledge-economy (*k*-economy) and globalization, an effective instructional design is pivotal. Computer technology such as computer-based education, interactive videos, simulations, intelligent tutors, and the Internet help reform science education and may provide alternatives to instructional strategies. Since Malaysia is committed to developing and providing world-class educational systems, an effective instructional medium, with the incorporation of an appropriate learning environment in various fields, is needed.

Therefore, this study intends to design and develop a multimedia visual presentation to solve the learning difficulties in biology. The Meiosis concept is the fundamental concept in Genetic Inheritance that poses understanding difficulties among students and has been identified as a difficult concept in biology (Kindfield, 1994; Kleinsmith, 1987; Fong, 2000).

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1877-0428 doi:10.1016/j.sbspro.2012.06.493

2. Statement of the Problem

Biology education delivers a truly broad scope and an integral position of biology, not only among the sciences but also in our daily life and activities in general. Fong (2000), Kindfield (1994), and Kleinsmith (1987) reported that biology is an abstract and a formal subject and thus, it often results in learning difficulties of students. In Malaysia, a report by the Malaysian Board of Examination on the performance of the 1996 Malaysian Certificate of Education Examination (*Sijil Pelajaran Malaysia*, SPM) concluded that the topic Cell Division is the basic in Biology that needs to be emphasised (*Lembaga Peperiksaan Malaysia*, 1996). The Meiosis concept is the main concept that is taught in the topic of Cell Division. A question that tested students' understanding about the change of homologous chromosome in meiosis shows that 51% of the total candidate did not understand that the homologous chromosome can carry different genetic information. From the report, the weakness of the students were that they lack the understanding of the dynamic process of crossing over, formation of chiasma in meiosis, that contribute to the exchange of genetic material between maternal and paternal chromosome occurring. Besides, Fong (2000) reported that approximately more than 42% SPM 1996 Biology candidates failed to identify the stages involved in the separation of chromatid. The weakness of these Form 5 students will affect the prior knowledge upon entering the Matriculation program. Therefore, the teaching and learning of biology in the Matriculation level should be improvised to enhance the understanding of the meiosis concept as it is the foundation in biology. Thus, the instruction that was designed for this study tends to elevate these students to the formal operations level that promotes hypothetical-deductive reasoning, scientific-inductive reasoning and reflective abstraction as proposed by Piaget (1970).

The objectives of this research were:

a) To investigate the effect of the Animation Narration (AN) modes compared to the Animation Narration Text (ANT) modes in learning of "Meiosis" on students' achievement score (as will be measured by the pre-test and post-test).

b) To investigate the effects of the AN modes compared to the ANT modes in the learning of "Meiosis" between the high spatial intelligence and low spatial intelligence students.

3. Literature Review

3.1. Relationship between Modes of Animation-Narration and Animation-Narration-Text

Clark and Mayer (2003) recommended the redundancy principle, the use of animation and narration rather than animation with onscreen text to describe the graphic that is evident to produce significant learning gains. The rationale for this recommendation is that learners may experience on overload of their visual/pictorial channel when they simultaneously process graphics and the printed words that refer to them. Since the crucial initial step in multimedia learning is to attend to relevant words and pictures, visual presentation should be designed to minimize the chances of overlapping the learners' visual/pictorial channel.

According to the cognitive theory of learning, people have separate information processing channels for visual/pictorial and for auditory/verbal processing (Figure 1). When the learners face concurrent graphics onscreen text, both will be processed initially in the visual/pictorial channel. Since the capacity of the each channel is limited, both must compete for the same limited visual attention. In contrast, when the verbal explanation is in speech form, it enters the cognitive system through the ears and is processed via the auditory/verbal channel only. Simultaneously, the graphics enter the cognitive system through the eyes and are processed in the visual/pictorial channel. Thus, neither channel is overloaded. But both words and pictures are processed.

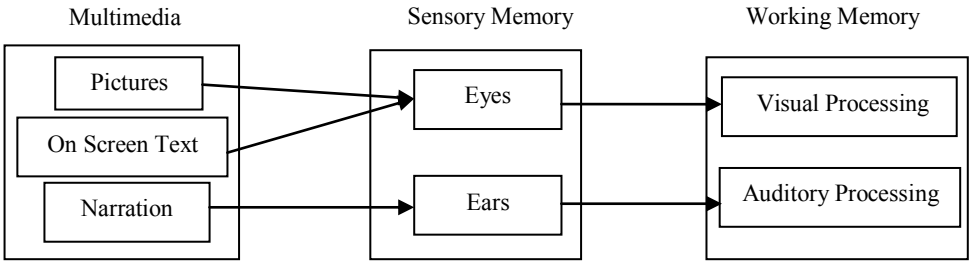

Figure 1. Access of Visual and Auditory Channels with Presentation of Narration and Graphics (Clark & Mayer, 2003)

3.2. Spatial Intelligence Differences

Several investigators have suggested that visual animation presentation in education may provide their greatest potential for disadvantaged students, those of low spatial intelligence and concrete operational students (Kong, 2006). The low intelligent students were unable to comprehend three-dimensional images and shapes. They cannot interpret the dimensions of space that cannot be seen. Therefore, they need guidance and well-structured learning environments. Meanwhile the high spatial intelligence students have the ability to comprehend three-dimensional images and shapes. They can interpret dimensions of space that cannot be seen. Thus, they can interpret and have high sensitivity toward any visual details given.

4. Methodology

Quasi-experimental was employed in this study since intact classes were assigned to receive specific treatments. The advantage of using the intact group is to avoid and minimize any disorder or any possible effects from reactive arrangements (Gay & Airasian, 2003). The study employed a 2 x 2 factorial design with repeated measures of the moderator variable.

The independent, dependent, and moderator variables were used in the study. The independent variables are the multimedia presentation employed to teach Meiosis. The two instruction methods were the AN and ANT. The dependent variable was the achievement score. The subjects of the study were divided into groups based on two levels of spatial ability. The low or high spatial intelligence students were determined using the differential aptitude test (Bennet et al., 1972, translated by Toh, 1998). Students scoring below the group mean in the test were considered low spatial intelligence while scoring above the group mean were considered high spatial intelligence.

The experimental group was given the AN and the control group was administered the ANT whereby both groups were given a pre-test before the treatments. At the end of the study, both groups took the post-test. The difference between the pre-test and the post-test scores was compared to determine the effectiveness of the treatments. The pre-test and post-test measures were the achievement score for the topic on Meiosis. It was further designed to investigate the effects of the independent variables on the dependent variable at each of the two levels of the moderator variable.

The multimedia presentation was designed based on the instructional systems design by Alessi and Trollip (2001), the nine conditions of learning by Gagne (1985), and Mayer's Cognitive Theory of Multimedia Learning (2001). It was based on the first chapter of the Matriculation Biology syllabus (*Huraian Sukatan Pelajaran Biologi Matrikulasi*, 2003) designed by the Malaysian Ministry of Education for all Biology science stream students in Matriculation level. The curriculum specifications show that the chapter was divided into five sub-topics, namely (1) Terminologies in Meiosis, (2) Stages of Meiosis I & II, (3) Events in Meiosis I and II, (4) Importance of Meiosis, and (5) Comparison between Mitosis and Meiosis.

4.1. Sample

The sample of this study consists of Matriculation Biology students from a Matriculation College in the northern area of Malaysia. Their ages ranged from 18 to 19 years old. A total of 250 Matriculation Biology students

participated in the research. One hundred and twenty-six students were assigned in the experimental group and 124 were in control group. Among them, 66 high spatial intelligence and 60 low spatial intelligence used the AN while 63 high spatial intelligence and 61 low spatial intelligence students followed the ANT presentation.

4.2. Instrument

The first instrument was the pre-test and post-test to measure the achievement scores in the Meiosis sub topic. It consists of objective questions and structural questions. The second instrument is 'The Differential Aptitude Test' which measures the spatial intelligence of the students that was developed by Bennet et al. (1972) and translated to the Malay Language by Toh (1998). It has 30 two-dimensional patterns that can be folded into three-dimensional objects. The reliability of this instrument is 0.91 (Bennet et., 1972).

4.3. Research Process

The subjects of the study were given the pre-test and the Differential Aptitude Test before the treatment. Then the subjects were divided into the experimental and control groups. Both the experimental and control group were taught by separate facilitators by using the AN and ANT multimedia presentations for the respective groups. The subjects were exposed to the biology lesson twice for duration of 40 minutes each. The biology lecturers acted as facilitators for the whole session. They handled the technical setting and did not interrupt or gave any information about the content to the student throughout the treatment given. Both the experimental and control groups underwent the post-test after the treatment.

Descriptive and inferential statistics were used to gather the information. Data was analysed using Statistical Packages for the Social Sciences software at a level of significance of 0.05 ($p<0.05$). Descriptive statistics for the pre-test and post-test were then collected. First, the descriptive statistics were computed for the high-low spatial intelligence of students using the AN and ANT approach. Then, the achievement score and motivation score were analyzed using an analysis of variance (ANOVA) to determine whether there was a significant difference between the two means. The two-way analysis of variance (ANOVA) was used to obtain the interaction between the independent variable (AN and ANT) and the moderator variables (spatial intelligence levels).

5. Results

5.1. Descriptive Statistics of the Variables

Table 1 shows the distribution of sample frequencies, mean of achievement score and the standard deviations of the pre-test and post-test scores.

Table 1. Mean Scores and Standard Deviations of Achievement Score for Independent and Moderator Variables

Spatial Intelligence Levels		Modes Presentation				Total	
		AN		ANT			
		Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
High Spatial Intelligence	N	66	66	63	63	129	129
	M	9.10	16.83	9.51	16.68	9.31	16.76
	SD	2.05	1.64	2.01	1.401	2.03	1.88
Low Spatial Intelligence	N	60	60	61	61	121	121
	M	9.88	19.01	9.19	13.16	9.54	16.09
	SD	1.60	1.37	1.75	1.63	1.68	1.45
Total	N	126	126	124	124	250	250
	M	9.49	17.92	9.35	14.92	942	15.66
	SD	1.83	1.50	1.88	1.52	1.85	1.92

The findings showed the achievement mean score for students who used the AN mode (8.43) was higher than the achievement mean score for the students using ANT mode (mean= 5.57). The increment score is 2.86 or 33.91%. Meanwhile, LSI students that used the AN mode gets the highest increment score of 9.13 (48.01%) while for LSI students using ANT mode gets a lower increment score (3.97 or 30.17%). Table 1 also reveals that the post-test achievement score for both multimedia presentation modes is 5.85 or 30.77%. This percentage difference indicates that the LSI students using AN performed higher than the LSI students using the ANT mode. On the other hand, achievement scores for HSI students using the AN mode is 7.73 (45.94%) while HSI students using ANT mode is 7.17 (42.99%). It shows a difference in achievement of only 0.15 (1.94%) whereas this percentage indicates there is no true increment for HSI students using the AN or ANT modes.

5.2. Inferential Statistics

Sample t-test and two-way ANOVA were conducted for the Pre-test and achievement score. The level of significance was set at 0.05 ($p<0.05$). Comparison between the mean score for Pre-test between Modes of Presentation and Spatial Intelligence Level are shown in Table 2.

Table 2 showed that there is no significant difference between the achievement score for Pre-test between the two modes of presentations ($t=0.51$, $p=0.61$) and for the spatial intelligence levels ($t=-0.98$, $p=0.33$). This indicates both samples are the same levels in terms of their prior knowledge in the meiosis topics. Any achievement changes that occur were due to the intervention that the researcher did.

Overall findings indicate that LSI students performed significantly better than the HSI students who used the multimedia presentation. AN modes presentation was beneficial to both spatial intelligence levels especially the LSI students (Table 3, Table 4 and Table 5).

Table 2. T-test Result for Pre-test Achievement Score

		N	M	SD	t-value	df	*P*
Presentation Modes	AN	126	9.43	1.89	.51	248	.61
	ANT	124	9.35	1.89			
Spatial Intelligence Levels	HSI	129	9.30	2.04	-.98	248	.33
	LSI	121	9.53	1.71			

Table 3. ANOVA of Achievement Mean Score of the Spatial Intelligence Levels on Multimedia Presentation Modes

Source	Sum Square	Df	Min Square	F-Value	*P*
Multimedia Presentation Modes (AN/ANT)	507.39	1	507.39	111.23	.000*
Spatial Intelligence Levels (HSI/LSI)	50.64	1	50.64	11.10	.001*
Multimedia Presentation Modes * Spatial Intelligence Levels	329.73	1	329.75	72.29	.000*

* Significant at $p<0.05$ level

Table 4. T-test results for High Spatial Intelligence Students using the AN and ANT Modes

		N	M	SD	t-Value	df	*P*
Presentation Modes	AN	66	7.73	2.45	1.345	247	.181
	ANT	63	7.17	2.21			

Table 5. T- test results for Low Spatial Intelligence students using the AN and ANT modes

		N	M	SD	t-Value	df	*P*
Presentation Mode	AN	60	9.125	2.031	14.881	119	.00*
	ANT	61	3.975	1.769			

* Significant at $p<0.05$ level

6. Conclusion

The finding shows a positive and significant effect on both visual presentation modes towards the students' achievement. Students in the AN group obtained a significantly higher achievement level compared to the ANT group. There was a significant difference between the achievement of students' with HSI and LSI after following the two presentation modes. Further, the achievement of students with LSI was significantly different after following the two visual presentation modes but was not significant for students with HSI. It is found that the low spatial intelligence students who were presented with AN obtained a higher and significant achievement compared to those presented with ANT. However, the achievement of students with HSI shows no significant difference after following the two modes of presentation. This study implies that the AN presentation enhance learning task that involves abstract concepts and complex processes. Therefore, AN visual can be used to help students' learning, especially for those with LSI who have difficulties in constructing intrinsic visualization without the interference of text that will increase their cognitive load.

Students are expected to deal with a huge volume of information that is changing rapidly. It is imperative to provide them with correct teaching materials so that they can digest and analyze the information as well as synthesize the information in a meaningful manner and in an authentic situation. Therefore, AN visual can be used to help students' learning, especially for those with low spatial intelligence who have difficulties in constructing intrinsic visualization without the interference of text that will increase their cognitive load.

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