EFFECTS OF MULTIPLE SIMULATION PRESENTATION AMONG STUDENTS OF DIFFERENT ANXIETY LEVELS IN THE LEARNING OF PROBABILITY

Soon Fook Fong
School of Educational Studies, Universiti Sains Malaysia, Penang, Malaysia
sffong@usm.my

Fei Ping Por
School of Educational Studies, Universiti Sains Malaysia, Penang, Malaysia

Ai Ling Tang
School of Educational Studies, Universiti Sains Malaysia, Penang, Malaysia

ABSTRACT
The purpose of this study was to investigate the effects of multiple simulation presentation in interactive multimedia courseware on the achievement of students with different levels of anxiety in the learning of Probability. The interactive multimedia courseware was developed in two different modes, which were Multiple Simulation Presentation (MSP) and Single Simulation Presentation (SSP). These presentation modes acted as independent variables, while the dependent variable was the students' mean score of posttest. The moderator variable was the different levels of anxiety. The sample of the study was 70 Form Four Malaysian students from five intact classes. Descriptive statistics and inferential statistics were carried out to analyse the research data. Analyses of Covariance (ANCOVA) were used to study the main effects and the interaction effect of independent variables against the dependent variables. The findings of this study showed that students in SSP mode had achieved significantly higher mean score of posttest than the students in MSP mode. The high anxiety students who were presented with SSP mode had achieved significantly higher mean score of posttest compared to the high anxiety students who were presented with MSP mode. This study implicated that students learn better when corresponding with SSP mode, especially for students with high level of anxiety.

INTRODUCTION
Visual presentation is one of the dominant methods in multimedia. According to Dwyer (1978), visual presentation is effective in teaching facts, concepts and procedures. Rieber (1994) explained that visual designed computer refers to the output of computer, encompassing graphic and text. Mayer (2001) further elaborated that there are two types of visual representations: static and dynamic. Static visual representation presents static illustration relating to the learning contents. Dynamic visual representation, however, is the combination of multiple media, for example, animation, 2D graphic (two dimensions) or 3D graphic (three dimensions), and also video. Selection of appropriate visual representation inevitably facilitates the learning process. However, to what extent does visual representation bring benefits to the learning of Mathematics, particularly for difficult Mathematics topics, such as 'Probability'? Research by delMas (2002) found that problems arise in learning probability when students inadequately developed rational number concepts and proportional reasoning as well as when conceptual conflict occurred between formal probabilistic ideas and everyday experiences.

'Chalk and Talk' is the preferred and convenient teaching method adopted by majority of the teachers to teach 'Probability'. This uncreative method causes the lessons to be boring and subsequently hinders students from further understanding the concept of 'Probability'. In view of this problem, interactive multimedia courseware emerges to promote students' understanding towards 'Probability' and correspondingly improve their performance in Mathematics.

Bruntlett (1998) justified that multimedia enhances the quality time between students and teachers whereby information is delivered in a faster pace with consistent quality. Interactive multimedia courseware captures students' attention, stimulates learning motivation, heightens creativity and encourages critical thinking (Charp, 1996). ChanLin (1999) emphasized that when students learned instructional materials with self-regulated visual presentation shows better achievement compared to systemized learning on the ground that self-regulated learning encourages students to synthesize their visual strategies when interacting and learning happened at the same time.

Gagne's Information Processing Model
According to Gagne's (1985), Information Processing Model proposes teaching with visual support. Gagne's Information Processing Model provides comprehensive description of how the human mind processes information by making analogies based upon the information processing system of a computer. This

Copyright © The Turkish Online Journal of Educational Technology

information processing model also illustrates learning as a series of knowledge transformation in which cognitive process occurs when information is transferred from input to output affected by external stimulus (Gagne, 1985). This model infers that internal structure of human brain and internal cognitive process are following the structure (Gagne, 1985).

This internal human brain structure includes sensory register, short term memory (working memory), long term memory, executive control structure and expectancies structure (refer to Figure 1). Knowledge or information is transferred from perception through the stages of memory (Gagne, Briggs & Wager, 1992).

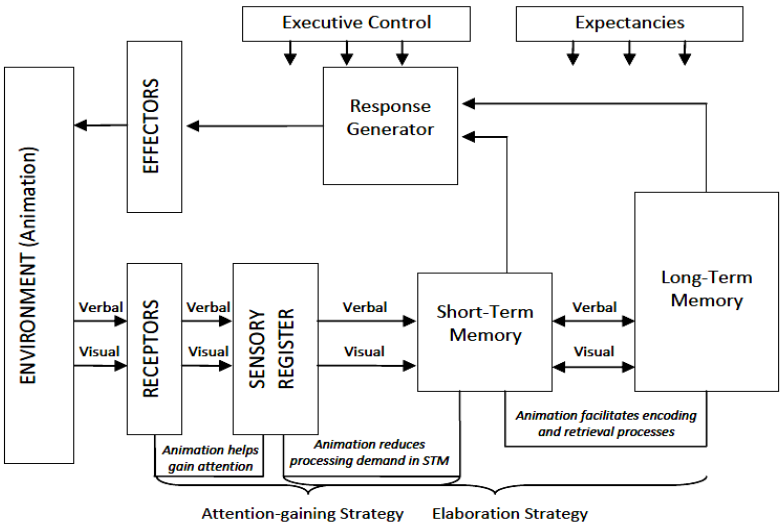

Figure 1: A Model of Animation, Dual-Coding and Information Processing (Gagne, Briggs & Wager, 1992)

Internal cognitive processes are attention, selective perception, semantic encoding, retrieval, response organization, control processes, and expectancies (Gagne, 1985). According to this model, the five senses of human function as receptors to interpret stimulus in the form of a neutral signal and is then sent to sensory register (Gagne, 1974). This information processing system will receive increased burden if all the impulses are accepted and this will weaken the functions of the brain. In view of this, it is noted that only meaningful and relevant input is selected and processed.

Cognitive Theory of Multimedia Learning

The Cognitive Theory of Multimedia Learning by Mayer (2001) accentuates three assumptions which are dual channel theory (Paivio, 1986; Baddeley, 1992), limited human memory capacity (Baddeley, 1992; Chandler & Sweller, 1991), and active learning processing (Mayer, 1999; Wittrock, 1989) as outlined below:

(i) there are two separate channels for visual (pictorial) and auditory (verbal) in terms of information processing system, information sourced from visual and auditory is processed distinctly;
(ii) each channel has a limited capacity in processing the total amount of information at a time;
(iii) information process in respective channels is an active cognitive process of organizing coherent mental representation and integrating information based upon prior knowledge.

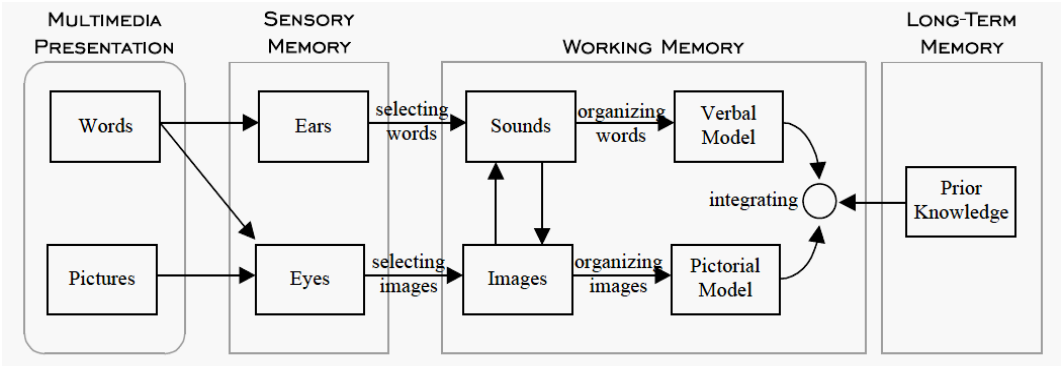

Figure 2: Cognitive Theory of Multimedia Learning (Mayer, 2001)

Words and graphics displayed through multimedia presentation enter the sensory memory through the eyes and ears. Written text and graphics are stored in visual sensory memory, whereas spoken words and sounds are stored in auditory sensory memory. In the figure above, the arrow showed from graphics to eyes relates to the graphics registered in the eyes; on the other hand, the arrow showed from words to ears relates to the spoken words registered in the ears; concurrently, the arrow showed from words to eyes relates to the written text registered in the eyes. All information in sensory memory is processed in the working memory which stores and manipulates knowledge. Working memory will organize the information in the structures of verbal and visual representations and the representations will then be integrated in long term memory.

Mayer (2001) explained that meaningful learning occurs when individual selects relevant information actively, organizes information into systematic representation and then integrates information with prior knowledge.

Interactive Multimedia Courseware

To investigate the effectiveness of using animation visual graphic in teaching and learning probability, this study was conducted by developing two modes of interactive multimedia courseware, namely Multiple Simulation Presentation (MSP) and Single Simulation Presentation (SSP). MSP mode and SSP mode are similar in terms of content, text presentation and graphic presentation. As for the differences, MSP mode displays three different types of presentation simultaneously on the same screen. On the contrary, SSP mode only displays one type of presentation on the screen.

In MSP mode, the presentations of experiment data, stack and bar are displayed simultaneously on one same screen (Figure 3); whereas for the SSP mode, the information is displayed in only one presentation: (i) experiment data (Figure 4); or (ii) stack (Figure 5); or (iii) bar (Figure 6).

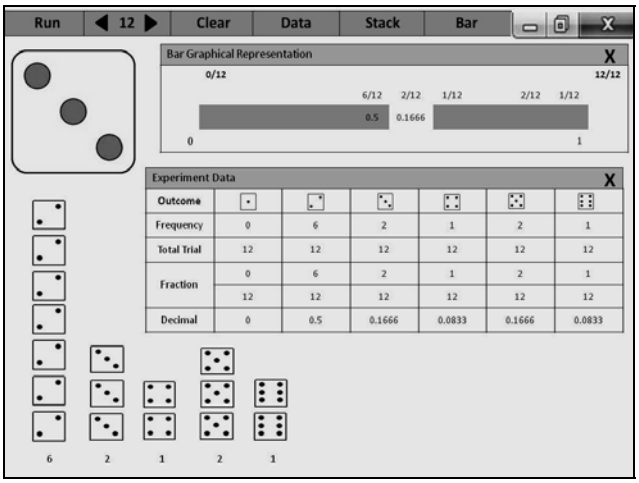

Figure 3: MSP mode

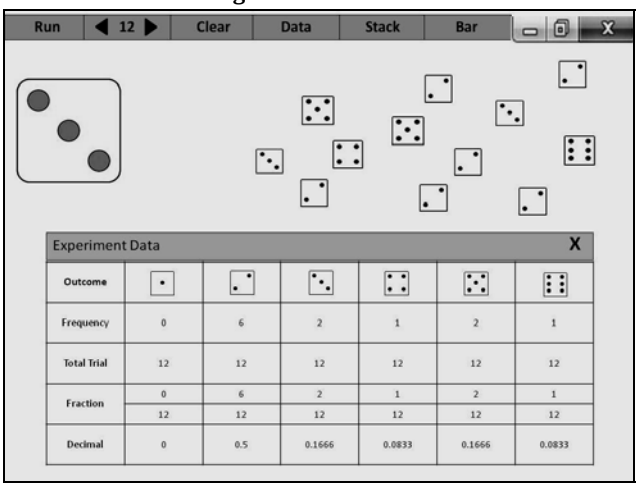

Figure 4: Experiment Data (SSP mode)

Copyright © The Turkish Online Journal of Educational Technology

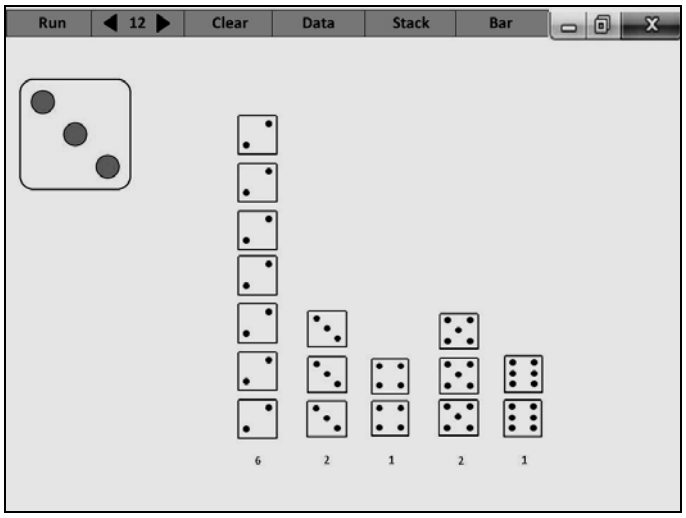

Figure 5: Stack (SSP mode)

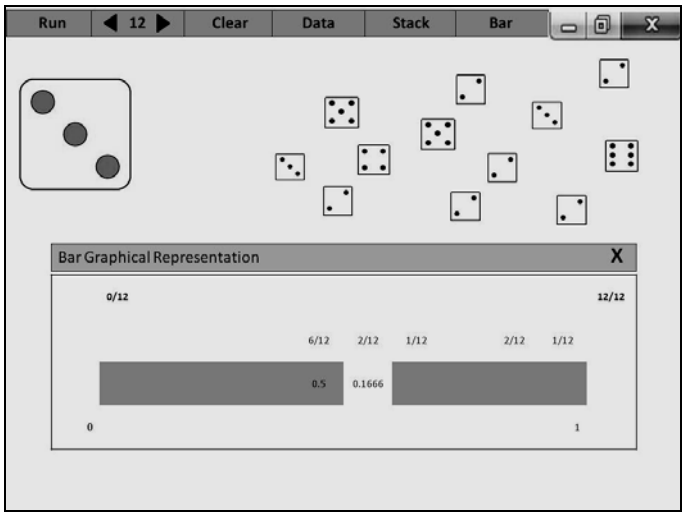

Figure 6: Bar (SSP mode)

Anxiety and Learning

To further enhance the depth of the study, the different levels of anxiety which is considered to influence students' performance was also explored.

Anxiety is a natural physiological response and behavior in consequence of the unpleasant feelings when facing difficult situations or having inabilities to execute task. Spielberger (1966) conceived anxiety as "subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system" (Spielberger, 1966, p.17). This emotional state brings positive and negative effects – effects of motivating and helping as well as effects of disturbing and frustrating cognitive process.

Duffy (1972) posited the inverted U-shaped relationship between anxiety and performance. This relationship explains that performance for a task peaks at the medium level of anxiety. Unfortunately, it is predicted that the low level of anxiety before the optimal level and the high level of anxiety beyond the optimal level will impair performance. The findings of Toh's (1998) research showed that students with high level of anxiety encountered difficulties in processing information and this situation hindered their performance.

Two types of anxiety are recognized by Spielberger, Gorsuch & Lushene (1970), which are State Anxiety and Trait Anxiety. State anxiety refers to temporary anxiety with varying intensities and it changes according to time. The level of state anxiety is usually low except when the subject is aroused with a highly dangerous stimulus. In

Copyright © The Turkish Online Journal of Educational Technology

contrast, trait anxiety refers to individuals with relatively high tendency and frequency of being anxious over a long period. In this study, the term 'anxiety' refers to trait anxiety.

The differences which exist between levels of anxiety and modes of presentation need to be harmonized for promising accomplishment. Thus, this study focused on identifying and matching the modes of graphical presentation with the levels of anxiety.

METHOD

The design and development of the interactive multimedia courseware for the 'Probability' topic was based on the model of Instructional Systems Development proposed by Alessi and Trolip (2001). The screen design was established on Gagne's (1985) Nine Events of Instructional Model, and the visual and verbal presentation was grounded on the principles of Cognitive Theory of Multimedia Learning by Mayer (2001) to ensure the learning process is effective.

Research Design

This research adopted 2x3 factorial quasi-experimental design as illustrated in Figure 7:

	MSP	SSP
HA		
MA		
LA		

MSP - Multiple Simulation Presentation
SSP - Single Simulation Presentation
HA - High Anxiety
MA - Medium Anxiety
LA - Low Anxiety

Figure 7: Presentation Modes and Levels of Anxiety (2x3 Quasi-Experimental Design)

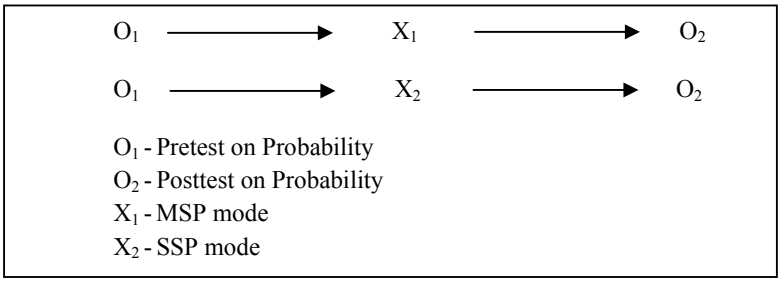

Figure 8: Research Design

Variables

This study involved three types of variables: independent variables, dependent variables and moderator variables. Dependent variables of this research were mean score of posttests; independent variables included two types of presentation modes, which are MSP (Multiple Simulation Presentation) and SSP (Single Simulation Presentation); moderator variables of this research refer to the levels of anxiety: high, medium and low.

Sampling

The sample size of this research was 70 Form Four Malaysian students aged between 16 and 17 years from five intact classes. These students were yet to be exposed to 'Probability', and they were from medium and low socioeconomic status. This sample was assigned randomly into two groups. They were unaware of the differences between each teaching mode.

Pretest and Posttest on Probability

A set of test questions was prepared to assess the mastery level of students on probability. All the items used in the instruments were developed with the help of two experts in Mathematics.

When developing the test items, the characteristics of validity, reliability and practical were taken into consideration by the researcher to ascertain if the instruments used met the requirements. For the content validity, the researcher referred to the Description of Measurements of Form Four Mathematics in accordance with The Malaysian National syllabus for Secondary School.

Copyright © The Turkish Online Journal of Educational Technology

Pilot test was conducted to confirm the validity of the tests on probability. The questions of pretest and posttest comprised of 15 multiple-choice questions with four options. Twenty-five students completed the tests in 45 minutes. Questions for both pretest and posttest were the same in terms of content but they were different from the arrangement of sequence. To measure internal consistency, the value of Cronbach's alpha computed using SPSS (Statistical Package for the Social Sciences) was 0.729.

A-trait Anxiety Test

This instrument was translated into Malay language by a group of researchers involved in the InSpire USM project (Maznah & Ng, 1985). This Trait Anxiety Test was used to measure the trait anxiety levels of students and there were 20 statements about the feelings of students. The range of marks for each statement was between 1 and 4. 1 represented the total absence of worries whereas 2 to 4 represented the presence of worries. The marks for each statement were totaled corresponding to the selected numbers except for Statement 1, 6, 7, 10, 13, 16 and 19 in which the total marks were reversed. Alpha reliability coefficient was reported of more than 0.90. Based on the test, students were categorized into three groups according to their levels of anxiety: low, medium, and high.

Data Collection

Data collection was done voluntarily with the help of two assistant teachers. The researcher informed the assistant teachers about the detailed instructions in collecting data to ensure correct procedure was followed. The procedure of data collection was divided into four phases as shown in Table 1 below:

Table 1: Procedure of Data Collection

Phase	Experiment
Phase 1 (Before the use of interactive multimedia courseware: 'Probability' topic)	Pretest Cattell Test Trait Anxiety Test
Three weeks later	
Phase 2	Learning with interactive multimedia courseware: 'Probability' topic
One day later	
Phase 3	Learning with interactive multimedia courseware: 'Probability' topic
Phase 4 (The same day after the learning session with interactive multimedia courseware: 'Probability' topic)	Posttest

Internal Validity

All the questions and answers of pretest were re-collected after the test. Answers of pretest were concealed to avoid leakage of test questions. The sequence arrangement of the posttest questions were randomized and conducted three weeks later lest the sample still remembered the questions in pretest. The research sample was assigned randomly to each mode of presentation (MSP mode and SSP mode) to minimize the effects of selection bias.

External Validity

The research sample was randomly assigned to two different groups of presentation mode (MSP mode and SSP) and the sample was unaware of the differences. The sample of each mode was prohibited from interacting with another sample group. To prevent any cases of bias, the study was conducted by assistant teacher. The assistant teacher was a Mathematics teacher who was given detailed explanation for all the procedures.

FINDINGS

A number of statistical analysis techniques were employed, namely descriptive analysis, Pearson correlation, analysis of variance (ANOVA) and analysis of covariance (ANCOVA). The results of inferential statistics was discussed based on the hypotheses of this study at the significant level, p=0.05.

Copyright © The Turkish Online Journal of Educational Technology

Table 2: Mean Score of Posttest and Standard Deviation of Each Presentation Mode and Anxiety Level

Presentation Mode	Anxiety Level	Mean	Standard Deviation	N
MSP Mode	Low	8.00	2.650	3
	Medium	9.58	2.760	19
	High	7.85	2.440	13
	Total	8.48	3.925	35
SSP Mode	Low	9.25	1.890	4
	Medium	9.68	3.270	22
	High	8.89	1.830	9
	Total	9.27	2.330	35
Grand Total	Low	8.65	2.140	7
	Medium	9.63	3.010	41
	High	8.37	2.230	22
	Total	**8.88**	**3.128**	**70**

Table 2 shows the mean score of posttest, frequency distribution of sample and standard deviation for the 'Probability' topic of each presentation mode together with different anxiety levels among students. Overall, the posttest mean score for students with high anxiety level was 8.37 which was slightly lower compared to students with low anxiety level with mean score 8.65. For MSP mode, posttest mean score for students with high anxiety level was 7.85 which was also slightly lower compared to students with low anxiety level with mean score 8.00. As for SSP mode, posttest mean score for students with high anxiety level was 8.89 which was also lower compared to students with low anxiety level with mean score 9.25.

Posttest mean score for students with high anxiety level exposed to MSP mode was 7.85 which was lower compared to posttest mean score for students with high anxiety exposed to SSP mode. Similarly, posttest mean score for students with low anxiety level exposed to MSP mode was 8.00 which was lower compared to posttest mean score for students with low anxiety level exposed to SSP mode.

Table 3: Two-Way ANCOVA for Posttest Mean Score According to Presentation Mode and Anxiety Level with Pretest Mean Score as Covariate

Source	Type III Sum of Squares	Df	Mean Square	F	sig.	Eta Squared	Observed Power
Covariate							
Pretest	186.004	1	186.004	39.227	.000	.384	1.000
Main Effect							
CATTELL	22.121	2	11.061	2.333	.366	.069	0.456
Mode	7.522	1	7.522	1.586	.391	.025	.237
Two-Way Interaction							
X Mode							
CATTELL	6.446	2	3.223	.680	.510	.021	.160
Error	298.731	63	4.742				
Total	**6336.000**						

* significance: $p<0.05$

The main effect of anxiety level is shown in Table 3, F-value (2,63) = 2.333, Mean Square = 11.061, p = 0.105 and $\eta^2 = 0.069$. This shows that there was no significant difference of posttest mean score between students with high anxiety level and students with low anxiety level exposed to MSP mode and SSP mode. Posttest mean score for students with high anxiety level ($x\square = 8.37$) was lower than students with low anxiety level ($x\square = 8.65$) as shown in Table 2. The degree or strength of relationship ($\eta^2 = 0.069$) between anxiety level and posttest mean score was low (Gay and Airasian, 1996).

Copyright © The Turkish Online Journal of Educational Technology

Table 4: One-Way ANCOVA for Posttest Mean Score According to Presentation Mode and High Anxiety Level with Pretest Mean Score as Covariate

Source	Type III Sums of Square	df	Mean Square	F	sig.	Eta Squared	Observed Power
Between Groups	7.522	1	7.522	1.586	.212	.025	.237
Within Group	298.731	63	4.742				
Total	**6336.000**	**70**					

* significance: p<0.05

Table 4 shows the research data for students with high anxiety level, F-value (1,63) = 7.522, Mean Score = 7.522 and p = 0.212 for presentation mode. This shows that there was no significant difference for posttest mean score between high anxiety research sample exposed to MSP mode and SSP mode. Posttest mean score for students with high anxiety level exposed to MSP mode ($x\square$ = 7.85) was lower than posttest mean score for students with high anxiety level exposed to SSP mode ($x\square$ = 8.89) as shown in Table 2.

Hypotheses Testing

Hypothesis 1

Students exposed to Multiple Simulation Presentation (MSP) will have significantly higher mean score in posttest compared to students exposed to Single Simulation Presentation (SSP).

$x\square_{MSP} > x\square_{SSP}$

Table 2 shows that posttest mean score for students exposed to SSP mode ($x\square$ = 9.27) was significantly higher than posttest mean score for students exposed to MSP mode ($x\square$ = 8.48). The results of ANCOVA in Table 3 shows significant difference between presentation modes at F-value (2,63) = 1.586, Mean Square = 7.522, p = 0.212 and η^2 = 0.025. This shows that there was no significant difference of posttest mean score between students exposed to MSP mode and students exposed to SSP mode. Therefore, this hypothesis was not supported.

Hypothesis 2

Students with low anxiety (LA) will achieve significantly higher mean score in posttest compared to students with high anxiety (HA).

$x\square_{LA} > x\square_{HA}$

Table 2 shows that posttest mean score for students with low anxiety level ($x\square$ = 8.65) was higher compared to posttest mean score for students with high anxiety level ($x\square$ = 8.37). The results of ANCOVA in Table 3 shows that there was no significant difference between anxiety levels at F-value (2,63) = 2.333, Mean Square = 11.061, p = 0.105 and η^2 = 0.069. Therefore, this hypothesis was not supported.

Hypothesis 3

Students with high anxiety (HA) exposed to Multiple Simulation Presentation (MSP) will achieve significantly higher mean score in posttest compared to students with high anxiety (HA) exposed to Single Simulation Presentation (SSP).

$x\square_{HA\text{-}MSP} > x\square_{HA\text{-}SSP}$

Table 2 shows that posttest mean score for students with high anxiety level exposed to SSP mode ($x\square$ = 8.89) was higher than posttest mean score for students with high anxiety level exposed to MSP mode ($x\square$ = 7.85). The results of ANCOVA in Table 4 shows that there was no significant difference of posttest mean score between students with high anxiety level exposed to MSP mode and students with high anxiety level exposed to SSP mode at F-value (1,63) = 1.586, Mean Square = 7.522 and p = 0.212. Therefore, this hypothesis was not supported.

DISCUSSION

The findings do not support Hypothesis 1, Hypothesis 2 and Hypothesis 3. Students who learned with SSP mode obtained higher mean score significantly compared to MSP mode. These findings are consistent with the research findings of Benshoof & Hooper (1993) which revealed that students' performance are better if they are exposed to 'single window' in the treatment.

The 'Probability' topic is abstract and procedural. Single Simulation Presentation (SSP) is found to be more effective for the learning of probability, especially for students with high anxiety level. Sweller, van Marrienboer

Copyright © The Turkish Online Journal of Educational Technology

& Paas (1998) explained that cognitive load is higher when extensive information is displayed simultaneously on the same screen which causes learners confused. Therefore, SSP mode helps to simplify the process of information processing which directly improves the understanding and performance of students in the learning of probability.

Cognitive Load Theory employs the connections between the information structures and the human cognitive knowledge to establish an instructional design to reduce the redundant or irrelevant cognitive load (Jeroen, Enboer & Sweller, 2005). Human processing memory consists of multiple memory stores including a very limited working memory and an extensive-long term memory. The working memory is limited in capacity and in duration when dealing with novel information (Mayer & Moreno, 2003). Furthermore, the limitations of the working memory make it difficult for learners to understand multiple information elements simultaneously (Artino, 2008). The long term memory can hold all the knowledge which in turn can be processed as a single element by the working memory because all learning activities require the working-memory capacity. If the required working-memory capacity exceeds the learner's limit, the learning performance will be affected due to cognitive overload (June-xia, 2007).

A high cognitive load will occur when the learner's attention is split, that is the learner is required to process multiple sources of information at the same time (Cierniak, Scheiter & Gerjets, 2009). The split-attention effect is experimentally concluded by Sweller (2005). Therefore, in this study, the findings demonstrate that SSP mode with single window reduces the cognitive load and maximizes the learner's performance.

The research findings also show that there is difference of mean score among students with different anxiety levels using two different modes of presentation, MSP mode and SSP mode. Students with low anxiety level obtained higher mean score in comparison to students with high anxiety level. According to Elliot & McGregor (2001), low and medium anxiety levels help in learning whereas high anxiety level distracts learning. However, the differences found are not significant. This shows that anxiety level is overall not a hindrance towards students' performance in the learning of probability though it makes a difference. In addition, this study shows that students with high anxiety level using SSP mode obtained higher posttest mean score compared to students with high anxiety level using MSP mode. This precisely proves that using SSP mode effectively helps students with high anxiety level in the learning of probability.

CONCLUSION

The research findings illustrated that SSP mode is more effective in helping students with high anxiety level to understand the 'Probability' topic as it displays clearer pictures without confusing students in the process of understanding the concepts. This proves that SSP mode shows positive results if it is used accordingly by meeting the terms and conditions stated in the findings of Benshoof & Hooper (1993) whereby organized structure and appropriate amount of information are presented simultaneously. The presentation mode helps ease learning topic which is complicated and abstract. It enables students to visualize abstract information and subsequently improves students' understanding and performance.

Individual differences such as anxiety level have to be taken into consideration as the findings show that students with different anxiety levels achieve different results. The developer of interactive multimedia courseware needs to pay attention and give consideration to the target group in the process of designing presentation mode. The mode of presentation is to be tailored to the needs of students.

For future study, the research should be replicated to larger sample involving more schools, particularly schools in rural areas to increase precision in estimates. Besides, the effects of Single Simulation Presentation (SSP) should be investigated on students with different age range and socioeconomic status to determine the overall effects of SSP mode from various aspects. SSP mode needs to be designed and developed based on theories, principles, concrete research findings and consistency of the functions of human brain.

REFERENCES

Alessi, S. M. & Trollip, S. R. (2001). *Multimedia for learning: Methods and development.* Massachusetts: Allyn & Bacon

Artino, A. R. (2008). Cognitive load theory and the role of learner experience: An abbreviated review for educational practitioners. *AACE Journal*, 16(4), 425-439.

Baddeley, A. (1992). Working memory. *Science*, 255, 556–559.

Benshoof, L.A. & Hooper, S. (1993). The effects of single- and multiple-window presentation on achievement during computer-based instruction. *Journal of Computer-Based Instruction*, 20(4), 113-7.

Copyright © The Turkish Online Journal of Educational Technology

Bruntlett, S. (1998). Selecting, Using and Producing Classroom-based Multimedia. In Leask, M. & Pachler, N (Ed.) (2001), *Learning to Teach Using ICT in the Secondary School.* London: Routledge Falmer.

Chandler, P. & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, 8, 293-332.

ChanLin, L. (1999). Visual Treatment for Different Prior Knowledge. *International Journal of Instructional Media,* 26(2), 213-219.

Charp, S. (1996). Curriculum integration. *Technological Horizons in Education Journal*, 23(10), 4.

Cierniak, G., Scheiter, K. & Peter Gerjets, P. (2009). Explaining the split-attention effect: Is the reduction of extraneous cognitive load accompanied by an increase in germane cognitive load? *Computers in Human Behavior*, 25(2), 315-324.

delMas, R. C. (2002, April). A review of the literature on learning and understanding probability. Paper presented at the Annual Meeting of the American Educational Research Association. Retrieved June 3, 2005, from http://www.gen.umn.edu/faculty_staff/delmas/aera2002_rev_of_prob_lit.html

Duffy, E. (1972). Activation. In N. S. Greenfield & R. A. Sternbach (Ed.), *Handbook of Psychophysiology*. New York: Holt, Rinehart & Winston.

Dwyer, F. M. (1978). *Strategies for improving visual learning.* State College, PA: Learning Services.

Elliot, A., & McGregor, H. (2001). A 2 x 2 achievement goal framework. *Journal of Personality and Social Psychology, 80*(3), 501-519.

Gagne, R. M. (1974). *Essential of learning (4th ed.).* New York: Holt, Rinehart & Winston.

Gagne, R. M. (1985). *The conditions of learning and theory of instructional.* New York: CBS College Publishing.

Gagne, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of instructional design (4th ed.).* Fort Worth, TX: Harcourt Brace Jovanovich.

Jeroen, J., Enboer, V. & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review*, 17(2), 147-177.

Jun-xia, G. (2007). Action research: The application of cognitive load theory to reading teaching. *Sino-US English Teaching*, 4(4), 19-23.

Maznah, I., & Ng, W. K. (1985). Relationships of locus of control, cognitive style, anxiety and academic achievement of a group of Malaysian Primary School Children. *Psychological Reports*, 57, 1127-1134.

Mayer, R. E. (1999). *The promise of educational psychology.* Upper Saddle River, NJ: Merrill Prentice Hall.

Mayer, R. E. (2001). *Multimedia learning.* Cambridge, UK: Cambridge University Press.

Mayer, R. E. & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, 38(1), 43-52.

Paivio, A. (1986). *Mental Representation: A Dual Coding Approach.* Oxford, England: Oxford University Press.

Rieber, L. P. (1994). *Computers, graphics, and learning.* Dubuque, IA: Wm. C. Brown Communications, Inc.

Spielberger, C. D. (1966). Theory and research on anxiety. In C. D. Spielberger (Ed.), *Anxiety and behaviour* (pp. 3-20). New York: Academic Press.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory.* Palo Alto, California: Consulting Psychologists Press.

Sweller, J., van, J. & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10(3), 251-296.

Sweller, J. (2005). The redundancy principle in multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning*. Cambridge: Cambridge University Press.

Toh, S. C. (1998). *Cognitive and motivational effects of two multimedia simulation presentation modes on science learning*. (Unpublished Ph.D. thesis). Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia.

Wittrock, M. C. (1989). Generative processes of comprehension. *Educational Psychologist,* 24, 345-376.

Copyright © The Turkish Online Journal of Educational Technology