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The Effects of Varied Animation in Multimedia Learning: Is the extra effort worthy?

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ABSTRACT

Animation in multimedia is said to be beneficial to learning especially when the learning material demands visual movements. The emergence of 3-Dimensional animated visuals has extended the presentation mode in multimedia learning. It is said that animated visuals in a 3-D representation not only possess motivational value that promotes positive attitudes toward instruction but also facilitate learning when the subject matter requires dynamic motion and 3-D visual cue. The field of computer science, especially in operating systems concepts uses an array of abstract concepts such as virtual memory, paging, fragmentations etc to describe and explain the underlying processes. Various studies together with our own observations strongly indicate that students often find these concepts difficult to learn, as they cannot easily be demonstrated. This study investigates the effects of animation on student understanding when studying a complex domain in computer science, that is, the subject of memory management concepts in operating systems. A multimedia learning system was developed in two different versions: 2-D animation and 3-D animation. A hundred and one students took part in this study and they were assigned into one of these groups. All the students who took part in this experiment had low prior knowledge in this subject and after viewing the treatment, they were asked to take a test which tested them for recall and transfer knowledge. This test was used to determine if, in fact, improved learning actually occurred and which version of the animation produced the better outcome. Initial analysis of results indicates no statistical difference between the scores for the two versions and suggests that animations, by themselves, do not necessarily improve student understanding.

Keywords: multimedia learning, animation, 3-D animation, memory management.

1 INTRODUCTION

The last decades have led to an increased use of computer technologies and hence also multimedia learning materials across all levels of education. According to Mayer (2001), multimedia learning is learning from words and pictures and multimedia instructional message or multimedia instructional presentation (or multimedia instruction) is presentation involving words and pictures that is intended to foster learning.

Based on various studies by researchers (Khalili & Shashaani 1994; Wan Fatimah & Halimah 2005, Faridah & Halimah 2008) the effects of multimedia

on learning suggest that multimedia can improve learning performance, irrespective of subject matter, but specifically Mathematics, Sciences and Language. In other studies (Seel & Schenk 2003; Adamczyk et al. 2009) which have compared learning during non multimedia-based and multimedia-based learning, have reported improved learning with the use of multimedia technology.

Despite progress in multimedia learning theory due to an enormous number of empirical investigations, Ploetzner and Lowe (2004) point out that our understanding of how learners process dynamic visualizations as one important component of many multimedia messages is still in its infancy. Therefore, empirical research on understanding what kind of instructional design of animation helps student learn better is necessary. The present study is aimed at deepening some findings on the benefits of animated instructions whether in a 2 dimensional or a 3 dimensional form. We used a theoretical framework on multimedia learning (Mayer 2001, Mayer 2009) as a basis for this study.

The subject taught in this multimedia presentation is a topic from operating systems, memory management. Operating Systems (OS) is an important course in many Computer Science, Information Science and Computer Engineering curricula. Some of its topics require a careful and detailed explanation from the lecturer as they often involve theoretical concepts and somewhat complex calculations, demanding a certain degree of abstraction from the students if they are to gain full understanding (Park, & Gittleman, 1992; Maia et al., 2005).

Animation in Learning

Animated pictures are used in multimedia environments to represent the dynamic aspects of complex subject matters in an explicit way (Lowe, 2004). According to Schnotz and Rasch (2005), animations have two different positive functions in learning. First, they enable learners to perform more cognitive processing (enabling function) by providing them with additional information that cannot be displayed by static pictures. Second, they help learners to build a dynamic mental representation by giving them an external support for simulating the behavior of the system depicted.

There have been many literatures on the use of animations in computer science related subjects in the past years. The intuition of computer scientists has led many to believe that animations must provide a learning benefit, but prior experimental studies dating back to the early 90s have provided mixed results.

A study on computer algorithms and data structure examined students learning about the algorithm by reading only a textual explanation and students learning about the algorithm using the text and interacting with an animation of the algorithm (Stasko et al. 1993).There was no significant difference in the two groups' performances on the post-test, but the trend favored the animation group. Grissom, McNally, and Naps (2003) conducted research to measure the effect of varying levels of student engagement with algorithm visualization

to learn simple sorting algorithms. The three levels of engagement studied were: not seeing any visualization; viewing visualization for a short period in the classroom; and interacting directly with the visualizations for an extended period outside of the classroom. Results of their study revealed that algorithm visualization has a bigger impact on learning when students go beyond merely viewing visualization and are required to engage in additional activities structured around the visualization. The researchers also state that it is important that visualizations used by students be consistent with algorithms in their textbooks, or else the visualizations may serve more to confuse them than to aid them.

English and Rainwater (2006) studied the instructional effectiveness of using animations to teach 32 learning objectives in an undergraduate operating systems course. Findings of this study indicate that animations are not effective in conveying information for all learning objectives; i.e. some learning objectives, especially those that are less procedural and more conceptual, are more difficult for students to learn from animation. The use of animations was more beneficial in the sub-topics of *processes*, *memory management* and *virtual memory* (English & Rainwater 2006).

In the context of this research, we wanted to know if 3-D animation is any better than 2-D animation. Cockburn and McKenzie (2001) compared the use of 3-D interfaces with their traditional 2-D counterpart. The study describes the comparative evaluation of two document management systems that differ only in the number of dimensions used for displaying and interacting with the data. The primary purpose of this experiment was to see if there were any differences between the 2-D and 3-D interfaces in the efficiency of storing and retrieving web page thumbnail images. Also, they wanted to know how performance in these tasks might be affected by increasing densities of data ('clutter') within the displays. The 3-D system supports users in sorting, organizing and retrieving 'thumbnail' representations of documents such as bookmarked web-pages. Results showed that the subjects were faster at storing and retrieving pages in the display when using 2-D interface, but not significantly so. Retrieval times significantly increased as the number of thumbnails increased. Despite the lack of significant differences between the 2-D and 3-D interfaces, subjective assessments showed a significant preference for 3-D interface.

Computer based multimedia material offers different means of supporting 3-D information representations (Huk, 2006). Viewing dynamic and 3-D animations is assumed to be a possible way of changing and improving students' incomplete mental models (Wu & Shah, 2004). Nevertheless, based on various researchers (Gerjets & Scheiter, 2003; Paas et al. 2003), it is found that 3-D models may lead to cognitive overload problems in hypermedia-learning environments in particular. On the other hand, the findings of Ferk et al. (2003) research revealed that some representations of molecular 3-D structure are better understood and can be more readily used by students in solving tasks of different complexity. However, empirical studies that focuses on the impact of 3-D visualization on learning are, to date, rare and

inconsistent (Keller, Gerjets, Scheiter, & Garsoffky, 2004).

The present study therefore focuses on weather learning using animation in 3-D is more beneficial to learning with just 2-D animation.

2 METHOD

Participants were 101 first year students from the Faculty of Computer Sciences at UiTM, Shah Alam. These students had no prior knowledge in this subject (all computer sciences students are supposed to take this subject in their third semester) and were assumed to be homogenous in terms of age, education and cultural background. To be certain, a prior knowledge survey and demographic survey questions were filled out by these participants and they had either none or very little knowledge in the area of operating systems and memory management concepts. These students were than divided into 2 groups. The first group (G1) viewed the version with 2-D animation and the second group (G2) viewed the 3-D animated version. All the text contents in these versions were the same and in accordance with the syllabus (Silberschatz at al. 2006) for the subject taught.

The self-paced multimedia-based instruction explains on the memory management concepts which consist of background on memory management, swapping technique, contiguous allocation technique and paging technique. Then the students were asked to view the multimedia instructions which were installed in each computer in the computer lab during the two hour lab session. The students could take their time to view the slides and re-visit the slides as often as they wanted within that time frame. The animation was self-paced and interactive. Students could view the animation with the play button and they could rewind, pause or stop according to their individual needs. After the treatment, each participant had to take a test. This test was divided into two parts, which are, the recall test and transfer test. Recall test asked questions which required them to recall or remember some basic facts mentioned in the slides and the transfer test required them to solve some problems based on the knowledge learned in the multimedia learning system they had viewed. All questions were in a multiple choice form, except for one, where the students had to label a diagram. All students answered the questions with paper and pencil. This test procedure followed the conventional paradigm used to evaluate the mental model constructed during multimedia learning (Mayer & Anderson 1992).

The system with 2-D animation had animation designed using Macromedia Flash and concepts of swapping, contiguous memory allocation and paging techniques were explained using animated form in 2-D. For example, the use of geometric shapes is used to show movements of data when the play button is pressed. Process B will search from the top to find the first hole which is big enough to fit its memory in, as shown in Diagram 1.

The system with 3-D animation had animation designed using 3D Max and the concepts of memory management were explained using animated form in a 3-D realistic version. For example, the concept of contiguous memory

allocation was explained using a forklift to carry large chunks of data to be put into empty spaces in the memory as shown in Diagram 2.The concept of first fit is applied in Diagram 2, but the constructivist approach to learning was applied here. Constructivist learning is where the learning of new information is facilitated by making it possible for the learner to relate it to knowledge already possessed and transform old knowledge into new knowledge (Jonassen 1999).

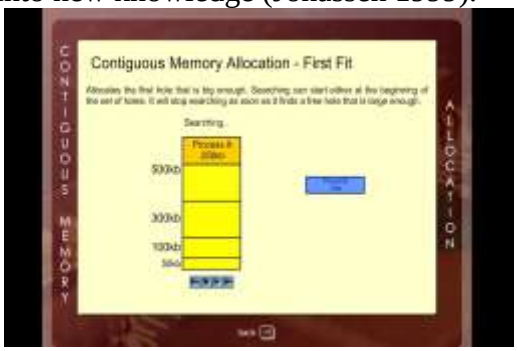

Diagram 1 Snapshot of Contiguous Memory Allocation with 2-D animation

3 RESULTS

Table 1 Independent Sample *t*-test on Recall Score

Dimension	Mean	Std. Deviation	N	t-value	p-value
2 D Animation	61.3208	18.19105	53	-1.313	0.192
3 D Animation	66.2500	19.52903	48		

Table 2: Independent Sample *t*-test on Transfer Score

Dimension	Mean	Std. Deviation	N	t-value	p-value
2-D Animation	37.1968	17.79431	53	1.057	0.293
3-D Animation	33.3333	18.94603	48		

Based on the Independent Sample *t*-test in Table 1, there is no significant effect for visual dimension for neither 2-D nor 3-D animated group on the recall score for low prior knowledge students since the *p*-value is greater than α=0.05, Also, there is no significant effect for visual dimension for either 3-D or 2-D on the transfer score for these students since the *p*-value is greater than α=0.05. However, when the mean score test is observed, the percentage of score for the recall and transfer tests are higher for students who viewed the 3-D version (76.8% and 35.3%) as compared to students who viewed the 2-D version (63.5% and 34.5%). The figure difference between the recall and transfer test is vast even though the number of questions are total scores are divided equally. This is because, the recall test questions are straightforward and require students to remember some facts they had learnt. Whereas, the transfer questions require students to solve problems based on facts and formulas shown in the treatment.

4 DISCUSSION & CONCLUSION

Findings of the experiment conducted showed that there was no significant effect on 2-D or 3-D animated group on the recall scores and transfer scores for students. This means that there were no advantages of 3-D animation over 2-D animation in generating better recall knowledge amongst the students.

When the mean scores were analyzed, it was obvious that students performed better in recall questions than transfer questions. This was because transfer questions were problem based and students, who were especially those with low prior knowledge, could not understand all the concepts enough to solve some of the more complex problems.

The non-significance of the findings can be analyzed from two standpoints. First, the differences of visual display at the encoding and retrieval time negatively influenced learning gains. The post-test questions in the experiment were presented in two-dimensional format for all experimental groups. The students under the condition of 3-Dimensional animation studied the learning material in 3-D format while they were provided with post-test questions in 2-D format. The 3-D representation was used as an encoding and retrieval cue, confused the students in the 3-D animated group, and they did not take advantage of the 3-D animated representation of learning material to answer the post-test.

Consistency between encoding and retrieval cues was suggested by Paivio (1991). The effects of instructional visuals were maximized when the same kind of pictorial cues were used at retrieving and encoding time. Similar findings were found in a study by Hye (1999) who compared the use of 3-D graphics in student learning and attitude, with that of 2-D graphics in learning the "Motion of the Earth and Moon" in space. The study found no significant gain in students learning in both the groups where the argument was partly blamed on the differences of visual cues at encoding and retrieval time, which is similar to the arguments of the existing study. Kulhavy et al.