Jurnal Teknologi Maklumat & Multimedia 11 (2011): 29 - 39

Representing Children's Digital Flashcards using Rapid Serial and Visual Presentation Techniques

Siti Zahidah Abdullah
Nazlena Mohamad Ali
Riza Sulaiman
Mohd Syazwan Baharuddin

ABSTRAK

Kajian ini mengaplikasi teknik Rapid Serial and Visual Presentation (RSVP) untuk menvisual imej kad imbas digital. Kaedah kad imbas diguna bagi memberi pendedahan awal pembelajaran digital kanak-kanak. Kajian ini melibatkan dua kumpulan pelajar (6-8 tahun) dari kelas tipikal dan LINUS. Dua eksperimen utama yang terlibat: 1) penerimaan terhadap RSVP, dan 2) perbandingan mod paparan dalam RSVP. Hasil kajian menunjukkan RSVP diterima secara positif. Terdapat variasi penerimaan bagi setiap kumpulan pelajar dari segi prestasi dan perhatian. 60% daripada pelajar memilih mod dinamik, manakala 40% memilih mod statik. Memori dan prestasi pelajar mengguna mod statik adalah lebih baik yang mana min purata skor bagi mod statik mencapai 3.4, adalah lebih tinggi berbanding mod dinamik dengan min purata skor hanya 0.7. Kepentingan bagi kajian ini adalah dapat menyedia pendedahan awal pembelajaran kad imbas secara digital mengguna teknik RSVP bagi kanak-kanak.

Kata kunci: Antara muka manusia-komputer, memperbaiki pengajaran dalam bilik darjah, persekitaran pembelajaran yang interaktif, media dalam pendidikan; sistem multimedia/hipermedia

ABSTRACT

This research implemented Rapid Serial and Visual Presentation (RSVP) technique to visualize digital flashcard images. Flashcard method is used to provide early exposure for children's digital learning. This research involves two groups of students (6-8 years old) from typical and LINUS classes. Two main experiments were involved: 1) acceptance of the RSVP, and 2) comparison of difference modes in the RSVP. The results show that the RSVP was positively accepted. There were variations of acceptance amongst each group of students; in terms of performance and concentration. Sixty percent of the students chose the dynamic mode, and 40% chose the static mode. The memory and performance of students using the static mode was better, which the mean scores for the static mode achieved 3.4, higher than the dynamic mode of only 0.7. The significance of this study is to provide an early exposure through digital flashcard learning, using RSVP for children.

Keywords: human-computer interface, improving classroom teaching, interactive learning environments, media in education, multimedia/hypermedia systems

INTRODUCTION

Based on previous studies in the field of educational psychology of children (Burns et al. 2004; Ehri 2005; Skinner 1996; Stanovich 1994), flashcards have played an important role in the early education of children in kindergarten or school. Flashcards are often used to teach basic facts, such as the names and sounds of the letters of the alphabet (Young et al. 1983).With use of the flashcard method in teaching, the number of words children are able to read can be increased (MacQuarrie et al. 2002). In this study, we applied the Rapid Serial Visual Representation (RSVP) technique for image representation, in a flashcard learning context, for children aged six to eight years old. The RSVP technique is used to rapidly present a series of images, and has been widely used in visualization and psychophysics experiments (Hauptman et al. 2006). The RSVP technique can be used either in a moving or static representation of digital image collections. This research involved two groups of children to be tested; there are students from the normal class and another group from the LINUS program class. RSVP keyhole, shelf, and carousel modes, were used to present digital flashcard images, in order to gain a comparison amongst these three modes. Specifically, the purpose of this study is to investigate the acceptance of the RSVP technique within these groups of children, and to identify the children's preferred modes in the RSVP technique. We explored which presentation modes (i.e., static or moving) were more effective for the children in a digital flashcard learning context.

RELATED WORKS

The RSVP technique has been extensively used to present series of images, mainly for the purpose of image visualization. The main idea behind RSVP is to eliminate eye movement, as this takes time away from the task of looking at an image (Hauptman et al. 2006). Research published in literature reviews by Raymond et al. (1992), Cooper et al. (2006), Jeremy Wolfe et al. (2007), Chun & Potter (1991), and Bruijn & Spence (2002), have shown that moving and static objects can affect user performance in the context of cognitive memory, eye gaze behaviour, attentional blink, and user preferences.

Spence (2002) states that RSVP has its own objectives, namely to support the efficient formation of a mental model of data, using the method of displaying information (i.e., text, images, and video) in a limited space, in which every part of the information is displayed only briefly. According to Spence (2002), the earliest RSVP technique, in the context of electronic information, was the carousel-mode. This mode is comprised of a flow of images that emerge from one side of a container, follow a circular route around it, and disappear into the opposite side of the container. This mode is commonly used in Web Navigation (Bruijn & Spence 2002). The second RSVP mode is the collage mode. This mode is suitable for sales on the internet (Bruijn & Spence 2002). It quickly displays images one by one, only a short distance apart, so that as many images as possible can be seen simultaneously before the current image is hidden by the latest image. The third RSVP mode is the floating-mode, where each image is displayed set initially in the middle of the screen, then moves towards the edge of the display, with the image growing in size all the time. The fourth mode is the shelf-mode, in which the initial presentation of a picture is 'full size,' located in the lower right hand corner of the screen. After a while, it moves towards the opposite corner and shrinks in size. This mode is suitable to display online products (Bruijn & Spence 2002).The other RSVP mode is the keyhole mode. Similar to a slide-show, in which images are displayed in the same location each time, the keyhole mode is a static presentation mode; also known as the 'slideshow mode' (Cooper et al. 2006). Figure 1 shows the different modes of the RSVP technique.

According to the literature review, the RSVP technique has more benefits and advantages than some of the other techniques. Bruijn & Spence (2002), Spence (2002), Wittenburg et al. (2000), and Wittenburg et al. (2003), found that this technique has great potential in visualizing digital images. Through their experiments, they showed that users are more likely to use this technique, due to its effectiveness in relation to the activities performed. Spence (2002) gave an overview of the RSVP technique, and its different carousel, floating, collage, keyhole, and shelf modes. Each mode also has its own advantages and disadvantages. According to Bruijn & Spence (2002), the keyhole mode is found to be of the highest ranking, compared to the other modes. The researcher's experimental results of studying the "pattern of eye gaze," found that the three other RSVP

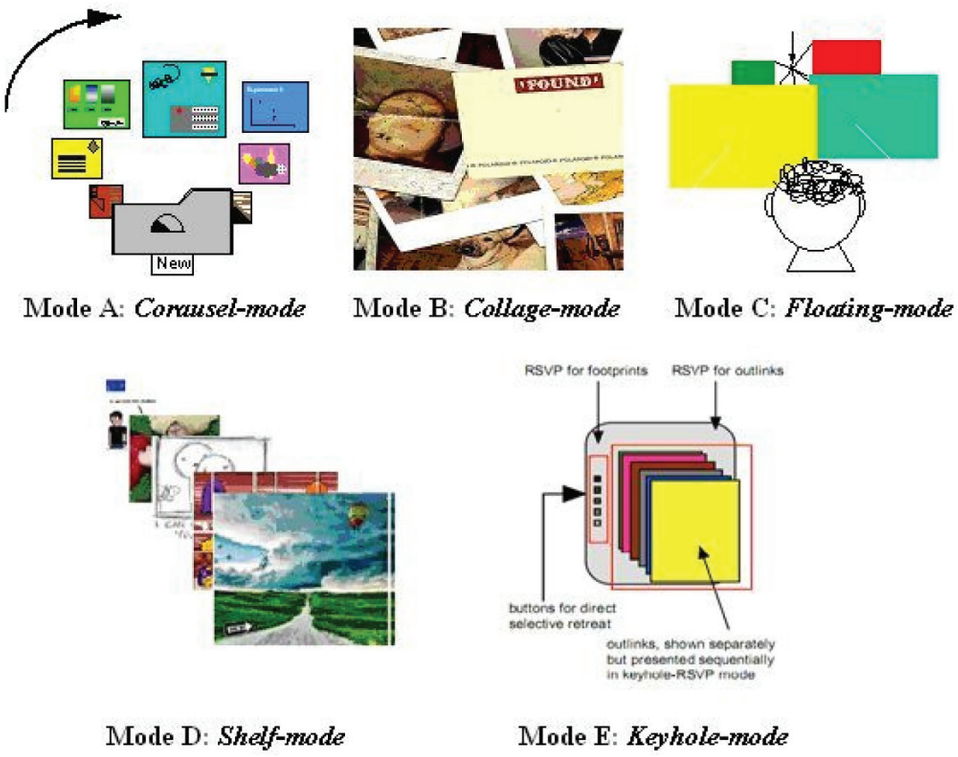


FIGURE 1. Modes of the RSVP technique

modes were less effective, because they involved eye movement, especially for image recognition.

Cooper et al. (2006) provided a comparison between three RSVP technique modes. In their experiment, they investigated slideshow mode, mixed mode and tile mode, as shown in Figure 2. For all three modes investigated, it was found that the mixed mode had lower recognition error rates and a higher preference by the users. The experimental results showed that the percentage of accuracy for the recognition of static images was higher than that of moving images. They suggested that these results could be explained by eye-gaze behaviour.

Spence (2002) gave an overview of RSVP, in relation to human computer interfaces. The most basic RSVP method involves temporal sequencing of single images, known as the keyhole mode. He also discussed the other four RSVP technique modes i.e., carousel mode, collage mode, floating mode, and shelf mode. It was found that keyhole mode had a higher rate compared to the collage mode. Other experiments were carried out comparing the carousel and keyhole modes. The results showed that the keyhole mode offered a trade-off between space and time. Spence (2002) also highlighted the need for further research in many other features that could provide a better interaction. One of the issues suggested, was the suitability of RSVP modes to users or the application itself.

Since previous studies have not explored how far this technique can be applied in children's flashcard learning, our investigation will be broadened to include children's acceptance of the RSVP technique. In this study, we propose to investigate only three modes of the RSVP technique, namely the shelf mode, carousel mode, and the keyhole mode. These three modes were selected due to the literature review by Cooper et al. (2006), Bruijn & Spence (2002), Spence (2002), and Wittenburg et al. (2003). A previous study by Cooper et al. (2006), comparing static and moving presentation modes, found that the keyhole mode (as a static mode) had higher rates of user preference. Results showed that 50% of the subjects preferred the static mode, and only 25% of the subjects preferred a moving mode. Spence (2002) also stated that human performance, as measured by the keyhole mode, is more effective than using the carousel mode in image recognition tasks. Besides, the pattern of eye-gaze study by Bruijn & Spence (2002) showed that the carousel mode had unique characteristics to be investigated. The circular motions of the carousel mode require eye movement. Eye tracking or gaze tracking, is a particularly useful technique for determining which features in a display attract the user's attention (Bruijn & Spence 2002). Based on these studies, we chose to compare the keyhole mode and the carousel mode, in the context of children's preferences and learning environment. Wittenburg et al. (2003) applied the shelf mode to display digital video to consumers. The shelf mode was found to be useful in the distinction of scenes, compared to traditional television broadcasts. They also applied this mode to digital photo collections.

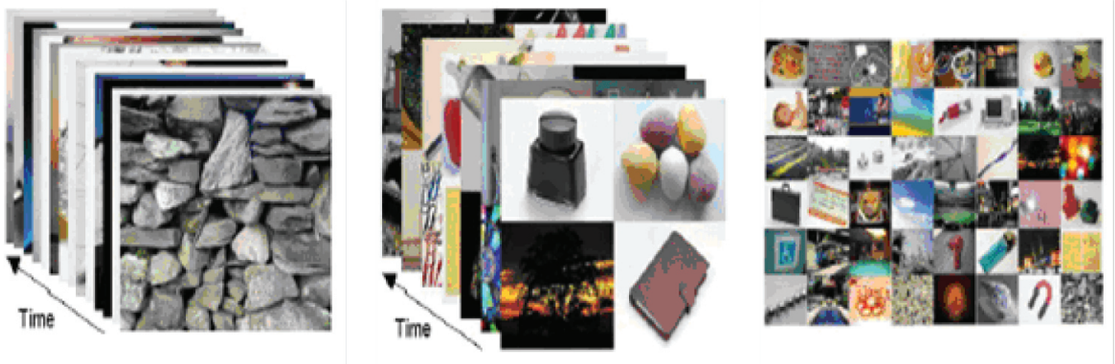
EXPERIMENTAL DESIGN

There are two experiments in this study, namely Experiment 1 and Experiment 2 (Experiment 2 was divided into two sub-experiments). These experiments are described as follows:

EXPERIMENT 1

The objective of this experiment is to evaluate each of the three RSVP technique presentation modes, in order to identify which mode is more preferred by the children, in the representation of digital flashcard learning. Our hypothesis is that children prefer a moving mode, such as the shelf mode and the carousel mode, rather than a static mode, such as the keyhole mode.

Subjects – Twenty children, aged six to eight years old, from the e-Xra Learning Centre, Bangi, Malaysia, participated in this experiment. The children were divided



Slideshow Mode Mxed Mode Tile Mode

FIGURE 2. Tree presentation modes

into two groups; ten students from normal classes and another ten students from LINUS program classes.

Design and Procedure – The first interface, in the form of a digital flashcard learning tool, was developed to test the children. This application was written using Flex Builder 3.0 with a flash plug-in, and was presented on an Intel Pentium-M computer, using Adobe Flash Player 10. The application used several of the selected RSVP technique modes to present the flashcard images. Three different RSVP modes were chosen for this experiment, namely the shelf mode (MODE A), the carousel mode (MODE B), and the keyhole mode (MODE C). The experimental sessions took place in a classroom, where the subjects were seated in front of a computer, and asked to see and play with the application. After the task completed, they were asked to answer a questionnaire (under the teacher's guidance), in order to obtain their feedback regarding the experience. Figure 3 to 5 show the application interfaces.

RESULTS

During the earlier experimental question, we believed that participants would choose the shelf mode (MODE A) as their favourite technique; as inferred by Wittenburg et al. (2003). The introduction of new images in a circular motion could have resulted in the child's preference. Feedback given by some of the normal class's students contended that the carousel mode was more challenging to them. It was common for these students to focus their attention on looking for the movement of the flashcard image. However, the majority of the LINUS program class's students commented that the carousel modes interface made them feel dizzy. This was because these students have difficulty in focusing and recognizing the moving image. Some images, which moved fast (i.e., shelf mode and carousel mode) compared to the eye-gaze direction, caused the most activity and results in the limited recognition of visual images (Forlines & Balakrishnan

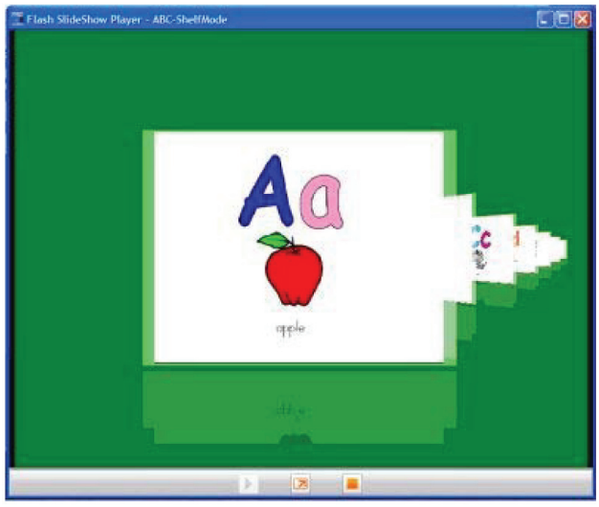


FIGURE 3. Digital flashcard application in MODE A

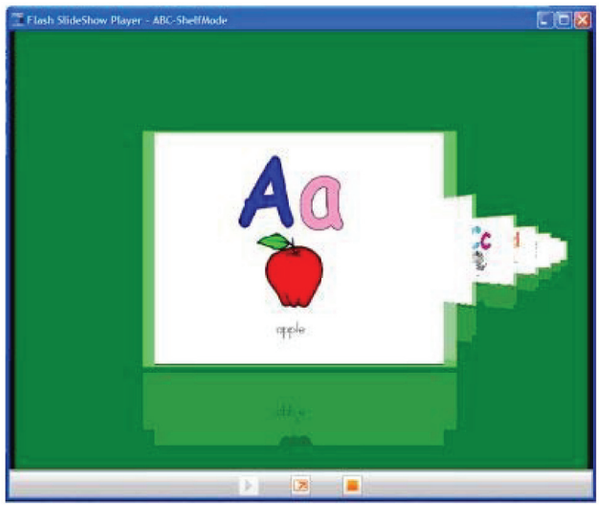


FIGURE 4. Digital flashcard application in MODE B

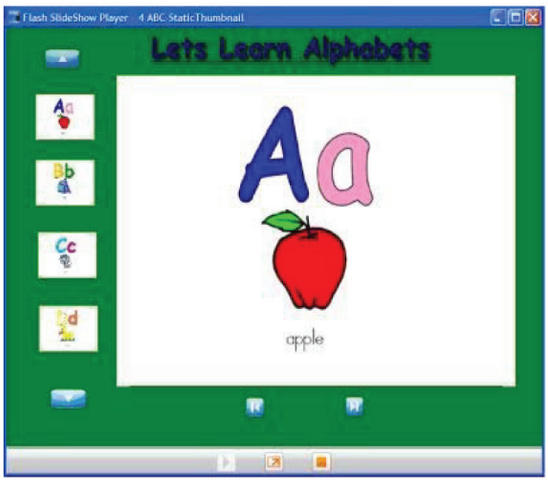


FIGURE 5. Digital flashcard application in MODE C

2009). In particular, for the shelf and carousel modes, the movement of images may have caused some strain on the visual system in requiring a smooth pursuit eye movement to keep the images in foveal vision (Bruijn & Spence 2002). In the keyhole mode, the image is presented on the screen one at a time, and students commented that this was quite easy for them to visualize. Some students commented that they enjoyed the keyhole mode due to its simplicity. Figure 6 shows the findings of these different choices.

According to Figure 6, 50% of the children favoured the carousel mode and the majority of these students were from the normal class. Meanwhile, 45% of the students,with the majority being from the LINUS program class, preferred the keyhole mode, and the remainder (only 5%) preferred the shelf mode. It is clear that different choices exist between the normal class students and the LINUS program class students. The normal class students preferred a dynamic mode, whereas students from the LINUS program class were more inclined to choose a static presentation mode.

EXPERIMENT 2

Initial findings from Experiment 1 highlighted a positive satisfaction in using the RSVP technique for these groups of children. Therefore, the aim of Experiment 2 was to investigate between moving and static RSVP technique presentation modes, on children's performance using digital flashcard learning. For comparison purposes, this experiment was divided into two sub-experiments, namely Experiment 2(a) and Experiment 2(b).

Experiment 2(a) – The objective of this experiment was to evaluate the possibility of children from both classes to remember and identify a list of letters and pictures

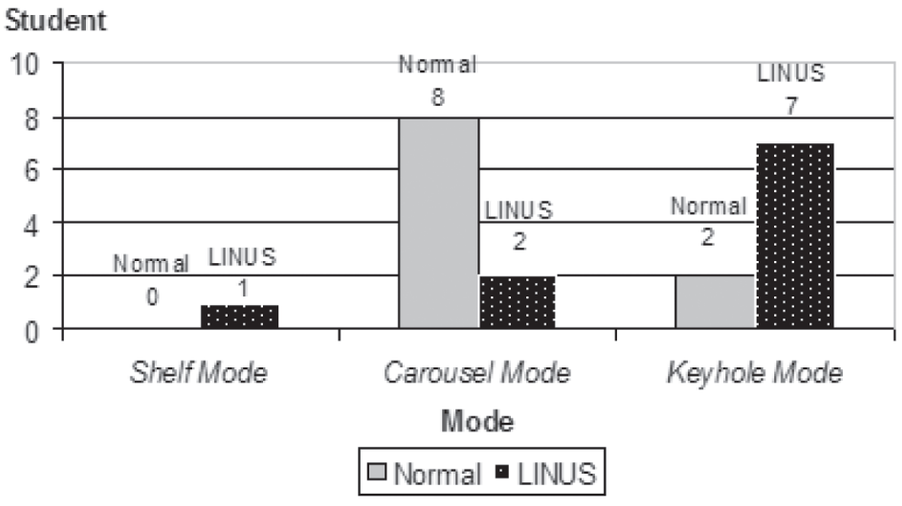


FIGURE 6. User preferences by presentation mode and class

embedded into the RSVP image stream. The list of letters and pictures are presented in carousel and keyhole modes (i.e., moving and static). Our hypothesis suggested that the normal class students would perform better than the LINUS program class students.

Subjects – The same twenty children that were involved in Experiment 1 were tested here in Experiment 2(a) i.e., ten students from the normal class and ten students from the LINUS program class.

Design and procedure – an interface, in the form of a digital flashcard learning tool, was developed to test the children. This application was written using Flex Builder 3.0 with the flash plug-in and was presented on an Intel Pentium-M computer using Adobe Flash Player 10. The application used the two selected RSVP technique modes to present the flashcard images, namely the carousel and keyhole modes, as moving and static representation techniques.

Two tasks were setup in this experiment (i.e., Task 1 and Task 2). Task 1 presented items in uppercase using the moving mode, and Task 2 presented items in lowercase using the static mode. The stimuli included 13 letters in uppercase (i.e., A-Z) and 13 letters in lowercase (i.e., a-z) in a random order. They were presented in 72-point Comic Sans MS font, in black. Images of the alphabet were deemed suitable for this experiment, as was done by most previous researchers (Akyurek & Hommel 2006; Dux & Coltheart 2005; Chun & Potter 1995).The list of letters was presented at a rate of four seconds per item. This presentation rate was chosen for the immediate memory test, because memory effects may occur in less than one second, when viewing a pictured scene or reading a sentence (Potter 1993).

This experiment was conducted in a classroom, with the subjects seated in front of a computer at approximately the same distance for each subject. Subjects were asked to view the letters presented on the screen; they were given the chance to view each item twice. Previous research found that when an item was repeated, subjects tended to omit the second repetition of the item in their response (Raymond et al. 1992). After the subjects finished viewing the list in the given time, they were asked to answer a question to test their memory of those items. Each subject needed to complete Task 1 and have a break before continuing onto Task 2. Figure 7 and 8 show the application's interface; whilst the experimental setup is shown in Figure 9 and 10.

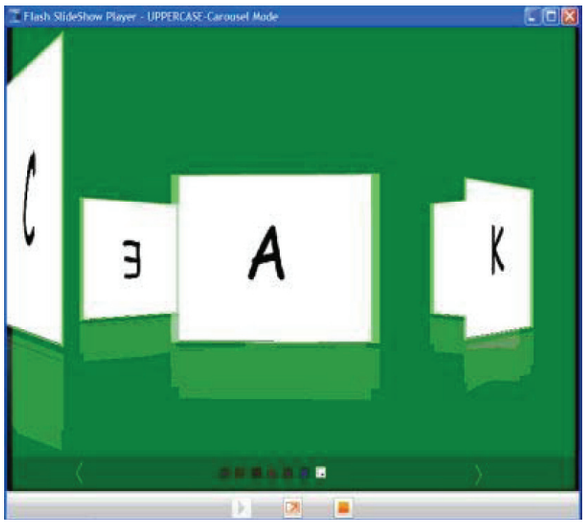


FIGURE 7. Application interface used in Task 1

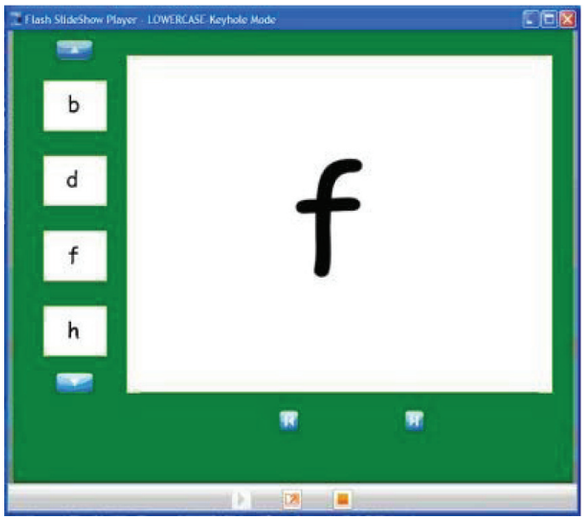


FIGURE 8. Application interface used in Task 2

FIGURE 9. Experimental set up in Task 1

RESULTS

In this experiment, we examined the effects of the two presentation technique modes for this group of children. To remember the items in Task 1 using the carousel mode, students from the normal class took less than three minutes to answer the question and were able to recall 7 to 12 of 13 items. The LINUS students encountered some difficulties and needed more time to remember, with

FIGURE 10. Experimental set up in Task 2

overall scores of 4 to 5 out of the 13 items. However, two students from the normal class scored higher (up to 12 out of 13 items), because they really enjoyed using this presentation mode.

In Task 2, by using the keyhole mode, subjects from both classes were able to answer the question in less than 2 minutes, scoring higher than their scores in Task 1. However, some of the normal class students were not interested with this presentation mode and did not give their full attention. Therefore, these students could only remember 4 out of the 13 items. Table 1 shows the student's scores in Task 1 and Task 2 (i.e., 10 students from the normal class and 10 students from the LINUS program class).

TABLE 1. The scores of the students in Experiment 2(a)

Techniques	Task 1: Carousel Mode		Task 2: Keyhole Mode	
Student	Normal	LINUS	Normal	LINUS
1	11	4	5	7
2	12	4	4	7
3	10	4	11	7
4	9	4	11	8
5	9	5	10	8
6	8	5	10	9
7	8	5	8	9
8	7	5	7	8
9	7	5	7	8
10	7	5	8	9

A paired sample t-test was performed to see the comparison score for each group of students in dynamic and static presentation modes. Mean scores for the normal class students are shown in Tables 2 and 3.

Research Hypothesis: The dynamic presentation mode gives a better score to the normal class students.

Null Hypothesis: The dynamic presentation mode does not give a better score to the normal class students.

TABLE 2. Paired sample statistics for normal class's student

	N	Mean	Std. Deviation	Std. Error Mean
TASK 1	10	8.80	1.751	0.554
TASK 2	10	8.10	2.424	0.767

TABLE 3. Paired sample test for normal class's student

	Paired Differences			t-test for Equality of Means		
Score	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
TASK 1 TASK 2	0.700	3.433	1.086	0.645	9	0.535

The t-test results were not significant ($t = 0.645$, $df = 9$, $p > 0.5$) and therefore, the null hypothesis is accepted. The results show that the dynamic presentation mode does not give a better result for the normal class students. A paired sample t-test was performed to calculate the mean score for the LINUS students. Tables 4 and 5 show the t-test results for the LINUS students.

Research Hypothesis: The static presentation mode gives a better score to the LINUS students.

Null Hypothesis: The static presentation mode does not give a better score to the LINUS students.

TABLE 4. Paired sample statistics for the LINUS student

	N	Mean	Std. Deviation	Std. Error Mean
TASK 1	10	4.60	0.516	0.163
TASK 2	10	8.00	0.816	0.258

TABLE 5. Paired sample test for the LINUS student

	Paired Differences			t-test for Equality of Means		
Score	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
TASK 1 TASK 2	3.400	0.516	0.163	20.821	9	0.000

The t-test results were significant ($t = 20.821$, $df = 9$, $p < 0.5$). The static presentation mode gave a higher score for this group of students. The difference mean score (3.4) shows that the static presentation mode was better than the dynamic presentation mode for the LINUS students. These results indicate that the children's performance was better using the static presentation mode. They could remember more items in the keyhole mode, compared to the carousel mode. However, in some cases, due to user preference, some children scored higher in the carousel mode than they did in the keyhole mode. Figure 11 shows the comparison graph.

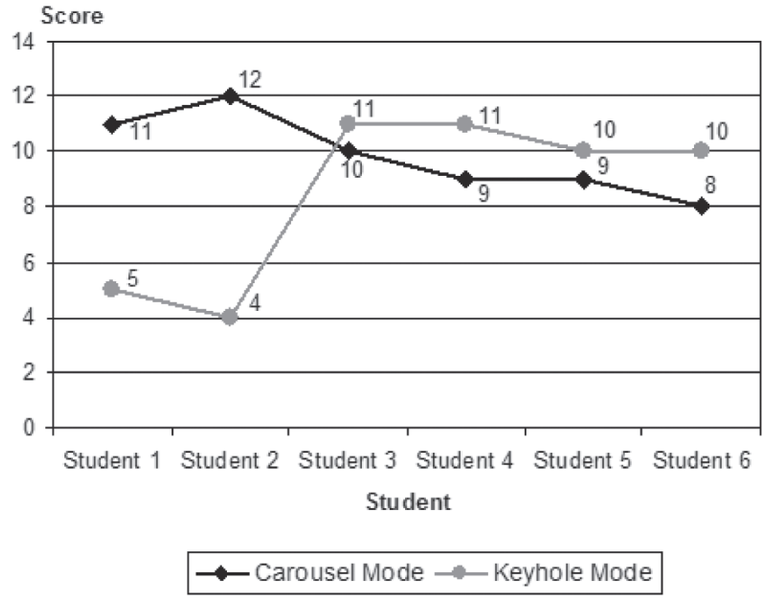


FIGURE 11. A comparison graph of individual student's scores

Experiment 2(b) – This experiment was conducted with the objective of identifying which presentation mode (i.e., dynamic or static) is better in children's learning. The experiment tested the abilities of the normal class students (same level) to identify animal images presented in dynamic and static presentation modes on digital flashcard learning.

Subjects – Ten subjects were selected from Experiment 1's normal class students, and divided into two groups (Group A and B) of five.

Design and procedure – Two interfaces, using the carousel mode and the keyhole mode of the RSVP technique, were developed. The application was written using Flex Builder 3.0 with the flash plug-in and presented on an Intel Pentium-M computer using Adobe Flash Player 10. In this experiment, we used two types of images: (1) a set of animals that give birth, such as bears, cheetahs, cows, dogs, elephants, giraffes, goats, horses, rhinoceroses, and zebras (presented in the moving mode), and (2) a set of animals that lay eggs such as birds, cockroaches, crocodiles, fish, frogs, hens, lizards, spiders, and squid (presented in the static mode). Each set consisted of ten animal images.

Subjects were seated in front of the computer at approximately the same distance and were asked to view the images. Each subject in Group A was presented with a set of animal images using the carousel mode, whilst subjects in Group B were presented using the keyhole mode. We asked subjects to view and remember the animal images. Each subject needed to list the names of animals that they had learned, according to their assigned groups. The two types of stimuli are shown in Figure 12 and 13.

RESULTS

Table 6 shows that in the memory task, the children's performance was significantly better in the keyhole mode. Students in Group B (using the keyhole mode) could remember and identify images more easily, compared to the students in Group A (using the carousel mode).

TABLE 6. Comparison of the result in experiment 2(b)

Techniques	Group A: Carousel Mode	Group B: Keyhole Mode
Time taken	>5 minutes	<5 minutes
Score	1-2 items	5 items
Level	☹ Difficult	☺ Easy

Students in Group A were observed to have some difficulty and confusion in listing their answers. They took more time to recall, compared to the students in Group B; who could remember the items in a shorter time. Figures 14 and 15 show the reactions of students during the experiment. Students in Group A appeared to have difficulty in the task, whilst students in Group B enjoyed answering the questions.

FIGURE 12. A set of animal images presented in the carousel mode

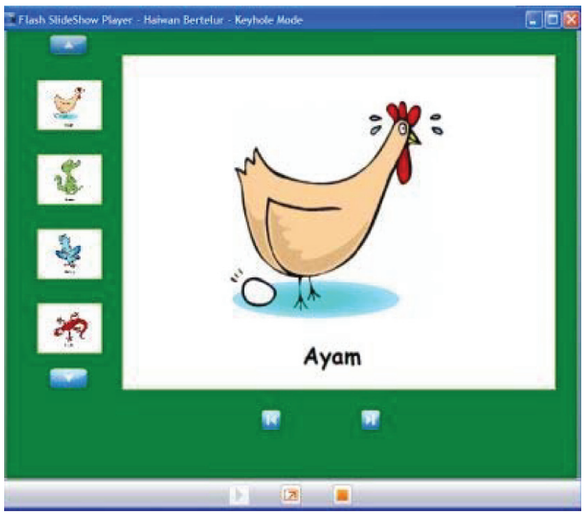


FIGURE 13. A set of animal images presented in the keyhole mode

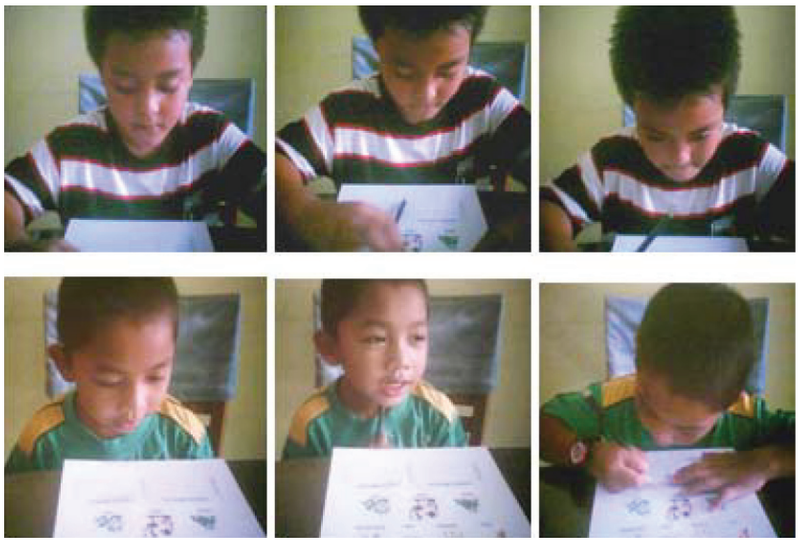


FIGURE 14. Group A students; using the carousel mode.

DISCUSSION

These experiments were challenging as far as the student participants were concerned, because the subjects were unfamiliar with the digital flashcard tools, and because some of them had come from the LINUS program class; which is comprised of children with learning disabilities. Our objective was achieved, as the children accepted using the RSVP technique as part of their learning tools. The findings from the experiments gave positive results. Overall, these groups of students really enjoyed this technique, and from our observation, this technique has the potential of improving their attention to learning, but needs further investigation in a learning context.

Previous studies have shown that in certain learning situations, some learners can benefit more than others from a simultaneous presentation of words and pictures (Acha, 2009). This study shows that students with learning disabilities (i.e., LINUS program class) need more working memory resources than normal students, to shift their attention from target to target, within the RSVP technique's moving mode. In a dynamic presentation mode, using the carousel mode, the LINUS program student's performances were much poorer than those from the normal class.

The results from Experiment 2 indicate that viewers consolidated single pictures into memory, much easier (Task 2) than they consolidated multiple simultaneous pictures in the moving mode (Task 1). Spence (2002) states that presentations in which images move and disappear in different positions in rapid succession naturally require more cognitive processing than static mode presentations.

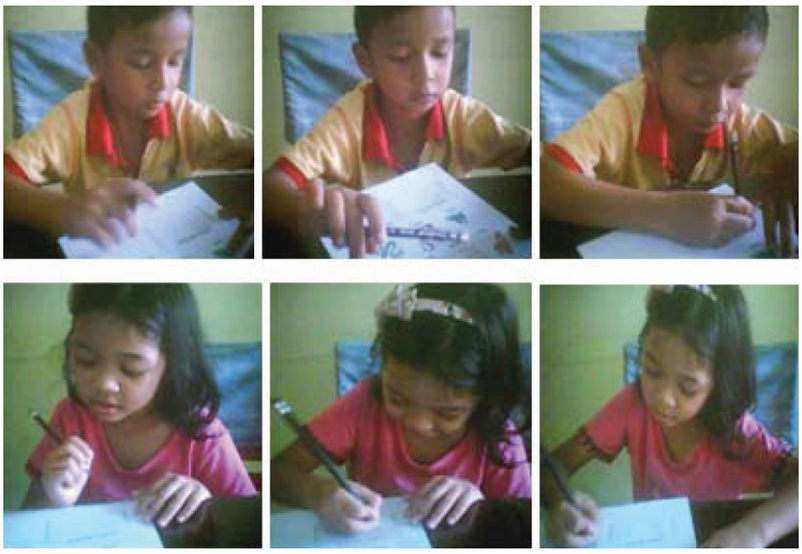


FIGURE 15. Group B students; using the keyhole mode.

However, results in this experiment show that children, who preferred moving objects, gave their full attention during the learning process and could score higher in this presentation mode. This situation was related to a previous study by Nieuwensteinet al. 2007, who found that a previously imagined object, automatically attracted attention when it was presented in a sequence of other objects.

Experiment 2 (Task 2) investigated the children's ability to identify and remember the images that they had learned. Earlier work by Potter (1993) showed that such images can be temporarily understood, but they are then likely to be forgotten within minutes. In the keyhole mode, without moving eye-gaze position at all, subjects could extract a lot of information from a rapidly changing sequence of images. In the carousel mode, subjects had to change the position of their eyes as the presentation proceeded; they may have lost some of the advantages of rapid presentation, simply because they could not keep up (Wittenburg et al. 2003).

CONCLUSION

This study investigated the acceptance of RSVP modes for children, and the children's performances, by using dynamic and static presentations in a digital flashcard context. The RSVP technique has already been shown to have a potential in the general field of information visualization, and our evaluation has also shown that it has potential as an application for children's digital flashcard images. In certain situations, RSVP modes show different acceptance levels amongst users. This work reveals that as far as recognition success and user preferences are concerned, the static presentation mode is better than the dynamic presentation mode. Further research is necessary in the future, particularly on flashcard learning effects. The use of an eye-tracker device to detect eye-gaze would also be interesting to explore.

REFERENCES

Acha, J. 2009. The effectiveness of multimedia programmes in children's vocabulary learning. *British Journal of Educational Technology* 40(1): 23-31.

Akyurek, E.G. & Hommel, B. 2006. Memory operations in Rapid Serial Visual Presentation. *European Journal of Cognitive Psychology* 18(4): 520-536.

Bruijn, O. & Spence, R. 2000. *Rapid Serial Visual Presentation: A space-time trade-off in information presentation*. Proceedings of the Working Conference on Advanced Visual Interfaces (AVI 2000) di Palermo, ITALY, 189-192.

Bruijn, O. & Spence, R. 2002. *Patterns of eye gaze during Rapid Serial Visual Presentation*. Proceedings of Advanced Visual Interfaces (AVI 2002), Trento, Italy, 209-217.

Burns, M.K., Dean, J.D. & Foley, S. 2004)0. Pre-teaching unknown key words with incremental rehearsal to improve reading fluency comprehension with children identified as reading disabled. *Journal of School Psychology* 42: 303-314

Chun, M. Marvin, & Potter, C. Marry. 1991ز A two-stage model for multiple target detection in Rapid Serial Visual Presentation. *Journal of Experimental Psychology: Human Perception and Performance* 21(1): 109-127.

Chun, M. Marvin, & Potter M.C. 1995. A two model for multiple target detection in Rapid Serial Visual Presentation. *Journal of Experimental Psychology: Human Perception and Performance* 21(1): 109-127.

Cooper, K., Bruijin, O., Spence, R. & Witkowski, M. 2006. A comparison of static and moving presentation modes for image collections. ACM, 1-59393-353-0/06/0005.

Dux, P.E. & Coltheart, V. 2005. The meaning of the mask matters. *Research Report in Psychology Science* 16(10).

Ehri, C. Linnea. 2005. Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading* 9(2): 167-188.

Forlines, C., & Balakrishnan, R. 2009. Improving visual search with image segmentation. *ACM Visualization* 978-1-60558-246-7/09/04.

Hauptman G. Alexander, Wei-Hou Lin, Rong Yan, Jun Yang, & Ming-Yu Chen. 2006. *Extreme Video Retrieval: Joint Maximization of Human and Computer Performance*. MM'06. October 22, Santa Barbara, CA.

Jeremy Wolfe, Horowitz, S. Todd, Michod & Kristin, O. 2007. Is visual attention required for robust picture memory? *Vision Research* 47: 955-964.

MacQuarrie, L.L.,Tucker, J.A., Burns, M. K. & Hartman, B. 2002. Comparison of Retention Rates using Traditional, Drill Sandwich, and Incremental Rehearsal Flash Card Method. *School Psychology Review* 31: 584-595

Nieuwenstein, R. Mark, Addie, J., Kanai, R. and Martens, S. 2007. Cross-task repetition amnesia: Impaired recall of RSVP targets held in memory for a secondary task. *Acta Psychologica* 125: 319-333.

Potter, C. Marry. 1993. *Very Short Term Conceptual Memory*," Symposium "Short-term memory: Where do we stand? 32nd Annual Meeting of the Psychonomic Society, San Francisco 1991, 21(2): 156-161.

Raymond, E. Jan, Shapiro, L. Kimron & Arnell, M. Karen. 1992. Temporary suppression of visual processing in an RSVP task, – An Attentional Blink. *Journal of Experimental Psychology. Human Perception and Performance* 18: 849-860.

Skinner, H. Christopher, Fletcher, A. Priscilla & Henington, C. 1996. Increasing learning rates by increasing student response rates: A summary of research. *School Psychology Quarterly* 11: 313-325.

Spence, R. 2002. Rapid, Serial and Visual: A presentation technique with potential. *Information Visualization* 1(1): 13-19.

Stanovich, E. Keith. 1994. Constructivism in reading education. *The Journal of Special Education* 28: 259-274.

Wittenburg, K., Chiyoda, C., Heinrichs, M. & Lanning,T. 2000. *Browsing through Rapid-Fire Imaging: Requirements and industry initiatives*. Proceedings of Electronic Imaging '2000: Internet Imaging, San Jose CA, USA, 48-56.

Wittenburg, K., Forlines, C., Esenther, A., Harada, S. & Miyachi, T. 2003. *Rapid Serial Visual Presentation Techniques for Consumer Digital Video Devices*. UIST '03 Vancouver, BC, Canada 5(1): 115-124.

Young, C. C., Hecimovic, A. & Salzberg, C. L. 1983. Tutor-tutee behavior of disadvantaged kindergarten children during peer teaching. *Education and Treatment of Children* 6: 123-135.

Siti Zahidah Abdullah
Faculty of Information Science and Technology
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor
Malaysia
Email: ctz1986@gmail.com

Dr. Nazlena Mohamad Ali
Institute of Visual Informatics (IVI),
C/o Faculty of Information Science and Technology
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor
Malaysia
Email: nazlena@ivi.ukm.my

Assoc. Prof. Dr. Ir. Riza Sulaiman
Industrial Computing Department
Faculty of Information Science and Technology
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor
Malaysia
Email: rs@ftsm.ukm.my

Mohd Syazwan Baharuddin
Research Officer
Faculty of Information Science And Technology
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor
Malaysia
Email: syazwan@ftsm.ukm.my