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Do Digital Devices Work Better Than Paper Materials for Learning?

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This paper investigates the medium of paper, PCs and iPads as learning devices and describes the results of a comparative experiment that was conducted based on an experimental design regarding the effectiveness and characteristics of the aforementioned media. A comprehension test and questionnaire were conducted on three groups of subjects who were learning using paper, PCs and iPads on to which learning materials relating to information education had been printed or installed. The results of these tests and questionnaires were then compared. The results predict that using paper and an iPad in combination as learning devices provide the best learning effects.

Keywords: Learning devices, iPad, Paper, Digital materials, Learning effects

Introduction

A great deal of literature has been published in relation to media and learning (Andersen, 2011). For example, Kozma (1991) has undertaken many reviews of the research on learning through books, television, computers and multimedia environments. In recent years, PCs, tablets PCs and the Internet have come to be used as learning devices, but recently, it is the iPad that has been attracting interest. The iPad is a slate information terminal, but is rapidly becoming popular as a device that allows the realization of electronic publishing.

At this point, the author would like to call attention to a paper authored by Murphy (2011). In this paper, the author looks at the iPad as a next generation learning device appearing after the personal computer. The features of next

generation learning terminals such as the iPad have been described as highly portable, able to connect to the Internet, have a touchscreen interface (Meurant, 2010) and offer all the characteristics of a laptop computer (Melhuish & Falloon, 2010).

In the past, the author conducted a comparative experiment on learning using paper, desktop PCs, tablet PCs and digital pens. The purpose of this experiment was to clarify whether differences in the input tool (pencils for paper, keyboards for desktop PCs, touch pens for tablet PCs and ballpoint pens for digital pens) exert an influence on memory, comprehension, analysis and synthesis in the learning process. The results of this experiment demonstrated that the same trends were seen in both paper and digital pens, while identical trends were also observed with desktop PCs and tablet PCs (Kato, Kato, Akahori, Yoshimoto, & Sugiyama, 2010).

In this study, paper, notebook PCs and iPads were compared in a parallel experiment conducted using these same learning materials. This experiment was designed to determine three items: (1) Differences in reading ability when using learning materials on paper and when using materials on a terminal screen, (2) differences between turning pages when using paper, the operation of a mouse device when using a desktop PC and the action of touching a screen with a finger when using an iPad, as well as (3) differences between text and diagrams on paper, and text, diagrams and video on desktop PCs and iPads.

Experimental Methodology

The methodology of the experiment in this study is described below. An overview of this experiment's methodology is illustrated in Figure 1. In this experiment, three types of learning materials were prepared: paper materials, iPad materials and PC materials. After this, a total of 60 test subjects were assembled and these were then divided into three groups of 20, with each group studying using a different form of media. Hereafter, these are referred to as the Paper Group, iPad Group and PC Group. Learning materials used were developed and broadcasted as tools for the Open University of Japan. The copyright for these materials belongs to Akahori (Sugai, Akahori, & Nojima, 2002).

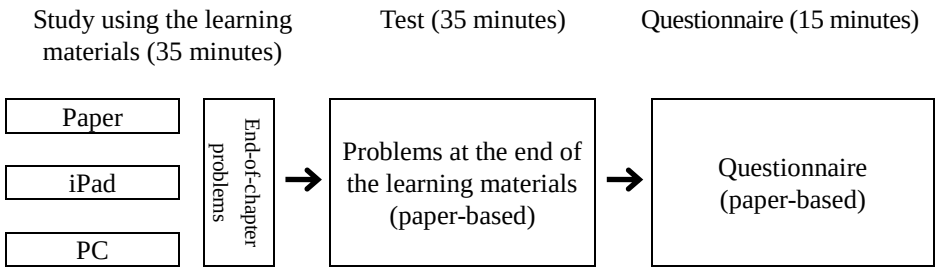

Figure 1. *Flow of the experiment*

Results of the Test Score Analysis

Results of the Overall Scores

The average overall scores for the iPad Group, PC Group and Paper Group are shown in Figure 2. The average overall score that is discussed here refers to the 20 problems that were a combination of the five end-of-chapter problems and the 15 problems at the end of the learning materials. The total score for these 20 problems is 60 points.

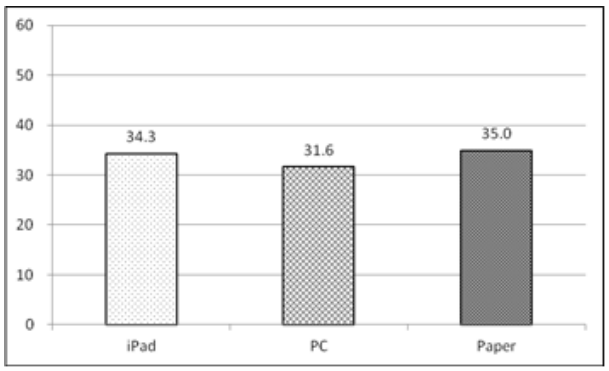

Figure 2. *Results of the overall score*

Summary of the Results of the Analysis

The analysis results for the aforementioned problems are summarized in Table 1. In this table, ◎ indicates that this was the highest score among all three groups; ○ indicates that this was the next highest score among all the groups; and △ indicates the lowest score among all the groups. However, these

symbols do not necessarily reveal the rankings of the three groups; instead, in the event that two of the three groups obtained more or less identical scores, the same symbol was used for both.

It is possible to extract the following characteristics of the various forms of media from these results:

(1) The media of paper has superior results for the end-of-chapter, multiple-choice problems, basic problems and knowledge/comprehension problems. Thus, it is possible to conclude that the media of paper is effective in accurately memorizing and comprehending the contents of learning materials.

(2) iPads have superior results for the overall score, written problems, applied problems and knowledge/comprehension problems. Thus, it is possible to conclude that the media of the iPad is effective for individual thinking and making judgments on their own.

(3) Although identical text, diagrams, photographs and videos were loaded onto the PCs and iPads, subjects in the PC Group were unable to show results as strong as those using iPads and paper. Thus, there is a necessity to conduct further investigation into the media characteristics of PCs. This will be discussed later in the considerations section of this paper.

Table 1. *Analysis results of the problems*

	End-of-chapter problems	Overall Score	Multiple-choice/ Written		Basic/Applied		Knowledge/Comprehension/ Comprehensive		
			Multiple choice	Written	Basic	Applied	Know-ledge	Compre-hension	Compre-hensive
iPad	○	◎	△	◎	△	◎	△	◎	◎
PC	△	△	○	△	○	△	◎	△	○
Paper	◎	◎	◎	○	◎	○	◎	◎	○

Results of the Analysis of the Questionnaire

The selection frequency distribution for the iPad Group, PC Group and Paper Group in regards to boredom and fatigue was analyzed, as shown in figure 2. The results show, paper was the media most likely to induce boredom, while the media least likely to do so was the iPad. In addition, PCs were the media

most likely to cause fatigue, while the media subjects most desired to use again was the iPad.

These results are thought to represent the characteristics of the various forms of media. That is, the media of paper possesses the characteristics of being easy to underline text and take notes, but at the same time it is perceived that this is a form of media that causes fatigue and so requires a certain amount of perseverance in the learning process. On the other hand, while underlining text and taking notes with the iPad is somewhat difficult, it does motivate users to study with it again. Consequently, iPads are characterized by the fact they make it easier to learn without becoming tired of studying and it is possible to perceive that learning with these devices is an enjoyable experience. Underlining text and taking notes is not so easy on a PC and this is likely to cause fatigue. Therefore, it is not possible to perceive that learning on PCs will be an enjoyable experience. These characteristics of the media are cited as the grounds for the difference in the average scores for the problems described in Table 1.

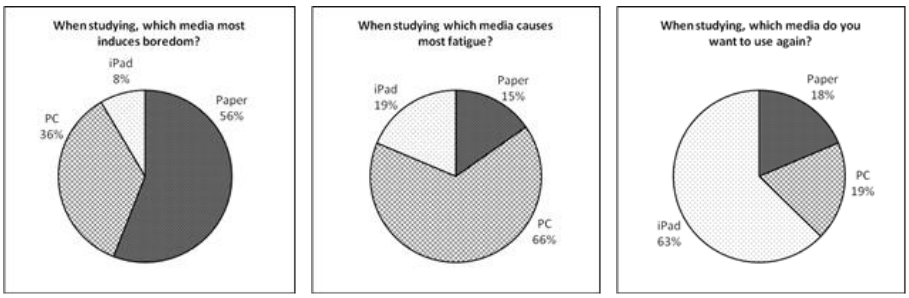

Figure 3. *A comparison of media in regards to boredom and fatigue*

Summary

Accordingly, this research demonstrates that paper is best for learning activities in which the content being studied is memorized or comprehended as knowledge in a predetermined scope. However, unless the users have the motivation to study, they are likely to become bored by using paper and this makes continuous learning a challenge. On the other hand, the iPad is best suited to problems in which an individual needs to comprehensively express their own thoughts and judgments. Also, iPads are characterized by the fact they encourage learners to continue with their studies. No particular special

features were observed with PCs. The content installed on both iPads and PCs is identical, so any difference is entirely due to the variation in the media. This difference is a point that is extremely interesting. That is, there is great variation in the learning effects of the media and device, even when the digital learning material is identical. Thus the main difference between iPads and PCs is the interface.

The operations of iPads are centered on touch control. In contrast to this, the operations of PCs rely mainly on the keyboard and mouse. Therefore, it is assumed that the effect of touching the screen of iPads directly with one's fingers is greater than that with a PC keyboard and mouse. Regarding paper, it is possible to write directly on it with a pencil and it is also possible to touch it with one's fingers. It may be correct to say that the difference in direct contact like this is one of the primary factors that have an impact on learning effects.

Furthermore, paper-based material has the characteristic of being able to take an overall view in that it is possible to browse through all of the learning content. On iPads and PCs, the learning material can be viewed only within a scope that is limited by the size of the screen, so these forms of media are inferior in terms of grasping an overall view of the content. In this respect, it is believed that paper is superior in terms of accurately memorizing and comprehending content described in learning materials. On the other hand, it is possible to load maps and videos onto iPads and PCs that cannot be included in a paper format. These supplementary forms can also contain a large amount of information with which it is possible for subjects to make judgments. The iPads were also superior in terms of comprehensively expressing an individual's ideas. Nevertheless, although there are significant differences between iPads and PCs, it is assumed that these differences are attributable to whether or not it is possible to perform direct operations as outlined earlier.

References

Andersen, L. (2011). Podcasting, cognitive theory, and Really Simple Syndication: What is the potential impact when used together? *Journal of Educational Multimedia and Hypermedia, 20*(3), 219-234.

Kato Y., Kato S., Akahori K., Yoshimoto M., & Sugiyama Y. (2010). Comparative analysis about the test using four kinds of media: Digital

pen, tablet PC, PC, and paper and pencil. *Proceedings of the 26th Annual Conference of the Japan Society for Educational Technology 2010*, 681-682 (Japanese).

Kozma, R. B. (1991). Learning with media. *Review of Educational Research, 61*(2), 179-212.

Melhuish, K., & Falloon, G. (2010). Looking to the future: M-learning with the iPad. *Computers in New Zealand Schools: Learning, Leading, Technology, 22*(3), 1-16.

Meurant, R. (2010). The iPad and EFL digital literacy. *Communications in Computer and Information Science*, *123*, 224-234.

Murphy, G. D. (2011). Post-PC devices: A summary of early iPad technology adoption in tertiary environments. *E-Journal of Business Education & Scholarship of Teaching, 5*(1), 18-32. Retrieved from http://www.ejbest.org.

Sugai K., Akahori K., & Nojima E. (2002). Information education – Educational technology approach. Retrieved from http://www.ua-book.or.jp.