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Does Digital Handwriting of Instructors Using the iPad Enhance Student Learning?

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Abstract Recently, projected electronic slides have been the most common tool used in classrooms. However, electronic projection slides, such as PowerPoint slides, do not provide sufficient flexibility to augment the displayed materials; therefore, instructors are not able to adjust their instruction instantly in response to the audience reaction and needs. Accordingly, many studies have suggested the use of tablet PC-based presentation tools in order to enable real-time handwritten annotations on predeveloped materials. Based on this rationale, the present study was designed in order to examine the effects of a tablet device (iPad in this study)-based instructors' digital handwriting on students' learning. Participants were 36 undergraduate students: half of the students were instructed using the typical PowerPoint-based presentation without the digital handwriting of the instructor, whereas the other half of the students were instructed using a tablet-based presentation with the instructor's digital handwriting. Results from a MANCOVA revealed a significant main effect for the presentation mode. Two follow-up ANCOVAs revealed that students in the tablet-based instructor's digital handwriting condition significantly outperformed the students in the animated PowerPoint-based presentation lecture for conceptual knowledge acquisition, despite the fact that there was no statistical difference in factual knowledge acquisition.

Keywords Technology integration · Digital handwriting · Tablet PC

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Introduction

Presentation technology, such as the blackboard and the overhead projector, has been utilized for a long period of time in order to deliver instruction. The virtue of these tools was that they enabled us to maintain a shared view between the instructor and students in class (Driessnack 2005; Stein 2006). When something is written on the board, most students in the classroom are likely to *perceive* it in a similar context, since information remains for a certain amount of time and provides a visual representation from the instructor. Although every individual would eventually *process* it differently, chances are students would recall the information as it was illustrated and organized on the board. Hence, almost every classroom is equipped with blackboards, and more recently projectors and screens, which have been set up for the use of electronic slides developed by presentation software, became the most common tool for sharing contents.

The advantages of such electronic media are as follows: First, instructors tend to prepare slides in advance, and therefore the chance of improving the structure of the lecture increases. Second, information-rich contents, including complex tables, diagrams, high quality examples and illustrations, are more easily integrated into the instruction. Third, instructional materials are easily shared, edited, and reused since they are in digital format (Anderson et al. 2004). Moreover, students can print and bring the materials for class; thus, they do not need to jot down every word during instruction. However, there are limitations in the use of electronic slides created by presentation software such as PowerPoint™. The projection of PowerPoint slides does not provide sufficient flexibility to augment the displayed materials. Instructors who feel the need to instantly present some content tend to write or draw on the blackboard

located by or behind the screen. In particular, this transition is not an easy task for less skilled instructors who depend heavily on predeveloped slides. Besides, the combination of PowerPoint and regular PC only allows for keyboard typing, which is quite limited for instructors who deal with extensive formulas and diagrams (Lim 2011).

After the PowerPoint software was introduced as a presentation tool for teaching, there has been an ongoing debate as to the benefit of using PowerPoint. At that time, the comparisons of overhead transparencies versus PowerPoint slides and traditional lectures versus PowerPoint lectures were investigated in order to figure out the impact of educational technology. The results were mixed: Some studies reported no statistically significant differences in student performance (Apperson et al. 2006; Susskind 2005), whereas others reported significant differences (Amare 2006; Erwin and Rieppi 1999). Despite the debate over the benefit of PowerPoint features, it has been agreed that students are likely to pay more attention to the material presented visually on the slides and accordingly, PowerPoint-based lectures may benefit in the retention of information due to the use of animated presentation, bullet-pointed keywords, and graphical images (Szabo and Hastings 2000). On the other hand, critics of PowerPoint claimed that the use of a preorganized, bulleted list of information may also stifle discussion and reduce the analytical qualities of the presentation as well as the verbal and spatial reasoning (Stein 2006).

Recently, tablet PCs have been drawing attention from practitioners and researchers in order to resolve these issues. A tablet PC is a versatile, mobile device with computing power along with a digitized pen for enhanced functionality, such as handwriting and the ability to annotate documents with digital ink (Steinweg et al. 2010). These affordances of tablet PCs to combine the advantages of the traditional presentation methods, such as blackboards and PowerPoint presentation, while mitigating their limitations have been explored. The literature supports the following advantages in the educational use of the tablet PC (Roschelle et al. 2007; Toto et al. 2007). First, compared to typing, digital ink enables more efficient and vivid representation through free handwriting, which leads to focus the students' attention on the key features of these visuals. Second, the quality of the interaction between the teacher and students can be changed since the tablet PC enables an instructor to mark up flexibly, while retaining facial contact with students. Lastly, annotated lecture notes become available online for students. That is, instructors have started using the tablet PC as a device to integrate digital ink with slides, allowing annotation with natural handwriting.

Brophy and Walker (2005) reported that students were more likely to pay attention during lecture and recognized more salient points of the presentation when instructors annotated on the slides on the fly. Also, Clark et al. (2007) concluded that students perceived that the instructor's use of the tablet PC supported their learning. More recently, research on the outcome of tablet PCs has been elaborated. For example, Brodie and Loch (2009) investigated the effects of digital-handwritten feedback using a tablet PC and Yoon and Sneddon (2011) explored the effects of tablet PC-based recorded lectures in undergraduate mathematic courses. However, most studies examined students' perception on learning, rather than directly measuring students' learning gains.

Today, we have a more advanced, easier to use, and a lighter version of a tablet device, such as the iPad and the Galaxy Tab. More importantly, they are cheaper and readily available for a large group of people compared to the traditional tablet PCs. Therefore, it is worth investigating the effective use of this new tablet device in order to improve learning. In this study, the impact of a tablet-based instructors' digital handwriting, that is, the key affordance of tablet devices, on students' learning was examined. Specifically, this study was designed to answer the following two questions: (a) Does the instructor's tablet-based digital handwriting lead to students' better acquisition of factual knowledge compared to an animated PowerPoint-based presentation lecture? (b) Does the instructor's tablet-based digital handwriting lead to students' better acquisition of conceptual knowledge compared to an animated PowerPoint-based presentation lecture?

Methodology

Participants and Treatment

The participants were 36 junior level college students. As a control group, one half of the participants, that is, 18 students, were instructed using the typical PowerPoint-based presentation without the instructor's digital handwriting. As an experimental group, the other half of the participants was instructed using the tablet-based presentation with the instructor's digital handwriting. In this study, the instructor used an iPad for the tablet-based presentation and the PDF Note® application for instant digital handwriting (see Fig. 1). The instructor developed PowerPoint slides for the session, and then the slides were transformed as a PDF file. In the experimental session, the instructor projected the PDF file using the PDF Note® application and instantly handwrote on the slides during the session by underlining, marking up, and annotating keywords. PowerPoint slides run through podium computer for the control group as well as the PDF file run through the iPad for the experimental group were projected to the main screen located at the center of the classroom. The contents of the study dealt with learning theories and were

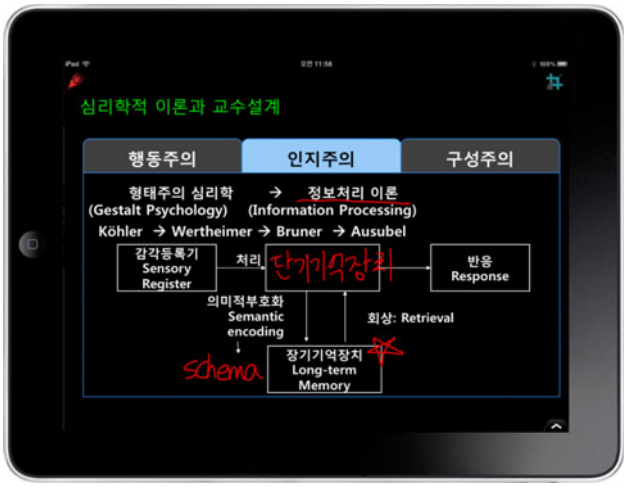

Fig. 1 An example of an iPad-based instant digital handwriting

Table 1 Measurement instruments

Constructs	Number of items	Reliability (α)
Prior knowledge	10	0.84
Knowledge acquisition		
Factual knowledge	10	0.68
Conceptual knowledge	10	0.62
Total	20	0.78

identically delivered for the control and experimental groups for a 2-h session. The annotated information provided for the iPad group was included as the animated information in the PowerPoint-based slides for the control group. Thus, the only critical difference in treatment was the instantaneous handwriting during lecture.

Measurement Instruments and Procedure

Before instruction, all of the participants took a pre-test, which consisted of ten items that required learners to match theorists to the related terminologies, in order to control participants' prior knowledge on the contents. The pre-test was reviewed by two content experts and revised based on a careful review of "corrected-item-total correlation" of a pilot test. The reliability of the test items using Cronbach's alpha was 0.84.

In order to measure the students' learning outcome, a 20-item test was administered. The two content experts also reviewed this post-test and revised some of the items based on a review of the "corrected-item-total correlation" of the pilot test. This instrument included two types of knowledge: factual and conceptual. Factual knowledge consists of basic elements that learners must know in order to be acquainted with the discipline, involving a recall or recognition of a single piece of information. Conceptual knowledge relates to the interrelationships among the basic elements within a larger structure involving understanding (Anderson et al. 2001). In this study, the first half of the ten items tested students' factual knowledge of specific terms and definitions relevant to the instruction. The second half of the ten items tested students' understanding of the instructed contents. The reliability of the test items using Cronbach's alpha was 0.78 (see Table 1).

Data Analysis

Data were analyzed using a multivariate analysis of covariance (MANCOVA), followed by two analyses of covariance (ANCOVA). Factual knowledge acquisition and conceptual knowledge acquisition were the dependent variables for the MANCOVA. In order to control the prior knowledge of students, the pre-test scores were used as the covariate. For all statistical analyses, a level of significance at 0.05 was chosen. To validate the use of the parametric tests, a correlation between factual knowledge and conceptual knowledge, homogeneity of groups, and normality of dependent variables was examined. The results revealed that none of the assumptions were violated.

Results

Students' performances in the pre- and post-test for each of the two groups are presented in Table 2. One-way ANOVA for the pre-test results indicated that the two conditions were comparable regarding students' prior knowledge ($F(1, 34) = 2.330$, $p = 0.136$, partial $\eta^2 = 0.064$).

Table 2 Means and SDs for knowledge acquisition

	Tablet PC-based instructor's digital handwriting			Animated PowerPoint-based presentation lecture		
	M	SD	*n*	M	SD	*n*
Pre-test	3.33	3.25	18	4.88	2.84	18
Post-test						
Factual	7.77	0.14		7.72	0.21	
Conceptual	7.94	0.16		6.72	0.21	

Results from the MANCOVA revealed a significant main effect for the presentation mode regarding the two dependent variables of the post-test (Wilk's Lambda: ($F(2, 32) = 3.599$, $p = 0.039$, partial $\eta^2 = 0.184$)). To determine whether the two dependent measures differed independently under the two conditions, two follow-up ANCOVAs were conducted with pre-test scores entered as the covariate. There was no statistical difference for factual knowledge acquisition ($F(1, 33) = 0.344$, $p = 0.561$, partial $\eta^2 = 0.010$). However, for conceptual knowledge acquisition, the students in the tablet PC-based instructor's digital handwriting condition significantly outperformed the students in the animated PowerPoint-based presentation lecture ($F(1, 33) = 6.287$, $p = 0.017$, partial $\eta^2 = 0.160$).

Conclusion

The results revealed that the tablet PC-based instructor's instant digital handwriting was more effective than the animated PowerPoint-based presentation lecture on students' conceptual knowledge acquisition; however, there was no difference on students' factual knowledge acquisition. This notion reminds us of the discussion of the effectiveness of the chalk and the blackboard. When instructors write with chalk on the blackboard, learners are able to see the progressive development of the contents (Hulls 2005), meaning that learners are able to follow the instructor's cognitive process, which might have disappeared in the PowerPoint-based presentation. After all, tablet PC-based instructor's instant digital handwriting is a mixture of electronic projection, which we often benefit from using PowerPoint, and instant handwriting, which we used to benefit from using the traditional chalk and blackboard.

The opportunity for students to comment on the instructor's use of the instant digital handwriting was voluntary, and the comments were very positive:

> I liked the feeling that the teacher's thought process was shared with students.
>
> When I take notes, I can just simply write down exactly the same thing as what the teacher wrote. Very convenient.
>
> Teacher responded more flexibly to student questions in class.

It is clear from this research on instant digital handwriting that there is no simple advantage of technology (Ellis et al. 2011). We have learned that improving learning is not simply adopting a new technology in the classroom. This leads us to much more interesting and challenging issues of understanding how to best use new media in education. The significance of this study lies in the research focus that investigates learners' achievement, rather than the perception that previous studies have examined, when instant digital handwriting was provided as an instructional intervention.

References

Amare, N. (2006). To slideware or not to slideware: Students' experiences with PowerPoint™ vs. Lecture. *Journal of Technical Writing and Communication, 36*(3), 297–308.

Anderson, R., Anderson, R., Simon, B., Wolfman, S. A., VanDeGrift, T., & Yasuhara, K. (2004). *Experiences with a tablet PC based lecture presentation system in computer science courses.* In Proceedings of the 35th SIGCSE Technical Symposium on Computer Science Education. Virginia: Norfolk, 03–07 March.

Anderson, L. W. (Ed.), Krathwohl, D. R. (Ed.), Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of bloom's taxonomy of educational objectives, complete edition*. New York: Longman.

Apperson, J. M., Laws, E. L., & Scepansy, J. A. (2006). The impact of presentation graphics on students' experience in the classroom. *Computers and Education, 47*, 116–126.

Brodie, L., & Loch, B. (2009). *Annotations with a tablet PC or typed feedback: Does it make a difference?* In Proceedings of the 20th Australasian Association for Engineering Education Conference. Adelaide: The University of Adelaide, 6–9 December.

Brophy, S., & Walker, G. (2005). *Case study of the pedagogical impact of tablet PCs as a presentation medium in large-scale engineering classrooms*. Paper presented at the ASEE (American Society for Engineering Education), Portland, Oregon.

Clark, S., Taylor, L., & Pickering, J. (2007). *Understanding the impact of tablet PCs on students' learning and academics' teaching*. In Proceedings of the Second Innovation in Accounting and Corporate Governance Education Conference. Hobart, Tasmania, 31 January–2 February.

Driessnack, M. (2005). A closer look at PowerPoint™ feature article. *Journal of Nursing Education, 44*(8), 347.

Ellis, R., Barrett, B., Higa, C., & Bliuc, A. (2011). Student experiences of learning technologies across the Asia Pacific region. *The Asia-Pacific Education Researcher, 20*(1), 103–117.

Erwin, T. D., & Rieppi, R. (1999). Comparing multimedia and traditional approaches in undergraduate psychology classes. *Teaching of Psychology, 26*(1), 58–61.

Hulls, C. C. W. (2005). *Using a tablet PC for classroom instruction*. In Proceedings of the 35th Annual Conference of Frontiers in Education, Indianapolis, Indiana, 19–22 October.

Lim, K. Y. (2011). What does the tablet PC mean to you? A phenomenological research. *Innovations in Education and Teaching International, 48*(3), 323–333.

Roschelle, J., Tatar, D., Chaudhury, S., Dimitriadis, Y., Patton, C., & DiGiano, C. (2007). Ink, improvisation, and interactive engagement: Learning with tablets. *Computers, 40*(9), 42–48.

Stein, K. (2006). The dos and don'ts of PowerPoint™ presentations. *Journal of the American Dietetic Association, 106*(11), 1745–1748.

Steinweg, S., Williams, S., & Stapleton, J. (2010). Faculty use of tablet PCs in teacher education and K-12 settings. *TechTrends, 54*(3), 54–61.

Susskind, J. E. (2005). PowerPoint™'s power in the classroom: Enhancing students' self-efficacy and attitudes. *Computers and Education, 45*(2), 203–215.

Szabo, A., & Hastings, N. (2000). Using IT in the undergraduate classroom: Should we replace the blackboard with PowerPoint™? *Computers and Education, 45*(2), 203–215.

Toto, R., Lim, K. Y., & Wise, J. (2007). Supporting innovation: The diffusion and adoption of tablet PCs in the college of engineering. In D. A. Berque, J. C. Prey, & R. H. Reed (Eds.), *The impact of tablet PCs and pen-based technology on education*. West Lafayette: Purdue University Press.

Yoon, C., & Sneddon, J. (2011). Student perceptions of effective use of tablet PC recorded lectures in undergraduate mathematics courses. *International Journal of Mathematical Education in Science and Technology, 42*(4), 425–445.