Promoting Knowledge Transfer With Electronic Note Taking

Andrew D. Katayama
United States Air Force Academy

R. Neal Shambaugh and Tasneem Doctor
West Virginia University

We investigated the differences between (a) copying and pasting text versus typed note-taking methods of constructing study notes simultaneously with (b) vertically scaffolded versus horizontally scaffold notes on knowledge transfer. Forty-seven undergraduate educational psychology students participated. Materials included 2 electronic chapter-length texts, 2 sets of computerized study notes, 2 tests (fact and application), and an attitudinal survey. Only the application test revealed a significant main effect for notes format. We conclude that keying in notes leads to higher retention of knowledge transfer than copying and pasting notes after a 1-week delay.

When students construct study notes to accompany text, they often perform better than students who studied notes provided by their instructor (Anderson & Armbruster, 1985; Russell, Caris, Harris, & Hendricson, 1983). Encoding one's notes using visual formats, such as concept maps (e.g., multidimensional diagrams using arrows and nodes), graphic organizers (e.g., two-dimensional matrices), and interactive study guides (e.g., electronic notes) serves to personalize individual knowledge construction (Katayama & Crooks, 2001; Shambaugh, 1999). In particular, when teachers presented graphic organizers before a text passage, student understanding was much improved when compared to no graphic aid (Brown, 1992; Hartman, 2002; Mayer, 1989).

Studies by Katayama and colleagues (Katayama & Crooks, 2003; Katayama & Robinson, 2000) suggest that students prefer copying and pasting text into their outlines or comparable study guides to actually typing their notes. However, few studies have examined electronic note-taking practices. The few studies that have examined this practice have noted that students will almost always choose not to take notes or rely exclusively on instructor-provided lecture notes (Graham, 2001). Furthermore, the new wave of studying has shifted from traditional pencil-and-paper notes to an electronic format (Igo, Bruning, & McCrudden, 2004; Waschull, 2001). Our empirical question was whether typed note taking provides for deeper encoding of information than the more preferred copying and pasting of text. We compared electronic partial graphic organizers (i.e., two-dimensional matrices where half of the information was provided) across two note-taking conditions: (a) format (typed note taking vs. copying and pasting text) and (b) scaffold (down vs. across notes cells). We hypothesized that typed-in notes are more effective for transferring knowledge than copying and pasting one's notes into the same study template. Based on research involving active learning and efficient encoding of paper-and-pencil notes (Benton, Kiewra, Whitfill, & Dennison, 1993) and with hypertext (Shapiro, 1998), we believed that the activity of typing in notes would lead to higher knowledge transfer than copying and pasting text because the act of typing in notes would promote greater cognitive encoding. Our prediction is consistent with research engaging students in the learning process by using active learning techniques (Newlin & Wang, 2002). Because electronic note-taking methods are relatively new and fairly complex, we wanted to narrow our study on the note-taking format. As a result, we decided to see if vertical scaffolding of notes provided any advantages to test performance when compared to the horizontal scaffolding of notes. The scaffolding mechanism not only provides an example of what type of notes to take, but also how much.

Method

Participants

Forty-seven undergraduate students (35 women and 12 men) enrolled in two separate sections of educational psychology at a large Eastern state university participated in our study in exchange for extra credit. The institutional review board at the university granted us permission by exemption to conduct this study, and all students completed an informed consent form prior to participating in our study.

Materials

We loaded the study materials on several computers in a computer lab. Crooks and White (2002) at Texas Tech University wrote the program. We used Macromedia Director 8 Shockwave Studio Educational Version to run the program. The study materials included two short chapter-length texts (approximately 2,000 words each) covering the basics of technology integration on the Web, two sets of study notes (corresponding to each of the two text passages), and two tests (fact and application), plus an attitudinal survey.

We administered the fact and application tests to each participant as hard copies. The tests consisted of (a) 10 four-item multiple-choice questions for which students had to recall information stated in the text and (b) 25 four-item multiple-choice questions for which students had to apply their understanding of the technology to real-life situations. For each application question, participants read a scenario and selected from four possible solutions. We gave the participants approximately 20 min to complete the tests. We also gave an attitudinal survey to each participant at the end of the testing session to collect information regarding prior knowledge about the content, interest level of the content, sufficient time to complete the tasks, and appeal of studying on the computer versus traditional textbook and paper. We also asked the participants for demographic information (e.g., age and gender) and academic information (i.e., grade point average).

Procedure

We replicated several procedural features of Mayer's (1983) study, using retention and application tests to assess learning. In the note-taking group, students typed their notes into the respective fields. The program did not allow the students to use the keyboard or mouse functions to copy and paste text into their notes. In contrast, students in the text copy and paste condition used their mouse to copy and paste information into their notes. The program did not allow students to type any additional notes. Participants read two short chapter-length passages of text (information about animation and graphics on the Web) and took notes. After 1 week, we gave participants 15 min to review their notes, take the two tests, and then complete the attitudinal survey. We implemented a 1-week delay before testing over the material to simulate a more genuine test of long-term memory (Robinson, Katayama, Dubois, & DeVaney, 1998).

We exposed all groups to the text and study materials on the computer for the same amount of time. We recorded time spent on taking or copying notes, time spent on reading the text, and number of notes typed or copied into the program during the study session (measured in kilobytes).

We randomly assigned participants to one of the two notes formats: typed note taking versus copying and pasting text, and the program randomly distributed the scaffolding condition evenly across the notes conditions. The program randomly selected a different row in which the scaffolded information appeared on the screen (e.g., some students had information scaffolded across the first row whereas other students had information scaffolded across the second row).

We first gave a 5-min demonstration to help the students navigate through the software program. We gave the students 40 min to read, perform their assigned study activity, and review their notes. After 1 week, students returned to the computer lab and reviewed their work from the previous week. We did not allow students to take any additional notes. After 15 min, we asked students to close their programs and we then gave the participants a 20-min test that consisted of a set of multiple-choice questions to test their recall. Two graduate assistants scored all tests using answer keys. Interrater reliability was 95% in agreement on a subsample of randomly selected tests.

Results

Fact Test

Due to the relation between students' prior knowledge of the content and the outcome measure on the fact test, $r(47) = .28$, $p = .05$, we controlled for prior knowledge in the fact test analysis and conducted a 2 × 2 factorial ANCOVA on the fact test. We found that the main effect of notes format was not statistically significant, $F(1, 39) = 2.93$, $p = .095$. The scaffolding variable was not statistically significant, $F(3, 39) = .32$, $p = .81$, nor was the interaction between notes condition and scaffolding condition, $F(3, 39) = .55$, $p = .65$. Therefore, performance on the fact test was not significantly different for typing notes when compared to copying and pasting text. This lack of statistical significance is not surprising given the small sample size and accompanying low power. Power analyses yielded observed power estimates of .39 for notes, .11 for scaffolding, and .15 for the interaction between notes and scaffolding. According to Cook and Campbell (1979), all three power estimates are relatively low. Analyses of the effect sizes revealed that study notes had a moderate effect ($\eta^2 = .07$), scaffolding had a small effect ($\eta^2 = .024$), and the notes by scaffold interaction had a small effect ($\eta^2 = .04$).

Application Test

Because Pearson's correlation was not statistically significant between prior knowledge and the transfer test, $r(47) = .13$, $p = .38$, we did not control for prior knowledge in the design of the analysis. The main effect of the notes condition was statistically significant, $F(1, 40) = 30.14$, $p = .001$. The typed note-taking condition ($M = 14.59$, $SD = 1.85$) significantly outperformed the copying and pasting condition ($M = 13.12$, $SD = 1.81$). The scaffolding condition was not statistically significant, $F(3, 40) = .65$, $p = .58$, nor was the interaction between notes conditions and scaffolding conditions, $F(3, 40) = .80$, $p = .50$. After a 1-week delay, we found that students in the typed note-taking condition did better on the application test than students in the copying and pasting text condition regardless of scaffolding format. Effect sizes showed that notes had a large effect ($\eta^2 = .41$), scaffolding had a small effect ($\eta^2 = .02$), and the notes by scaffold interaction had a small effect ($\eta^2 = .001$).

Discussion

There appears to be an advantage for typed note taking compared with copying and pasting text into a study template when knowledge application is under investigation. However, with factual knowledge, there seems to be little benefit from typing notes when compared to copying and pasting text into study templates. This finding is consistent with previous research concerning graphic organizers and fact-based tests (see Kiewra, 1989, for a review). Likewise, the two types of scaffolding had little effect on learning. We found that the more students attended to constructing their notes (e.g., typed note taking), the higher the probability they would be able to apply that information over a delayed period of time. Hence, copying and pasting notes into a study guide template seemed to provide limited internal encoding of the information. Our finding was supported by the lower application scores within the copying and pasting text condition. These results suggest that information studied via this surface level of study guide construction seemed to be less effective when compared to the typed note-taking condition. The process of taking (keying in) notes is an active process that increases the internal encoding of information being learned (Dreher & Guthrie, 1990; Guthrie, 1988).

Limitations of our study have to do with time and the design. By allowing students to review their notes after the 1-week delay, we introduced a possible confound to long-term memory. Another limitation of our study concerns the cognitive demands of conceptual learning. Were the tasks demanding and authentic enough to investigate an interactive effect on conceptual learning over time? We also observed the students in the copying and pasting text condition as spending slightly more time on task reviewing their notes than the group that typed their notes, which may have posed a potential confound in our design. A final limitation has to do with the assessment of students' comfort level of taking notes on the computer in a timed session. From our survey data, we learned that students were most comfortable taking notes at their own pace without researchers present in a laboratory setting observing their behaviors. Our observations may have influenced how they took notes as well as how well they studied their notes, hence affecting the level of encoding and their performance on the tests.

Our study has implications for students who distribute their note construction and study sessions over a longer period of time (e.g., preparing for a final exam 2 weeks prior to the exam). Researchers may consider increasing the cognitive demands of the task, such as using a conceptual learning model over time (e.g., an entire semester). To address the students' comfort level of taking notes on the computer, researchers could allow students to work at their own pace (e.g., out of class on their own time) and require students to produce a set of notes given a specific deadline that would be consistent for both conditions (typed note taking and copying and pasting text). In addition, a more authentic context of using the treatment conditions might confirm these results along different types of conceptual learning.

In conclusion, we found an advantage for typed note taking over copying and pasting text into a study template when students learned material on the computer. Our study provided support for this finding when students applied their knowledge to a novel situation after 1 week. We believe our finding is evidence that typing notes is a deeper process in terms of cognitive encoding when compared to copying and pasting notes. However, our study failed to show any differences between scaffolding notes vertically or horizontally and any effects these formats may have on student learning.

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Notes

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2. Send correspondence to Andrew D. Katayama, United States Air Force Academy, Department of Behavioral Sciences & Leadership, HQ USAFA/DFBL, 2354 Fairchild Drive, Suite 6L101B, USAF Academy, CO 80840–6228; e-mail: andrew.katayama@usafa.af.mil.