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ABSTRACT

Readily accessible computer technologies including on-line notepads provide new environments for notetaking. This study sought to describe the effects of technology on the notetaking strategies and behaviors of university students. The following questions were addressed: (1) Given a choice, do students prefer taking notes from a computer tutorial using pencil and paper or the computer itself? (2) Is there a relationship between the subject's confidence level towards using computer related technology and the method of notetaking selected? (3) Does the method of notetaking affect time on task or achievement? and (4) Does the content of the notes (word count, percent of information copied, and percent of main ideas) differ significantly between students who used pencil and paper and those that used a computer? Findings indicate that taking notes from computer-based instruction (CBI) using an on-line notepad: promotes greater achievement than pencil and paper methods; is preferred by learners who report higher confidence ratings towards new technologies; and promotes minimal recording of the learner's own thoughts. No significant difference was found was found between the two groups' average time per module spent reviewing and taking notes. Results are illustrated in six tables. (Contains 13 references.) (Author/MAS)

Title:

A Comparison of On-Line and Traditional Paper and Pencil Notetaking Methods During Computer-Delivered Instruction

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Abstract

Readily accessible computer technologies including on-line notepads provide new environments for notetaking research. Findings from this study indicate that taking notes from CBI using an on-line notepad: promotes greater achievement than pencil and paper methods; is preferred by learners who report higher confidence ratings towards new technologies; and promotes minimal recording of the learner's own thoughts.

Prior to the paradigmatic shift towards cognitivism in the mid 1970's, the significance of notetaking was openly challenged. Gagne' states in the 1970 addition of his text *The Conditions of Learning* that "Most (students) may be taking notes, which as far as anyone knows is an entirely useless activity quite unrelated to learning." Gage and Berliner in their 1975 publication of *Educational Psychology* suggest that "Notetaking may be effective only when a student's short term memory is relatively high." Despite of comments like this, learners have been encouraged for decades to take notes during lectures and from readings and to use them as a source of review (Hartley and Davies, 1978).

The movement towards cognitivism was significant because it shifted the focus to the learner's cognitive state and processing strategies as the primary determiners of learning. Wittrock's generative model of learning sought to summarize the constructive processes between the individual and stimuli required for learning. According to Wittrock's model, when a motivated learner is presented with a stimulus (lecture material, text readings, illustrations, etc.), the learner constructs and assigns meaning to it based on prior learning. Previously learned information used in constructing meaning for the stimulus may consist of rules, algorithms, schemata, or image or verbal memories of specific experiences. The goal of this construction process is to form associations. The more associations that the learner can establish between the stimulus and previously learned material, the more meaning the stimulus has associated with it, thus providing a better chance for it to be encoded into memory (Wittrock, 1974, 1978).

It is at this point, when the learner is actively engaged in building associations between what is known and that which is to be interpreted, that the inherent value of notetaking as a generative learning activity becomes apparent. Generative activities such as cognitive mapping, generating questions or mnemonic memory aids, underlining. paraphrasing, summarizing, and notetaking require the learner to knowingly and intentionally relate new information to their knowledge rather than passing over or responding to material without personal intervention.

The merits of notetaking can be viewed from two different perspectives: as a facilitator for encoding information into memory or as an external storage medium to enhance review of the subject matter (Di Vesta & Gray, 1972). The encoding hypothesis implies that notetaking is an individual task through which learners can actively integrate and elaborate upon what they hear, see, or read with their prior knowledge. Once generated, the external storage hypothesis posits that the notes themselves function as a review tool, a form of external storage device.

The majority of research studies on notetaking to date have utilized live-lecture situations and conclude that notetaking facilitates learning either through encoding or external storage or a combination of both (Hartley, 1983, Ladas, 1980, Henk & Stahl, 1985). Only a limited number of studies involving notetaking from text, films, and television exist (Hartley, 1983). Research conducted utilizing text suggests that the encoding function of notetaking is most significant (Barnett, Di Vesta, & Rogozinski, 1981, Bretzing & Kulhavy, 1979, Rickards & Friedman, 1978) The limited number of studies done using films and television offered no insight as to the function of notetaking. No research was located which utilized the computer as either a medium used to record notes or as a source from which notes were generated.

Looking forward, past the pencil and paper used in traditional notetaking research, are readily accessible computer technologies including on-line notepads, window environments, and notebook sized computers which provide new environments for notetaking research. The computer technology which facilitates notetaking research in and of itself is of little interest; rather it is the cognitive effects of these technologies on the intellectual performance of the learner that is significant (Salomon, Perkins, & Globerson, 1990).

This study sought to describe the effects of technology on the notetaking strategies and behaviors of university students. More specifically, the following questions were addressed in this study: (1) Given a choice, do students prefer taking notes from a computer tutorial using pencil and paper or the computer itself? (2) Is there a relationship between the subject's confidence level towards using computer related technology and the method of notetaking selected? (3) Does the method of notetaking affect time on task or achievement? (4) Does the content of the notes (word count, percent of information copied, and percent

of main ideas) differ significantly between students who used pencil and paper to take notes and those that used a computer?

Method

Subjects

A student profile questionnaire was administered at a university in southern Minnesota to 104 undergraduates whose major or minor was computer science. Computer science majors and minors were selected for this study because their discipline required significant time utilizing computer technology, thus assuring adequate experience with computers prior to the study. Only students who indicated they had worked extensively with microcomputers and word processing applications, and had no prior knowledge of the technical aspects of IBM's AS/400 minicomputer system were eligible for selection. Based on these criteria, 76 subjects participated in this study. Of this group, 61 had a class rank of senior and 15 had a rank of junior.

Materials

Tutorial. Over a period of five weeks, participants used either pencil/paper or a computer to generate notes while reviewing selections from IBM's AS/400 minicomputer on-line tutorial. The tutorial modules used in this study were: Introduction to the Operating System; Operating System and Architecture Support; Equipment Overview; Control Language Structure; Attachment of Personal Computers and Other Devices. No time limit was placed on viewing the modules.

On-line notetaking pad. The tutorial modules were accessible over a network configuration which allowed the participants to simultaneously view a module and access the on-line notetaking pad with a single keystroke. The computer notetaking pad consisted of a scrolling window that had the same formatting, editing, printing, and copy/paste capabilities as a word processor. The notepad was also dynamic; it could be sized and repositioned on the screen at any time.

Submission of notes. Each week, after the notes were submitted, the method used by each subject to take notes was recorded. In addition, the notes from randomly selected subjects from both groups were evaluated weekly for word count, percentage of copied information, and percentage of main ideas.

Post test. The achievement posttest consisted of fifteen question: seven multiple and seven fill in the blanks. The questions included recall, application and synthesis questions. Subjects were not allowed to review their notes prior to the test. The KR-20 reliability for this test was .71.

Exit questionnaire. This instrument consisted of open ended questions which sought to determine why a participant selected their dominate method of notetaking. Additionally, it served as a self report method to elicit the amount of time spent viewing and taking notes per module.

Procedures

Subjects were selected for the study based on their responses to key questions on the prestudy student profile questionnaire. Prior to the study, all subjects selected for the study participated in a two hour training session. The study required each participant to review and take notes using either pencil and paper or the on-line notepad from one tutorial module each week for five weeks. All notes were monitored weekly for the notetaking method used. In addition, randomly selected notes from both the pencil and paper and on-line notepad group were evaluated weekly for word count, percentage of copied information and percentage of main ideas. After the submission of the last weeks' notes, each student completed an achievement posttest and completed an exit questionnaire. Subjects completed all work on their own time and were given extra points equivalent to ten percent of their grade in one computer science class during the quarter of the study.

Training. Each subject took part in a two hour training session designed to: (1) review the criteria and benefits of good notes regardless of the medium; (2) define the objectives for each module used in the study; (3) provide hands-on experience accessing the AS/400 tutorial modules and on-line notepad. During the session participants were also instructed that at any time during the study they could select the alternate notetaking method.

Selection of Subjects for Weekly Monitoring. In addition to each participant's method of notetaking being recorded weekly, notes taken by subjects from both groups were randomly selected for weekly evaluation. After the first week's notes were submitted, four subjects (23.5 percent) who used pencil and paper and 12 (22 percent) who used the on-line notepad for notetaking were randomly selected for weekly monitoring during the entire study. Interestingly enough, each monitored participant used the same method selected for notetaking the first week throughout the remainder of the study. Also, an additional five subjects from the pencil and paper group and 12 from the on-line notepad group were randomly selected

each week for weekly monitoring. Thus, the notes from approximately 44 percent of the study's participants were evaluated weekly for word count, percent of copied material, and percent of main ideas.

Reliability of Random Evaluation Scoring. Prior to the beginning of the study, this author and a graduate research assistant in computer science reviewed each of the topics in the tutorial used in the study and each compiled an set of 'ideal' notes about the topics. Agreement was easily reached regarding the main ideas presented in each tutorial module. A printout which contained the text, diagrams, and questions found in the tutorial was made available to each reviewer.

Scoring reliability for the participants' notes' word count, percentage of main ideas, and percentage of information copied, was estimated by having both reviewers score a sample of notes taken on the same topic from the pencil and paper and on-line notepad groups. Using this method, we were able to ensure that the notes selected for review on any given topic were scored by two people. For the sets of notes used in the reliability check, disagreements were resolved by rechecking the notes and discussion. Based on the review of 75 sets of notes, the average percent of reviewer agreement was: 95.4 percent for word count, 98.3 percent for percent main ideas, and 96 percent for percent of information copied.

Dominant Notetaking Method. At the conclusion of the study, subjects were assigned, for statistical calculations, to one of three groups (pencil/paper, on-line, or combination of both methods) based on the dominate method used to record their weekly notes. To be placed in either the pencil/paper or on-line group, students must have selected that method for four or more weeks. All but three students participating in the study were originally assigned to one of these two groups. In other words, it appeared that once a subject selected a method to record notes, that method was used consistently throughout the study. Because of their limited number, the three subjects who comprised the third group were not used in the statistical calculations.

Posttest and exit questionnaire. Upon reviewing the five tutorial modules, subjects completed an achievement test and the exit questionnaire.

Data Analysis. Statistical calculations were carried out using SPSSX software. Significance level was set at $p = .05$.

Results

Achievement

Means and standard deviations for the posttest scores are given in Table 1. The on-line notetakers (M = 7.04) performed better on the post test than those using pencil and paper (M = 5.29). One way ANOVA results revealed that the difference between the post test means were significant [$F(1,71) = 4.519$, $p = .037$]. Two-way ANOVA results yielded no significant main effect for major or minor [$F(1,69) = 1.934$, $p = .169$] or the type of notetaking method [$F(1,69) = 2.244$, $p = .139$]. The interaction effect was not significant [$F(1,69) = .463$, $p = .498$].

Table 1: Means and Standard Deviations for Achievement

Group	N	Mean	SD
Pencil/paper	17	5.29	2.17
On-line notepad	56	7.04	3.15

Subjects' Use of Notetaking Methods

The number of subjects and the percentage of computer science majors and minors who used pencil and paper or on-line notepad as their dominate notetaking method is shown in Table 2. As previously described, subjects were assigned to a notetaking group based on their weekly notetaking method.

Table 2. Composition of Notetaking Groups

Group	N	Percent of Total	Percent of Group Total	Percent of Major/Minors
Pencil/paper	17	23.29		
Computer science majors	4		23.53	9.3
Computer science minors	13		76.47	43.3
On-line notepad	56	76.71		
Computer science majors	39		64.29	90.7
Computer science minors	17		30.36	56.7

Attitudes

Several Likert-type items on the prestudy student profile questionnaire were used to assess the subjects' confidence working with computers, word processors, and other new technologies. The means and standard deviations for these questions are presented in Table 3. The ranking scale consisted of the value five associated with low confidence rating and the value one associated with a high confidence rating. The on-line notetakers responded consistently more positively towards using computers and technologies than the pencil and paper group.

Table 3: Means and Standard Deviations for Attitude Scored Associated with Using Computers and Other Technologies

	Groups			
	Pencil/Paper (N=17)		On-Line Notepad (N=56)	
Questions	Mean	SD	Mean	SD
Use of microcomputers	1.65	.71	1.29	.60
Use of word processors	1.88	.86	1.36	.65
Use of computer related technologies	2.53	1.01	1.48	.69
Acceptance of new methods to perform tasks	2.59	1.06	1.76	.77
Adjust to using new technologies	2.47	.87	1.60	.78

One-way ANOVA results from follow-up comparisons between the mean scores revealed that the differences between the means for each question were significant: (use of microcomputers [$F(1,71) = 4.23$, $p = .04$]; use of word processors [$F(1,71) = 7.09$, $p = .01$]; use of computer related technologies [$F(1,71) = 23.48$, $p < .01$]; acceptance of new methods to perform tasks [$F(1,71) = 12.35$, $p < .01$; adjust to using new technologies [$F(1,71) = 15.16$, $p < .01$]).

In the exit questionnaire, subjects were asked to rank possible reasons for selecting their dominate notetaking method used during the study. A ranking of one indicated that it was the most important reason for selecting the method while the rank of six signified it was the least important. Reasons that were marked as not important in the decision making process were not included in the calculations. The means and standard deviations for each possibility are given in Table 4. Students selected the on-line notepad because of the speed and the ease of reading the notes once recorded. It appeared the other group viewed the pencil and paper as the easiest way to record their thoughts.

Table 4: Means and Standard Deviations for Reason for Selecting a Notetaking Strategy

	Groups			
	Pencil/Paper (N=17)		On-Line Notepad (N=56)	
Reasons	Mean	SD	Mean	SD
Faster method to record notes	3.77	.62	1.62	.20
Notes easier to read, study froma	4.86	.57	2.96	.26
Easiest way to record thoughts	3.22	.48	4.60	.30
Better environment to learn from	4.82	.50	4.40	.28
Used to working in a window environment	4.50	.53	4.79	.31
Not worked with an electronic notepad before	4.91	.56	5.51	.36
Not worked on the AS/400 computer system before	5.91	.69	5.94	.34

Time on Task

Subjects were asked on the exit questionnaire to estimate the time spent reviewing and recording notes for each of the modules. The means and standard deviations for the average time spent per module is reported in Table 5. A follow-up one-way ANOVA indicated no significance between the means of the two groups [$F(1,71) = .03$, $p = ..87$].

Table 5: Means and Standard Deviations for Time on Task

Group	N	Mean	SD
Pencil/paper	17	39.99	15.91
On-line notepad	56	39.32	13.82

Word Count, Percent Information Copied and Percent Main Ideas

The monitored subjects using the on-line notepad had significantly higher word counts, percentage of copied material, and percentage of main ideas than those using pencil and paper. The means and standard deviations for word count, percent information copied, and percent of main ideas for the groups monitored weekly are given in Table 6. More information was copied directly from the tutorial by the group using on-line notepad (M = 90.12 percent) than by the pencil/paper group (M = 46.17 percent). This may have accounted for the higher word count associated with the on-line notepad group. The notes from the on-line group also contained more main ideas (M = 86.63 percent) than the pencil/paper group (M = 72.75 percent).

Table 6. Means and Standard Deviations for Parameters Monitored Weekly

Parameter	Grouping	N	Mean	SD
Word Count				
	Pencil/Paper	13	175.67	132.94
	On-line notepad	43	341.60	179.72
Percent Copied				
	Pencil/Paper	13	46.17	24.37
	On-line notepad	43	90.12	15.89
Percent Main Ideas				
	Pencil/Paper	13	72.75	31.07
	On-line notepad	43	86.43	16.19

One-way ANOVAS revealed differences between the pencil and paper and on-line notepad group on the following parameters: average word count [$F(1,54) = 8.799$, $p = .005$, percentage of notes copied [$F(1,54) = 55.517$, $p < .000$], percent main ideas [$F(1,54) = 4.25$, $p = .04$].

Discussion

This study examined the following: if one method of notetaking promoted a higher level of achievement; if students favored taking notes from a computer tutorial with a microcomputer or pencil and paper; and if the content and structure of the notes differed between platforms used to record notes.

Results of this study show that taking notes using the on-line notepad is the most effective method of notetaking, as assessed by the post test, regardless of whether the participant's major or minor is computer science. It appears that the ability to copy and paste text as well as generating notes provides an environment which promotes more achievement than traditional pencil and paper methods.

Results of this study showed that subjects preferred using the on-line notepad rather than traditional pencil and paper. An overwhelming percentage of computer science majors and approximately half of the minors consistently used the on-line method to record notes. Participants who selected the on-line method reported higher confidence ratings towards using microcomputer, word processors and new technologies than those using pencil and paper. This discounts any suggestion that a novelty effect may have been associated with the use of the on-line notepad. Instead, these finding indicate that the more confident the subjects were with using the technology, the more it was utilized.

The results of the present study also revealed that notes taken by the on-line group consisted mainly of text that was copied from the tutorial and pasted to the notepad while the notes generated by the pencil/paper group reflected more of their own thoughts. The copy and paste strategy employed by the on-line group may have impacted the group's word count and percent of main ideas tabulations as well.

As previously enumerated, an important criterion used by both groups to select a notetaking method was how quickly notes could be recorded utilizing the method. When examined, no significant difference was found between the two groups' average time per module spent reviewing and taking notes.

As computer related technologies evolve, current images are redefined; books have become disks and pencils have been transformed into keyboards and mice. Although it is tempting, our primary attention should remain focused on the programs and tools which can be used with the technology and the activities they afford.

In order for the computer to function as a tool to enhance cognition, an individual must seek to develop an intellectual partnership with technology. As demonstrated in this study, the strength of the partnership relies heavily on how confident the individual is in using the technology, and whether the activities promoted by the technology encourage active, mindful engagement on the part of the learner.

As technology advances, its benefits may not be realized automatically. Further research should focus on the development and evaluation of activities, situations, and computer applications specifically crafted to promote engaging partnerships between the learner and the technology. Research should also focus on how cognitive effects, such as the development of problem solving strategies arrived at through such partnerships, can become more transferable to situations which do not involve technology.

Specific to this study, there are five areas which merit further investigation. First, identify the cognitive strategies employed by students who prefer using an on-line notepad for notetaking. Second, assess whether the on-line method of notetaking is as beneficial when students are not allowed to use the copy/paste function but rather must generate original notes. Third, examine whether the learner's familiarity with the content of the tutorial impacts the method of notetaking selected or the amount of material copied directly from the tutorial and placed in the notes. Fourth, identify the preferred notetaking method of learners form other discipline areas and grade levels. Fifth, examine the relationship between using technology to generate notes over an extended period of time and the process and product functions of notetaking.

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