Studying online: evaluation of an online study environment

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Abstract

This study evaluates student use of an online study environment. Its purposes were to (1) determine if college students will voluntarily use online study tools, (2) identify characteristics of users and nonusers of the tools, and (3) determine if the use of online study tools relates to course achievement. Approximately 25% of students used the online tools for more than one hour before each of three examinations. In comparing use of the study tools provided, the largest number of students made use of the online lecture notes and the greatest amount of online study time was devoted to reviewing multiple choice questions. The perceived ease of access to the Internet differentiated tool users from nonusers. Study tool users scored higher on course examinations after accounting for measures of ability and study skill. © 2002 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Computer technology potentially benefits students in many ways. It allows students more convenient access to their instructors and it can present course content. Computer technology may also help students study more effectively and it is this possibility that will be examined. While this research makes use of study tools developed specifically for this project, many introductory textbooks now provide students the option of purchasing related CDs or accessing web sites. Such resources intend to help students master the content of the textbook and might be viewed as alternatives to the more traditional student study guide. Computer tools instructors can use to prepare study experiences for students are also available and are sometimes offered at no cost from textbook publishing companies.

Studying is defined here as voluntary student behavior that follows the initial presentation of information (lecture, reading) and is intended to improve understanding and retention (Thomas & Rohwer, 1986). There is an abundant literature on various techniques and strategies students

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might use to study more effectively. Certainly the techniques used in this research (answering sample test questions, reviewing notes) are not unique and have been research topics for some time (e.g. Anderson & Biddle, 1975; Kiewra, 1985).

Two factors make the present investigation unique. First, this research examines what might be described as online study behavior. The focus is on voluntary student behavior within an Internet supported learning environment. It is important to understand that this study makes use of the Internet for study rather than information presentation. Although resources for providing such experiences are becoming more common, there are few published efforts to document what happens when students study within online environments or to determine if students benefit from such activities. Related research on computer-based study, in contrast to online study, does exist and is encouraging (e.g. Alessi, Anderson, & Goetz, 1979; Boone & Higgins, 1992; Grabe, 1992).

The second unique feature of this investigation is the effort to document student response to available study aids in a naturalistic setting. Basic questions of whether students actually make use of computer study aids and if they benefit from such experiences need to be answered. These questions could be compared to similar issues raised in evaluating other pedagogical aids available to students. For example, Weiten (Weiten, Deguara, Rehmke, & Sewell, 1999; Weiten, Guadagno, & Beck, 1996) attempted to evaluate if students use the learning aids (e.g. summaries, self-tests) embedded within textbooks and if using aids was beneficial. Results clearly indicate that it cannot be assumed that students use study aids or that benefits can be demonstrated when they do. The issue of what students actually do when provided voluntary access to study aids is probably a much more serious matter than most researchers would acknowledge.

The purposes of this study are to (1) determine if college students will voluntarily use online study tools, (2) identify characteristics of users and nonusers, and (3) determine if the use of online study tools can be related to course achievement.

2. Method

2.1. Participants

The participants consisted of 191 students enrolled in an Introductory Psychology class.

2.2. Course structure

Each week, students attended two lectures and one small group discussion section, however, this study concerns only the lecture component of the course. Performance in the lecture component was evaluated using multiple-choice examinations and accounted for 75% of the points determining final grades. The book, *In Search of the Human Mind* (Sternberg, 1998), was required reading for the lecture component of the course.

2.3. Online study tools

Students had access to four types of online study resources: (1) lecture notes, (2) book notes, (3) multiple choice practice questions, and (4) short answer practice questions. The course instructor
used a computer presentation system during lectures to provide an outline of the lecture, to list key terms and definitions, and to provide helpful illustrations and graphs. This information was transformed into a web page and made available as online lecture notes. Book notes were chapter summaries presented as individual web pages. Summaries were approximately 2000 words in length.

Approximately 100 multiple choice practice questions for each chapter were taken from the test bank accompanying the book. No practice question appeared on a course examination. Each question was presented as an individual web page. An incorrect response forwarded the student to a second web page that redisplayed the question and provided the page reference in the textbook the student should consult to review the information necessary to answer the question. A correct response forwarded the student to a second page that redisplayed the question and indicated that the answer given was correct.

Questions within each chapter were organized according to the major chapter divisions used in the textbook. Chapters had approximately 8–12 such divisions. Following a correct answer, the next question presented was drawn at random from the pool of questions for the entire chapter. The next question following an incorrect answer was selected at random from within the same division as the question generating the incorrect response. This technique focused students on material causing them the most difficulty.

Short answer practice questions were taken from the test bank accompanying the textbook. Because short answer questions were not used on course tests, all short answer questions from the test bank were used. Approximately 30–40 items were available for each chapter. Short answer questions were also presented as a sequence of two web pages. The first page presented the question. The second page presented the question, a possible answer, and the page reference from the textbook. Short answer questions related to the chapter selected for study were presented in a random order.

2.4. Instruments

2.4.1. Course examinations

Student achievement data were gathered from three multiple-choice examinations each covering approximately one-third of the course content. Examination items were both prepared by the course instructor and taken from the test manual accompanying the book.

2.4.2. Study tool questionnaire

In the lab session immediately following each lecture examination, students completed several five point rating scales. Two items were included as possible predictors of online study tool use. The first, asked students “How would you rate your computer skills?” and was anchored with the phrases “I have advanced skills” (rating = 5), “I have basic skills” (rating = 3), and “I know very little” (rating = 1). The second, asked students “How would you rate your access to a computer with Internet access?” and was anchored with the phrases “I have access in my room/home” (rating = 5), “I can find access if necessary” (rating = 3) and “I never have access” (rating = 1).

2.4.3. Inventory of learning processes (ILP)

Students were asked to complete the ILP (Schmeck, 1983) to provide an indication of the quality of their study strategies. The ILP provides scores on four subscales: (1) Deep Processing, (2) Methodical Study, (3) Fact Retention, and (4) Elaborative Processing.
2.4.4. Nelson–Denny reading test
The composite score (vocabulary and comprehension) from the Nelson–Denny reading test (Brown, Bennett, & Hanna, 1981) was used as a measure of reading competence.

2.5. Online procedure and data acquisition

Students were presented with a demonstration of the online study tools during an early lecture session and were told to ask their discussion group instructors for assistance if they needed help in operating a web browser. A link to the online study tools was available from the online version of the course syllabus. Student use of any online resource was completely voluntary.

Access to the online study tools was routed through a single entry page. This page served as the consent form for the study. Students were told that their participation was voluntary and were informed of the types of data that would be collected if they decided to use the online study tools. The entry page also required that students enter a student identification number. The identification number was checked against a stored list before access was granted. Every page on the study skill site was individually protected from unauthorized access and valid identification was required at the beginning of each study session. This protection system prevented unauthorized access to copyrighted materials and allowed the identity of students using the online tools to be related to data gathered during their study sessions.

The method for gathering data from online sessions made use of HTML forms. A form allows information to be sent from the browser back to the server. Data were sent to the server and then transferred to a storage file when a student followed a link from a lecture notes or book notes page or an essay or multiple choice question feedback page. For lecture and book notes pages, the information stored included the student identification number, the date and time (hour, minute, and second) of the response, and a unique page name. Data stored when a student left a short answer page included student identification number, the date and time, and a unique page name. Data stored when a student left a multiple choice page included student identification number, the data and time, the correct answer, the answer selected and the page name.

2.6. Data reduction

The data storage method created a large chronologically ordered data file. The first step in the reduction process was to sort this file by student identification number. The day, hour, minute and second variables associated with each line of data were then used to determine the time difference between successive lines of data. This difference score represented the delay between successive actions taken by the student and provides a way to define viewing time (e.g., examining a page of lecture notes, examining a multiple-choice question).

The procedure by which the viewing time data were generated resulted in some anomalies. The time variable associated with the last line of data for each student on each day was always undefined because there was no subsequent time data to use in the subtraction procedure. Misleading viewing time data were also generated when there were large gaps between study sessions on the same day. In this case, the subtraction procedure might indicate that a student viewed a page of lecture notes or a multiple-choice question for several hours. It did not seem appropriate to simply drop viewing data when the calculated times were obviously inaccurate. For example, it
was fairly common for students to view the notes for a lecture presented earlier that day. This was sometimes the only use these students made of the lecture notes and eliminating all flawed data entries would fail to demonstrate that these students viewed notes at all. The following conventions were adopted based on a preliminary analysis of viewing times. For multiple choice or short answer questions, any viewing time over 90 s was set equal to 90 s. Missing data were set equal to 60 s. For book and lecture notes, any viewing time over 180 s was set equal to 120 s. Missing data points were set equal to 90 s. Approximately 2.5% of the data were adjusted in this fashion.

3. Results

3.1. Use of study tools

Data summarizing student use of online resources in preparation for each of three course examinations are summarized in Table 1. This table presents the average number of items viewed and the average time spent on multiple choice questions, book note pages, and lecture note pages. The total time spent on preparation for each examination is also included. No data are provided on the use of short answer questions because very few students made use of this resource.

The proportion of students using the online tools was very similar across the three examinations (Test 1 = 0.61, Test 2 = 0.60, Test 3 = 0.56) while the time spent using the tools declined consistently across the three examinations. The average time spent online in preparation for the

<table>
<thead>
<tr>
<th>Test 1 (190 students)</th>
<th>Students</th>
<th>Number</th>
<th>S.D.</th>
<th>Time (s)</th>
<th>S.D.</th>
</tr>
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<tr>
<td>MC questions</td>
<td>79</td>
<td>140</td>
<td>155</td>
<td>6538</td>
<td>7306</td>
</tr>
<tr>
<td>Book notes</td>
<td>2</td>
<td>2.4</td>
<td>3.0</td>
<td>406</td>
<td>418</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>92</td>
<td>9.8</td>
<td>6.9</td>
<td>1326</td>
<td>930</td>
</tr>
<tr>
<td>Total time</td>
<td>116</td>
<td></td>
<td></td>
<td>5899</td>
<td>6964</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Test 2 (171 students)</th>
<th>Students</th>
<th>Number</th>
<th>S.D.</th>
<th>Time (s)</th>
<th>S.D.</th>
</tr>
</thead>
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<tr>
<td>MC questions</td>
<td>64</td>
<td>184</td>
<td>160</td>
<td>4958</td>
<td>3868</td>
</tr>
<tr>
<td>Book notes</td>
<td>61</td>
<td>3.69</td>
<td>3.13</td>
<td>545</td>
<td>780</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>76</td>
<td>7.84</td>
<td>5.29</td>
<td>1086</td>
<td>780</td>
</tr>
<tr>
<td>Total time</td>
<td>103</td>
<td></td>
<td></td>
<td>4279</td>
<td>4098</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Test 3 (165 students)</th>
<th>Students</th>
<th>Number</th>
<th>S.D.</th>
<th>Time (s)</th>
<th>S.D.</th>
</tr>
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<tr>
<td>MC questions</td>
<td>61</td>
<td>177</td>
<td>158</td>
<td>4753</td>
<td>3805</td>
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<tr>
<td>Book notes</td>
<td>75</td>
<td>2.39</td>
<td>2.90</td>
<td>473</td>
<td>388</td>
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<tr>
<td>Lecture notes</td>
<td>75</td>
<td>7.32</td>
<td>5.24</td>
<td>860</td>
<td>546</td>
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<tr>
<td>Total time</td>
<td>93</td>
<td></td>
<td></td>
<td>4097</td>
<td>3765</td>
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</table>

Total time for each examination was based on student use of any study tool and this method of defining use should be kept in mind when interpreting the number of students involved or the average time spent on the study tools.
last examination was still in excess of one hour. Because printing lecture notes appeared to be a
very common practice and lecture notes were the most widely used study activity, the time actu-
ally spent with study resources is underestimated by online study time. To put the number of
book and lecture pages viewed into perspective, there were approximately 10 lecture pages and 6
book pages per examination. Each lecture or chapter was summarized as a single web page. Of
the variables used, the time spent working with the multiple-choice questions is probably the most
accurate indicator of the time students actually used that study tool. The average multiple choice
tool user spent over 1.5 h per examination working with this tool. Approximately 40% of students
worked with the multiple-choice questions.

3.2. Characteristics of users and nonusers

Students were defined as study tool users or nonusers based on the total time they worked with
study tools for each examination. Students were classified as Users if they used the study tools for
more than one hour. There were 53 Users and 137 Nonusers for the first examination, 43 Users
and 128 Nonusers for the second examination, and 40 Users and 125 Nonusers for the third
examination.

One-way ANOVAs were used to compare Users and Nonusers. The dependent variables for
these analyses included reading ability (composite score from the Nelson–Denny), study behavior
(Deep Processing, Methodical Study, Fact Retention, and Elaborative Processing scales from the
Schmeck Inventory of Learning Processes), Internet access, and computer knowledge. Analyses
are reported as significant when \( P < 0.05 \). The number of students included in any given analysis
differed slightly because of missing data for a dependent variable.

On the first examination, Users and Nonusers differed in rated Internet access, \( F(1,164) = 6.92 \)
(Users \( M = 4.29 \), Nonusers \( M = 3.87 \)) and Methodical Study, \( F(1,162) = 5.92 \) (Users \( M = 65.2 \),
Nonusers \( M = 60.5 \)).

On the second examination, Users and Nonusers did not differ on any of the dependent
variables.

On the third examination, Users and Nonusers differed in rated Internet access, \( F(1,152) = 5.94 \)
(Users \( M = 4.43 \), Nonusers \( M = 4.00 \)).

3.3. Relationship of study tool use to achievement

3.3.1. ANOVA comparisons of user groups

One-way ANOVAs were used to compare the achievement test scores of students from the User
and Nonuser groups.

All ANOVAs produced significant group differences: Examination One, \( F(1,188) = 24.48 \) (Users
\( M = 34.0 \), Nonusers \( M = 28.5 \)); Examination Two, \( F(1,169) = 7.60 \) (Users \( M = 35.9 \), Nonusers
\( M = 33.0 \)); and Examination Three, \( F(1,163) = 7.52 \) (Users \( M = 35.6 \), Nonusers \( M = 32.4 \)).

3.3.2. Regression analyses

Regression procedures were used to determine if group membership would be related to exam-
nination score after accounting for differences in reading ability and study strategies. For regres-
sion procedure, Users were coded as 1 and Nonusers as 0.
Group, Reading Ability and the four Study Scales entered into a simultaneous multiple regression analysis predicting examination score. In a simultaneous procedure, each of the predictor variables is tested after all of the other variables have been entered in the regression equation. The results of these analyses are presented in Table 2. The reported slope coefficient estimates the amount of change in examination performance associated with one unit change in the predictor variable. The beta weight is a standardized slope coefficient that allows a comparison of the predictive strength of each of the predictor variables. The squared semipartial correlation ($r^2$) represents the proportion of variance in test performance accounted for by each of the predictor variables after all other predictors were in the regression equation. Whether or not students used the online study tools uniquely predicted examination score in the first and second, but not the third examination.

4. Discussion

This study demonstrated that a substantial proportion of those students enrolled in an Introductory Psychology course were willing to make voluntary use of on-line study tools. The proportion of students using the study tools for at least one hour was approximately 25% across

<table>
<thead>
<tr>
<th>Variable</th>
<th>Slope</th>
<th>Beta</th>
<th>$T$</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Examination one</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep Processing</td>
<td>0.29</td>
<td>0.374</td>
<td>4.21*</td>
<td>0.123</td>
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<tr>
<td>Methodical Study</td>
<td>−0.02</td>
<td>−0.031</td>
<td>−0.40</td>
<td>0.000</td>
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<td>Fact Retention</td>
<td>−0.03</td>
<td>−0.020</td>
<td>−0.24</td>
<td>0.000</td>
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<tr>
<td>Elaborative Processing</td>
<td>−0.01</td>
<td>−0.008</td>
<td>−0.10</td>
<td>0.000</td>
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<tr>
<td>Reading Ability</td>
<td>0.13</td>
<td>0.372</td>
<td>5.04*</td>
<td>0.167</td>
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<tr>
<td>User Group</td>
<td>3.96</td>
<td>0.245</td>
<td>3.67*</td>
<td>0.096</td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>Deep Processing</td>
<td>0.18</td>
<td>0.289</td>
<td>2.76*</td>
<td>0.061</td>
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<tr>
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<td>−0.00</td>
<td>−0.006</td>
<td>−0.06</td>
<td>0.000</td>
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<tr>
<td>Fact Retention</td>
<td>0.09</td>
<td>0.074</td>
<td>0.78</td>
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<td>Elaborative Processing</td>
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<td>0.089</td>
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<td>Reading Ability</td>
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<td>0.246</td>
<td>2.85*</td>
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<td>User Group</td>
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<td>0.157</td>
<td>2.01*</td>
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<tr>
<td><strong>Examination three</strong></td>
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<tr>
<td>Deep Processing</td>
<td>0.18</td>
<td>0.263</td>
<td>2.46*</td>
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<tr>
<td>Methodical Study</td>
<td>−0.01</td>
<td>−0.107</td>
<td>−0.17</td>
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<tr>
<td>Fact Retention</td>
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<tr>
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<td>Reading Ability</td>
<td>0.09</td>
<td>0.290</td>
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<td>User Group</td>
<td>2.07</td>
<td>0.139</td>
<td>1.75</td>
<td>0.026</td>
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</tbody>
</table>

*a* Examination One $T(127)$, Examination Two $T(118)$, Examination Three $T(115)$.

* Significant predictor at $P < 0.05$. 

three examinations. Because students are not necessarily willing to make use of study methods made available to them, the demonstration of substantial voluntary use of a study technique is of practical significance. One implication of a high level of student involvement might be that students feel a study strategy warrants their allocation of time.

College students differ in computer skills and in their access to computers and the Internet. The potential of online study is diminished to the degree that student skill or access limit use. In addition, if skill or access are limiting factors, voluntary use of the study tools less accurately reflects student interest in online study. Study tool Users and Nonusers did not differ in self-rated computer skills. Perhaps the skills necessary to use a web browser are either present or easy enough to learn and do not represent a limiting factor. It does appear that access to the Internet was a factor that influenced use. Since all students were provided access through multiple, campus computer laboratories and rated differences in access were still significantly related to whether or not students ended up classified as Users, it appears that the convenience of access is important.

This study demonstrated a consistent performance advantage for those students who used the online study tools. ANOVAs comparing Users and Nonusers revealed significant differences on all three course examinations. It must be acknowledged that assigning students to treatment groups based on voluntary student behavior limits the certainty with which statements of causality can be made. Researchers interested in evaluating the effectiveness of any study technique face a dilemma. The study behavior of college students is usually voluntary and whether or not students will make use of a study technique is crucial in evaluating the potential value of that technique. There is little value in developing study techniques students will not use. However, researchers interested in practical study techniques face the challenge of demonstrating that a voluntarily selected behavior is the cause of any performance differences that are observed. Perhaps student commitment to the voluntary activity is associated with some other variable (ability, motivation). There is no ideal solution to this difficulty. Our approach was to identify measures that seemed to provide a way to assess possible alternative explanations for why self-selected groups might differ in course performance. The strategy was to statistically determine if group differences in examination performance still existed after accounting for differences that could be attributed to these potential confounding variables. While the measures of reading ability and study skill we employed were good predictors of examination performance and thus potentially credible sources of confounding, use of the study tools was still related to higher examination scores after removing the effect of the additional variables on two of the three examinations.

The pattern of results in which voluntary use of study tools is helpful on early exams, but not on later exams is consistent with the results of an earlier study (Grabe, Petros, & Sawler, 1989). A potential explanation for this pattern would be that inexperienced students are poor at judging the quality of their preparation for a future examination. The availability of the online test questions would allow the students to determine how they might perform on an actual examination and provides general guidance as to whether additional study might be needed. As the students become more experienced in what will be expected of them, access to the online questions may provide less unique information.

Finally, it might be suggested that online study tools appear to be a growing option for students. Textbook companies provide study opportunities over the Internet and commercial software products allow instructors to provide students supplemental learning or study opportunities. This research provides what might be regarded as an early attempt to evaluate the effect of such
study opportunities. We anticipate that educational publishers will eventually move to integrate instructional content and study activities online. The techniques described here could easily be adapted to be integrated with an online book. In such a study environment, links from individual test items would take students directly to segments of the text associated with that item. The efficiency of identifying and rereading problematic passages could be dramatically improved. Future research efforts using similar techniques to those described here might more accurately track what students do as they work online, contrast the effectiveness of different online tools, identify student differences in the use of different tools, or identify patterns of use (e.g. when online tools are used relative to the date of an examination) in relationship to examination performance. In fact, the potential of computers to document aspects of student behavior may allow unique insights into general study behavior.

References


