Teaching Statistics With the Internet

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The Internet is a popular tool for accessing information and enhancing communication. We used components of the Internet to administer the laboratory portion of an intermediate statistics course offered to psychology honors students. Using an online questionnaire, we evaluated students' perceived effectiveness of using the Internet to offer the course. Students found the communication components of the Internet laboratory more useful than the information components, perceived few barriers to their learning, and rated the value of the system positively.

The Internet is a popular tool for instruction and can be used to provide students with greater access to information (Jones & Schieman, 1995; Pask & Snow, 1995). World Wide Web (WWW) pages on the Internet can be used to archive course information and assignments. More important, by using the Internet as a supplement, student learning is not confined to course materials or library research. Students can access networked information located all over the world through the Internet.

Increased access to information is one important pedagogical benefit of using the Internet to supplement traditional instruction. Another important benefit may relate to levels of communication (Anderson, 1995–96; Bruning, 1995; Hiltz, 1986, 1990; Jones & Schieman, 1995; Pitt, 1996). Increasingly, nontraditional students enroll in university courses. In many cases, these students cannot attend every lecture or discussion group and need support outside of the classroom. Opportunities for increased contact exist with Internet communication; e-mail and newsgroups allow for virtual office hours, which is particularly important for nontraditional students who may have difficulty attending traditional office hours. In addition, students experiencing learning problems are less likely to get caught in erroneous efforts that are a waste of time; instead, there is potential for contact outside of class or office hours. Furthermore, interpersonal communication may be enhanced; relevant discussion can extend beyond class time through the use of mailing lists, newsgroups, WWW boards, chats, e-mail, and similar services. Finally, given that increasing class sizes have forced a decrease in written assignments, students are able to practice writing skills and forms of argument through electronic communication.

To address these potentially beneficial components of information access and communication, we developed an Internet-based statistics laboratory in association with the more traditional lecture and discussion format class in intermediate statistics. The course was open only to psychology honors students. The types of statistical procedures the students learned were directly relevant to the research they were conducting as part of their honors theses. The goals of the laboratory portion of the course were: (a) to learn how to analyze psychological data using a statistical analysis program, (b) to learn how to interpret output in terms of statistical and scientific hypotheses, (c) to practice writing results in American Psychological Association (APA) format (APA, 1994), and (d) to become familiar with the Internet as a tool for psychological research and communication of results.

At the beginning of the term, we introduced the components of the Internet in a 30-min lecture, designed primarily to clarify the omnipresent jargon about the "information superhighway." Students learned about the most common services available on the Internet. With this context established, we demonstrated computer use and distributed a short handout of steps for starting the computers and running various applications. Students then completed separate short tasks to allow practice in accessing the Internet, using e-mail, posting to the newsgroup, and jumping to different applications. The students worked individually or in pairs in the laboratory, and we circulated to offer assistance and answer questions. The next day, a follow-up lecture and question period on networking and the Internet reinforced their new understanding.

The WWW home page integrated the Internet components of the course, including: (a) an online syllabus and course information, (b) online project description and data archive for laboratory assignments, (c) online help for describing data, (d) pointers to other statistics sites to obtain information or help, (e) integrated e-mail to the instructor and graduate teaching assistant (GTA) responsible for the laboratory, (f) an integrated newsgroup for discussion, and (g) an electronic form for submitting assignments. During the last week of classes, we added a pointer to an electronic evaluation survey.

Students met in the computer room for a weekly 2-hr laboratory period. We took a short amount of time at the beginning of the laboratory to discuss previous laboratory assignments, introduce the current laboratory, and discuss any other concerns. Students generally began to work on the assignments during the laboratory period; however, students completed most of the laboratory outside of the scheduled period. It was not uncommon for a student to e-mail the GTA in the middle of the night with a problem and to receive an immediate e-mail reply. In addition, many newsgroup discus-

sions occurred late at night. We were active participants in the newsgroup, posing our own questions, addressing student questions, and prompting student discussion.

One goal of this evaluation was to assess what components of the system students used as well as the perceived usefulness of each component (Anderson & Joerg, 1996). The Internet contains masses of information; do students use this information to learn statistics and report writing? We asked students to rate the usefulness of the Internet for information acquisition and communication as well as the other integrated applications. In addition, we asked students to rate the perceived usefulness of these various components of the laboratory computer system.

We were particularly concerned with students' abilities to access information on the Internet (Bruning, 1995; Hornby & Anderson, 1995–96; Jones & Schieman, 1995). Perhaps students would use the Internet sources only if they had the necessary skills and access. However, there may be numerous barriers to learning. The students had various levels of computer expertise, ranging from complete novices with only minimal word processing experience to experts who were familiar with Internet navigation. We were not sure that the 2-hr introductory session was sufficient to enable novice computer-using students to use all components of the system on their own. The students also varied in terms of their abilities to physically access a computer with Internet capabilities. A few students had computers at home but most had access only to on-campus computers.

Finally, we were interested in students' affective impression of the computer laboratory (Oswald, 1996; Varnhagen & Zumbo, 1990). Attitudes regarding any type of pedagogy may not be directly related to learning but may exert an indirect effect on learning. We did not want to continue to develop a system that students did not perceive as positive and appropriate for their learning.

Method

Students

Sixteen 4th-year honors psychology students (9 women and 7 men) participated in the laboratory. All students were actively engaged in research related to their honors theses and attended the lecture and discussion component of the course.

Evaluation Survey

The electronic evaluation survey included three sets of questions, relating to use and usefulness of various components of the system, perceived barriers to learning, and perceived value of the experience. In addition, it contained questions relating to self-ratings of computer expertise, estimates of use of the system, and ratings of the value of the system in comparison with other components of the course.

The response format for the perceived use and usefulness items consisted of pull-down bars for 5-item Likert scales; use responses ranged from 1 (*never used*) to 5 (*used every day*) and usefulness responses ranged from 1 (*not at all useful*) to 5 (*extremely useful*). The perceived barriers items used a similar pull-down response format, ranging from 1 (*major barrier*) to 5 (*no barrier at all*) and included a *not applicable* option. The perceived value items consisted of anchoring opposite adjectives with five click-boxes for responding between the adjectives.

The evaluation appeared on the class home page during the last week of classes. Students received a common access code and password to view the survey as well as an individual user alias for submitting their own completed form. The access code allowed only authorized individuals to view the survey. The individual user alias allowed only authorized students to submit responses, imposed a limit of one response per student, and ensured anonymity of responses.

Students completed the evaluation during the last 2 weeks of class. We directed the responses to a separate mailbox and did not view them until after the term was completed.

Results

We received 14 responses to the electronic evaluation. Five students rated themselves as "novice" in response to the computer expertise item, 8 students rated themselves as "intermediate", and 1 student rated him or herself as "expert"; we grouped the self-rated expert with the intermediate students for analyses considering expertise. Given the ordinal nature of Likert scales, the small sample size, and the disparate group sizes, we used descriptive and inferential procedures applicable to ordinal measurement scale data.

Median responses to the use and usefulness items appear in Table 1. The results indicate that the course-related communications aspects of the system and the other applications on the system were most frequently used and were perceived as extremely useful. Lower ratings were found for the other components. Most notably, students reported that they used the statistics information available on the WWW only occasionally or infrequently. No differences in use and perceived usefulness of the various components of the system were found as a function of computer expertise.

Spearman rank order correlations between use and perceived usefulness reflected a relation between use and usefulness ratings, ranging from a statistically nonsignificant $r_s(12) = .11$ for the e-mail to the instructor or GTA item (the majority of the responses were "used frequently" and "extremely useful") to $r_s(12) = .71$, $p < .05$, for the newsgroup item. The average correlation between use and perceived usefulness was $M = .40$ and indicated that, in general, when students reported having used a component they also rated the component as useful.

Table 2 shows median ratings of perceived barriers to learning. As shown in the table, students perceived minimal barriers. There was a statistically significant difference relating to computer training as a function of self-rated computer expertise, Mann-Whitney $U = 3$, $p < .05$. Although there was a statistically significant difference, the novice group did not perceive their inadequate training to be much of a barrier. In addition, the novice computer users appeared to be satisfied with training related to the use of the laboratory system.

Students did not have 24-hr access to the computer laboratory until the 2nd week of classes; although the results of

Table 1. Median Responses to the Use and Usefulness Items

Item	Use	Usefulness
Course-related information on the WWW		
Home page on the WWW	4	4
Syllabus on the WWW	3	5
Assignments on the WWW	4	5
Help with describing data on the WWW	3	3
Pointers to other statistics sites on the WWW	2	3
Course-related communication using the WWW		
Submit an assignment form on the WWW	4	5
Newsgroup	4	5
E-mail to or from instructor or GTA	4	5
E-mail to or from students in the class	5	5
Course-related applications on the system		
SYSTAT	4	5
Word processing	4	5
Other information and communication on the WWW		
E-mail to or from people outside the class	5	5
Accessing other WWW sites in the university	3	4
Accessing other WWW sites outside the university	3	4
Accessing other newsgroups	2	4

Note. Ratings for use and usefulness were based on 5-point scales ranging from 1 (*never used*) to 5 (*used every day*) and from 1 (*extremely unuseful*) to 5 (*extremely useful*), respectively. WWW = World Wide Web; GTA = graduate teaching assistant.

Table 2. Median Responses to the Perceived Barriers to Learning Items

Item	Perceived Barrier
Barriers related to ability, experience, required training	
Inadequate training on using the computer in general	
Novices	4
Intermediate–Experts	5
Inadequate training on using the computer system	5
Difficulty in learning to use the computer in general	5
Difficulty in learning to use the computer system	5
Discomfort in using the computer	5
Poor keyboarding skills	5
Getting lost in the World Wide Web pages	4
Difficulty in seeing the value of using the computer system	5
Physical barriers	
Inconvenient access to the laboratory	4
Difficulty in accessing the network in class	5
Slow speed of the computer system in class	4
Difficulty in reading the materials on the screen	5
Barriers related to home computer use	
Hardware difficulties in using the computer system at home	4
Software difficulties in using the computer system at home	4
Difficulty in accessing the network from home	3
Slow speed of the computer system at home	4

Note. Ratings were based on a 5-point scale ranging from 1 (*major barrier*) to 5 (*no barrier at all*).

Table 3. Median Ratings of Perceived Value of Using the Computer System

Anchors		
Left	Right	Median
Extremely good	*Extremely bad*	1.0
Stimulating	*Boring*	1.5
Productive	*Unproductive*	1.0
Easy	*Difficult*	2.0
Great fun	*Unpleasant work*	2.0
Time saving	*Time wasting*	1.5
Not frustrating	*Frustrating*	3.0
Friendly	*Imposing*	2.0
Confusing	*Clear*	3.5
Too much work	*Not too much work*	3.5

Note. Medians reported are based on a 5-point scale located between the two anchors, ranging from 1 (left anchor) to 5 (right anchor).

the electronic evaluation indicated minimal physical barriers to their learning, students were initially very vocal in their demands to have extensive laboratory access. Their need, in part, stemmed from limited access across campus or at home to a computer with Internet capabilities. In fact, only four students responded to the items regarding barriers related to home computer use. Based on the responses to these items, the one self-rated novice who attempted to connect from home experienced major problems.

Student attitudes were generally quite positive, as shown in Table 3. Although the median rating on the frustration dimension was moderate, students perceived the computer system as extremely good, stimulating, productive, moderately friendly, fun, and moderately timesaving. Statistical analyses revealed no attitude differences as a function of computer expertise.

Students varied greatly in the number of times per week they used the computer system ($M = 5.5$ times, $SD = 3.7$) as well as in the number of hours they spent per week ($M = 7.3$ hr, $SD = 7.5$). There were no statistically significant differences in number of times used or hours spent as a function of computer expertise.

Discussion

In general, students rated the communications aspects of the Internet more highly than the information aspects. Students also generally perceived minimal barriers to their learning and were quite positive about the use of the Internet-based statistics laboratory. There were few differences as a function of computer expertise. In part, this may have been due to a lack of technological problems; dissatisfaction with computer courses has been related to difficulties with the computer system (Pear & Novak, 1996). Possibly fortuitously, the applications were well integrated and ran smoothly in the Windows environment. Few computer or network crashes occurred.

Both quality of discussion and student writing skills appeared to improve during the term. Initial newsgroup posts had to do with identifying interesting WWW sites or advertising parties. However, as Bruning (1995) also observed,

students began to discuss topical issues, such as when to use what statistical technique and how to examine the data before blindly testing some hypothesis. Student writing also improved. Besides working with the GTA on a mastery approach for the results section assignments, students began to "flame" (criticize) each other in the newsgroup for poor grammar, spelling mistakes, and unclear writing style.

One finding of particular interest was that the students did not report accessing all of the information that was available. We had expected students to make extensive use of the online help and pointers to other statistical sites. Possibly the students did not recognize the richness of this resource. Indeed, one comment on the newsgroup late in the term (in response to a question about a particular way to present data visually) was "Someone went to an awful lot of trouble developing online help. Why don't you check out that pointer?"

We experimented with changing the cache settings in the WWW browser used in the laboratory so that we could use the WWW server's access logs to trace an individual student's progress though WWW pages. However, we were unsuccessful in obtaining any reasonable behavioral traces because only first hits on a page can be recorded; multiple hits and jumps to targets on a page are not recorded by the program. Possibly with new monitoring software we will be able to observe actual progress through WWW pages. On the other hand, students appeared to rely more on direct questioning of the GTA and instructor than on other sources of information (including the text, lecture notes, handouts, and the WWW). Our virtual office hours appear to have been the most convenient resource for the students.

Overall, our experiences with offering an Internet-based laboratory course have been positive. The key to our approach appears to have been a well-integrated system, introduction and practice in using the different components of the system, multiple options for communication, and instructor and GTA involvement in communication.

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Notes

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2. The most recent version of the home page is located at: http://web.psych.ualberta.ca/~varn/Psyco_406.html.
3. Correspondence concerning this article, including requests for copies of the electronic evalutation survey, should be sent to Connie Varnhagen, Department of Psychology, University of Alberta, Edmonton, Alberta, Canada, T6G 2E9; e-mail: varn@psych.ualberta.ca.