Introductory Statistics via the Internet

By Judith H. Hector
Walters State Community College
500 S. Davy Crockett Parkway
Morristown, Tennessee, U. S. A.
e-mail: Judy.Hector@wscc.cc.tn.us

INTRODUCTION

Higher education in the United States is embracing the Internet as a means of course delivery. One evidence of the rapid growth of Internet courses is the listing of 23586 courses and 2152 programs, as of July 14, 2000 on the ecollege.com web site. A recent article ("Web scholar," 1999) described the award of a two-year Associate of Arts degree to a student from Florida, who had studied for the degree using the Internet only. The student lived over 1,000 miles (1600 km) from the college located in Texas. This student was one of the first to earn a U. S. degree from a virtual campus. Another student living in Germany has indicated an interest also in completing the same degree. International boundaries are no barrier to this form of distance education. A front page article in the New York Times newspaper ("As Teacher," 2000) reports on the use of Internet courses by secondary school students to obtain university credit prior to completion of secondary school. These Advanced Placement (AP) courses help students gain admission to highly selective universities such as Harvard, M. I. T. and University of California at Berkeley. Use of the Internet allows delivery of AP courses unavailable at some secondary schools because it is too costly to offer such courses in small or rural schools. Recently the author's college and several others in the southeastern United States have signed agreements enabling students to complete a two year community college degree to be followed by two years of Internet coursework to obtain a baccalaureate degree from Franklin University ("Ohio college", 2000).

Higher education institutions in the United States are urging faculty to develop Internet courses. Institutions want to stay competitive. They do not want to lose students to other institutions, who have entered the Internet course marketplace early on. In fact, the U. S. Army has just announced a 600 million dollar Army University Access Online plan ("Army bares," 2000). The army expects 1 million soldiers, Army employees and family members to enroll during the next five years. The expectation is that higher education and private companies will propose courses for the plan to begin as early as January 2001. In the context of increasing demand, the author developed and taught an introductory probability and statistics course for the first time in Fall, 1999 via the Internet and repeated the course in Spring, 2000. This paper describes her experiences with the course. The focus of the paper is the psychology of learning and teaching on the Internet.

THE NATURE OF THE COLLEGE, STUDENTS, AND INTERNET COURSE

Walters State Community College offers the first two years of university coursework for students who intend to enter a variety of occupations such as engineering,

medicine, teaching, psychology, business, and industry. The college is 30 years old and is located in a rural area of the southeastern part of the United States in the state of Tennessee. The college awards associate degrees and also certificates for technical training in such fields as respiratory care, culinary arts, and law enforcement.

All 6,000 full and part-time students commute to class because there are no campus residences. Most students are the first in their families to attend higher education. The average age of the students is 27. One group of students enters the college immediately after secondary school. Another group begins college 10 or 20 years after secondary school. Many students have children or grandchildren and work at full-time jobs.

The course is an introductory probability and statistics course designed to meet university requirements in a variety of majors such as psychology, sociology, primary school teaching, or criminal justice. Local industry also encourages technicians to enroll to increase their skills in statistical process control. Each semester, the mathematics department offers about 10 sections of the course in a classroom based format. The Internet section uses the same syllabus, covers the same content, and uses similar testing procedures as the classroom based sections.

KEY FEATURES OF THE COURSE

The course is listed as an Internet course in the timetable of regular classes along with the URL (uniform resource locator) of the Web site for the course (http://vc.wscc.cc.tn.us/math1080/). After visiting the site, some students e-mail or telephone the instructor to discuss whether they are suited to taking an Internet class. The instructor has developed the following tips on how to succeed in the course. The tips also communicate to students instructor expectations. From these tips, students can self-evaluate whether the course is appropriate for them. The tips are also meant as a guide for student behavior throughout the semester:

How to Succeed in MATH 1080

- Send e-mail before end of 1st week of class.
- Pace study by dates on study guide.
- Distribute study over several days per week.
- Read book critically.
- Read Dr. Hector's e-mails thoroughly.
- Do exercises using TI-83.
- Take the quizzes seriously and on time.
- Use feedback on quizzes.
- Prepare sheet of notes for proctored tests.
- Review exercises and quizzes before tests.
- Contact Dr. Hector ahead of time if you will miss a deadline or a test

Students may enroll by telephone and pay fees at that time by entering a credit card number. Students attend a Sunday afternoon orientation session lasting about 3 hours. They receive a syllabus, assigned problems for the first chapter in the text, and hands on instructions on how to use a TI-83 calculator to do statistics. Students are

informed that the course is guided self-study with a textbook as the primary source of instruction. The instructor collects e-mail addresses from all students and asks them to send her an e-mail during the first week of the semester. During orientation, students also visit the class WebBoard to do a practice posting of autobiographical information and participate in a chat room associated with the course. There is a log on procedure to access the Windows NT laboratory computers on campus and a log on procedure to access the Web board. As the 15-week semester continues from August into December or January into May, students experience the following:

- weekly assigned probability and statistics readings and exercises,
- once a week or once every two weeks, an e-mailed quiz,
- a deadline by which the quiz is to be e-mailed back to the instructor,
- feedback on quizzes e-mailed to individuals by the instructor,
- an optional weekly chat session with the instructor,
- posting of information to the Web board by the instructor when needed,
- frequent e-mail contact between instructor and student initiated by each,
- optional chat and e-mail among students,
- the opportunity to e-mail to the instructor at any time for help or questions,
- optional telephone or face to face contact with the instructor, and
- scheduled on campus assessment by examination at the middle and the end of the course.

A little over half of the students who enroll complete the class for credit. Most choose the Internet course because it saves them time in that they do not have to drive to campus and sit through lectures. Most have jobs and appreciate being able to study at times convenient to them. Most use personal computers at home, although some access e-mail from their jobs. Some have taken Internet classes previously, usually in English composition or literature, and feel comfortable with the format. Usually, students who drop out before completing the course call or e-mail to explain the situation leading to the withdrawal. The reasons given have included a death in the family, personal or family illness, increased workload on the job, or other factors limiting time available to study.

Students express positive evaluations of the course at the end of the semester. Students respond anonymously to an online survey. The college's Webmaster summarizes responses for a course and also for all courses taught online that semester. For example, 83-92% of students state that they would like to take another Internet class. About 67% respond that they learned a great deal from the course. From 67-75% feel that the pace of the class was just right. From 67-75% of the students respond affirmatively that the frequency and quality of interaction with the instructor was adequate. The range is from 67% to 83% in the affirmative on whether the frequency and quality of interaction with other students are adequate.

A CONTINUUM OF INTERNET USE IN COURSES

Courses that use the Internet may be placed on a continuum. Some instructors merely post the course syllabus on a Web page. An instructor may then continue to develop a more extensive Web presence with assignments, solved problems, tutorials, links to additional Web sites for materials to support student learning, and practice tests. An example of an extensively used course Web site is http://www.unl.edu/wglider. The

site serves hundreds of students at University of Nebraska enrolled in a general biology course. The professors have collected data indicating that 90% of the students enrolled in the course use the site and seem to perform better because they use the site. The site is used to support learning as students also attend lectures and laboratory sessions each week. Partridge and Osborne (1999) describe the development and use of Web Study Pages for a third year university course in introductory plant pathology. Most students attend lecture on campus and are expected to come prepared to discuss the material in the study pages and from assigned textbook readings. About 12 students a semester also study the course at a distance and receive the classroom discussion by streaming audio and video. Distance learning students are to prepare for class using the study pages, but do not participate in the discussion. The distance learners are held to the same standards as the classroom students, but never come to campus. Distance learners take examinations from university approved test proctors near the students' homes. The Web site for this course is http://www.ianr.unl.edu/ianr/plntpath/peartree. (Note: much of the course material is password protected and available only to students currently enrolled in the course.) It is becoming fairly common for instructors to extend traditional classroom based classes with e-mail and Web research assignments.

Further along the continuum in terms of learning at a distance using the Internet are courses in which students meet face to face with the instructor only a limited number of times. The author's course falls somewhere here on the continuum in that students meet on campus only 3 times in a semester and receive instruction from a textbook, chat, a Web board, and e-mail. Yet further along the continuum are courses in which all course materials including lectures are posted on the Web. The distance learning students in the previously mentioned plant pathology course (Partridge & Osborne, 1999) have no face to face meetings. This type of course offers the student more flexibility in when and where they study. (For examples of archived webcast lectures with streaming video, access the Center for Internet Technology in Education through http://cite.ecollege.com/index.) Some courses with all course materials on the Web include scheduled sessions in which lecturers present via two-way audio and data in real time with software such as CentraSymposium (http://www.centra.com). Currently the University of Tennessee uses this technology for several courses including graduate courses for physicians studying for a master's degree in business administration. Students can learn at a distance in these courses, but must be available at a computer at the time specified for the scheduled live collaborative sessions.

One aspect of constructing materials for teaching on the Internet is worth considering. It appears that students read posted materials differently than printed materials. Often students merely skim longer pieces on the computer or print them off. Instructional materials may involve color and animation and be designed for interaction. Yet the student is likely to read a black and white print out that strips the materials of these features. Partridge and Osborne (1999) have questioned whether it is worth the course developer's time to incorporate color, animation, and interaction. There is much to learn still about styles of writing that are most effective for Internet instruction. For example, is an outline or bulleted format more useful for students than longer text? Should text be broken into short segments linked together?

CHARACTERISTICS OF LEARNERS LIKELY TO SUCCEED IN AN INTERNET COURSE

For a faculty member thinking of developing an Internet course, it is valuable to consider the characteristics of students who are likely to enroll. Connick (1999, p. 14) states that successful Internet students

- are highly motivated
- are independent
- are active learners
- have good organizational and time management skills.

Students fall on a continuum on these characteristics and instructors need to advise students to ask themselves and consult with others as to whether an Internet course is suitable for them. There are several Web sites with brief questionnaires designed to help student do this self-assessment. ("What makes", 2000) The following statement is useful for students to read:

> If you are considering distance learning, it may be partly because you have multiple responsibilities. Because you are probably already balancing a busy life, you (like other distance learners) need to be strongly motivated and able to structure your world to allow time for studying. *The fact is that you are likely to find that distance learning is more, not less, demanding than learning through traditional means* (Connick, 1999, p. 15)

The experienced instructor is likely to operate from either an implicit or explicit model of student learning. Shraw and Brooks ("Improving college", p. 1) propose an interconnected model of learning involving "cognitive abilities, an organized knowledge base, a repertoire of regulatory skills that include strategies and metacognitive knowledge, and motivational beliefs." Shraw and Brooks ("Helping students", p. 10) also recommend that the instructor promote student self-regulation in six ways:

1. Make students aware of what it means to be self-regulated.
2. Nurture appropriate motivational beliefs.
3. Foster an understanding of the knowledge base.
4. Enhance strategy repertoires.
5. Enhance metacognitive awareness of their own learning.
6. Provide practice using informational feedback.

The author's experience suggests that Internet learning can be appropriate for a variety of students, but students must increase awareness of these six factors and improve or compensate in areas of weakness.

THOUGHTS ON LEARNERS' COGNITIVE ABILITIES

Brody (1992, p. 229) states, "It is possible to define intelligence as the ability to acquire knowledge." For the Internet probability and statistics course, the author assumes that the college students eligible to enroll in the course have sufficient ability to learn the course content. Admission procedures for the college have either screened the students as eligible to enter an introductory freshman course or have mandated preparatory study of basic prealgebra and algebra. Students should have the knowledge base to begin the course, but many are anxious about taking a mathematics course. Some are especially anxious when they discover that all the exercises in the book are "word

problems." Students with the least confidence in their abilities in mathematics prefer courses with a focus on skill in applying algorithms. Introductory probability and statistics goes beyond mere skill in computing using formulas and asks the student to reason, problem solve, and interpret statistical results. The author spends time during the course orientation session encouraging students to believe that they have the necessary background to take the course, but will need to use effective learning strategies.

THOUGHTS ON LEARNERS AS NOVICES IN STATISTICS

Glaser (1996, pp. 305-6) states, "For the development of expertise, knowledge must be acquired in such a way that it is highly connected and articulated, so that inference and reasoning are enabled as is access to procedural actions. The resulting organization of knowledge provides a schema for thinking and cognitive activity. Structured knowledge, therefore, is not just a consequence of the amount of information received, but reflects exposure to an environment for learning where there are opportunities for problem solving, analogy making, extended inferencing, interpretation, and working in unfamiliar environments requiring transfer." Some students in an introductory probability and statistics course have not experienced mathematics learning in as rich an environment as proposed by Glaser. However, they need to experience an introduction to probability and statistics in a way that they begin to construct the connected and articulated knowledge that will allow them to apply what they have learned and go on to more advanced courses if required.

Some students enter the course as novices in probability and statistics and some enter with considerable background gained in previous courses and work experience. The author feels that there should be a progression in the amount of support students receive from the beginning to the end of the semester if the course is the first Internet course for the student. Glaser (1996, p. 305) states, "Initially, learning involves a significant degree of external environmental support, and as competence is attained, there is an increasing amount of internalized self-regulation that controls the learning situation and the fine honing of performance." The orientation meeting, specific instruction on how to use a calculator to perform statistical calculations, suggestions on how to schedule and pace study, and quick responses to student concerns and problems with e-mail and other Internet functions are important supports. It is also important to alert students to content areas found to be most difficult in previous semesters. For example, the author points out the pitfalls in chapters in the course text on probability and hypothesis testing. These topics are difficult for many students, but the unsuspecting student is likely to doubt his or her cognitive abilities when encountering difficulties rather than attributing the difficulties to the subject matter.

THOUGHTS ON LEARNERS' MOTIVATION

It is generally accepted that a learner should be highly motivated to attempt an Internet course. Graham and Weiner (1996) list six contemporary motivation constructs. They are self-worth, self-efficacy, learned helplessness, task vs. ego involvement, instrinsic vs. extrinsic motivation, and cooperative vs. competitive goals. These constructs are complex to apply to practical methods of enhancing learning, but they often come to the forefront of interchanges between student and instructor in an Internet course. Students tend to be more self-revealing in e-mail and dialogues than in a

classroom. Also each student tends to engage the instructor in more interchanges in an Internet class than in the classroom. A student may reveal feelings of low self-worth and let excuses handicap performance. Another student may talk of his belief that he will do well in probability and statistics because he has already passed certain certification requirements involving statistics for his job. One signal of "learned helplessness" is when a student makes no contact with the instructor for several weeks at the beginning of the semester. Such a student has given up before even beginning to study for the course. Other students struggle to get involved with the task of quizzes. They may lack the motivation to study on their own without the extrinsic motivation of a teacher's exhortations to prepare for classroom activities. Some students may have become dependent upon competition as a motivation and find that Internet learning is more cooperative than competitive. The instructor is likely to find Internet teaching requires more awareness of learner motivation and more responsiveness to the ways students express their doubts and anxieties about learning.

THOUGHTS ON TEACHING ON THE INTERNET

A faculty member may commit to teaching a course using the Internet out of a "concern to match the needs of students to a new set of possibilities for learning and personal achievement (Teare, Davies, & Sandelands, 1998, p. 9)." With that commitment comes the need to learn how to design a course that is pedagogically sound and makes effective use of the Internet. Schweizer (1999) focuses on what the on-line learner needs while providing practical steps to on-line course development. Brooks (1997) has written an encyclopedic book describing what is possible to include technologically in an Internet course and what instructional strategies are likely to be effective. Boettcher and Cartwright (1998) have written and posted an article on designing and supporting courses on the Web. The site on which their article is posted refers the reader to a large number of books related to using technology in distance learning (http://contract.kent.edu/change).

The author has found guidance for teaching an effective Internet course from seven principles of good practice in undergraduate education first proposed in 1987 by A. W. Chickering and later amplified upon with regard to using technology as a lever for implementation ("Best Practices", p. 1):

Seven Principles of Good Practice in Undergraduate Education

Good Practice

1. Encourages Contacts Between Students and the Faculty
2. Develops Reciprocity and Cooperation Among Students
3. Uses Active Learning Techniques
4. Gives Prompt Feedback
5. Emphasizes Time on Task
6. Communicates High Expectations

7. Respects Diverse Talents and Ways of Learning

1. Experience with Encouraging Contacts Between Students and the Faculty

The volume of e-mail contact in the introductory probability and statistics course is very large in comparison to the amount of contact in a classroom. Typically only a few students ask questions and actively discuss in a face to face class. Even fewer make use of faculty office hours or the telephone to contact the instructor. In comparison, Internet students tend to e-mail the instructor whenever they sit down to do reading and homework. Students seem to feel less shy about expressing themselves in writing on their own time when they are alone with their computers than when they are sitting in a class or when they have to make time to call or come to a faculty office at scheduled times. The author has also found that students expect one or more e-mails from the instructor in a week. The author attempts to motivate, express encouragement, share information, and offer problem solving help through e-mails. She tries to respond within a day to each student's e-mail even if the response is just to indicate that the e-mail has arrived and when a response can be expected. A clear sign that a student may not succeed in a course is when no e-mails arrive for two weeks and the student has not indicated that he/she will be out of communication for a period of time. Fewer students make use of the chat feature of the course. It seems to serve as live interaction for students who enjoy knowing that "someone is there." From the author's point of view, the amount of teaching and learning going on during the chat time is small. Also, it is hard to schedule suitable chat times for the diversity of schedules students have. In contrast to Chat, a very important feature of e-mail communication is that it is sent when convenient for the person sending the e-mail and read when the person receiving the e-mail has time to read it. A student may work on the course in the middle of the night. The faculty member may respond to e-mail at home on weekends or while off campus at a conference. It is still surprising to the author that students feel that an instructor is more personal and more responsive to student needs based on e-mail communication compared to face to face communications.

2. Experience in Developing Reciprocity and Cooperation among Students

The goal is to involve students in learning that is collaborative and social rather than competitive and isolated. The author has had mixed results in this area. It appears that students develop a collaborative relationship with the instructor and feel more comfortable with the instructor in the role of a guide or facilitator in comparison to the role of lecturer. Some collaborative and social relationships develop among students through the chat room and e-mail. However, several students each semester have succeeded in the course with only a relationship with the instructor. Family and work responsibilities limit the time available for any interactions with other students. The author intends to continue promotion of communication among students and will attempt to form learning teams during the orientation session. The learning teams will be based on when students are likely to work on course materials and be available for chat.

3. Experience with Promoting Active Learning Techniques

Beyond the first orientation meeting, it is not possible for students to sit and listen to learn in the author's course. Students must read critically, learn to use a calculator,

work out statistical exercises, check the answers to the exercises, work out the problems on quizzes and examinations, and ask questions. The author has assigned additional reading or articles on the Internet in which people report on how they have used statistics in real life. The Chance web site (http://www.dartmouth.edu/~chance/) is an excellent source of such readings. This aspect of the course is beneficial in exposing students to practical uses of statistics and will be enlarged. Students who have worked in industry have experienced many applications of statistics. However, some students approach statistics as a set of steps to be memorized rather than as a method of making sense out of real life data. Students have special difficulty taking the results they have found from applying statistical techniques and then writing an interpretation of what the results mean. This kind of reflective writing is not easy for graduate students doing research, so it is not surprising that undergraduates in an introductory course experience difficulty. Yet, it is an important goal of an introductory course that students become better able to interpret the statistics they encounter in the newspaper, in standardized test results for relatives in school, and in other areas of daily life.

4. Experiences with Giving Prompt Feedback

Many Internet students struggle with the deadlines set up by the instructor for when quizzes should be returned. The author uses the quizzes to make sure that students are pacing through the course at a speed that will allow them to finish by the end of the semester. So far, the author has not imposed a grading penalty for late quizzes, but procrastination is a problem. The author tries to return quiz results and feedback on errors promptly. Given the author's schedule as an administrator, it appears that quizzes should be scheduled as due on Thursdays so that she can print them on Friday and evaluate them on the weekends. The students who most need the prompt feedback are the ones who do not realize that they have not understood a particular section. The quizzes reveal what students do not understand. E-mail provides quick feedback, but it is very time consuming to write helpful feedback to students one by one. This aspect of an Internet class is labor intensive, but very effective. For face to face classes, there is rarely time to go over each individual's homework or quizzes to provide this feedback.

5. Experiences with Time on Task

The flexibility of when students can read and work problems allows them to make better use of their time. They save the time that they would use driving to campus and sitting in a class. A student's questions by e-mail are often succinct because they are written. Likewise, an instructor's responses are pertinent to an individual's question. The author believes that online students spend more time reading and working problems than classroom students do. Classroom students often think that they can learn by listening rather than by doing homework and reflecting. Online students who do not put in the time needed to read, do homework, ask questions, and reflect can tell that they are not learning because they can not answer quiz and examination questions. It is the author's experience that online students who persist to the end of the course perform better than classroom students. Student time on task seems to be a determining factor.

6. Experiences with Communicating High Expectations

The author begins the orientation session for the probability and statistics course with two points. The first is that the online course has the same content and requirements as the course taught in the classroom. The second point is that students tend to perform better on quizzes and examinations in the online course. Students have repeated this statement of high expectations at the end of the course and have indicated that it was a motivating influence. The author has also found it beneficial to offer encouragement to students experiencing difficulties during the semester. She states her belief that the student will succeed if he/she persists in asking questions and working to understand what is causing the difficulties. About half of the students drop out of the course, but they usually cite time conflicts arising from work and family problems. Some of the students who have successfully completed the course have overcome significant problems during the course of a semester. The author feels that she can offer support and a listening ear to students as they marshal resources to overcome problems.

7. Experiences with Respecting Diverse Talents and Ways of Learning

Community college students are diverse in age, experience, social status, and learning styles. The term, "non-traditional student" has been coined to reflect this diversity. In the classroom, middle aged students sometimes become annoyed at the undisciplined antics of recent secondary school graduates. Bright students may complain about slower students who ask questions with answers obvious to others in the class. Shy students may object to verbal students who seem to monopolize the instructor's attention. Working adults may express resentment that younger students are wasting their parents' money by not being serious students. Online students can collaborate at a distance with students of their choice without the conflicts that can arise in the classroom. The author has found that it is important to provide structure for online students through a timetable of assigned readings, problems and quizzes. Students who do not need this structure can work ahead. Slower students need more encouragement and feedback.

FOR FACULTY THINKING ABOUT TEACHNG AN INTERNET COURSE

Besides reading about teaching an Internet course, it is very helpful to attend short courses and workshops in which faculty with experience in Internet teaching share insights. The National Science Foundation supports several short courses related to teaching on the Internet through its Chautauqua program (http://www.engrng.pit.edu/~chautauq).

There are a number of online sources, some free and some with fees, offering help for a faculty member new to online teaching. The Learning Resources Network offers one week online courses on teaching online for a fee (http://www.lern.org/TeachingOnline). The Center for Internet Technology in Education has free live webcasts of lectures such as one scheduled for August 2, 2000 entitled "Lightening the Load of Online Instruction: Time Management Techniques and Strategies." (http://cite.ecollege.com/index.lear?action=Vision&subaction=Webcast). The live webcasts are archived and available for later viewing. The free sites are rich sources of information, but often contain sales pitches for course delivery software. A small selection of such sites includes:

1. http://www.ecollege.com
2. http://www.prenhall.com

3. http://www.abacon.com
4. http://www.distanceed.com
5. http://about.webct.com
6. http://pearsoned.com
7. http://www.cdl.edu
8. http://merlot.csuchico.edu
9. http://contract.kent.edu/change
10. http://www.blackboard.com

A NOTE ABOUT USE OF SYMBOLS IN MATHEMATICS AND SCIENCE ON THE INTERNET

An instructor wishing to communicate formulas involving special symbols such as square root must search out ways that go beyond the regular text features of word processors. Posting such formulas on the Internet is simpler than making the formulas interactive. The author found e-mail especially limited as a means of interacting with students on solving statistical problems. It is not hard to embed formulas in an e-mail attachment created in Microsoft Word with its built in Equation Editor. An add on piece of software called Math Type has a more complete set of features to handle most mathematical and scientific symbols and formula formatting. However, the limitation is that students must have the same or higher version of the word processor in order to open the attachment. The author has not felt that it was feasible to require that students purchase particular software or particular versions of the software for the course. She has written out problem solutions using English equivalents for symbols combined with calculator keystrokes to explain certain solutions. She has arranged telephone conferences and face to face meetings to overcome mathematical difficulties students were having. She is exploring what may be called a "second generation" course delivery software called, DE-CourseBuilder, from DistanceEd.com. This software incorporates "Formula Renderer" features that allow both instructor and student to click on a template of conventional mathematical notation. The "Renderer" translates mathematical notation with the usual grammar and syntax understandable to humans into a language understandable to the courseware for transmission on the Internet. Both instructor and student need only learn a few rules on how to operate the "Renderer." One feature of DE-CourseBuilder is that students need to learn only the rules and symbols applicable in the course they are taking. The rules and symbols needed by an introductory probability and statistics students is a small subset compared to the subset needed by a student in calculus or differential equations.

The author intends to place sample quizzes online to aid in giving feedback to students. She also intends to develop some online quizzes for evaluation purposes. It has been possible to use e-mail and slow mail to distribute and collect quizzes. The online materials can be richer in graphics and symbols. The Mathematics Department at University of Nebraska, Lincoln has used software from Wiley to develop online tests. (See http://calculus.unl.edu). The site offers suggestions to students on how to type in mathematical formulas and expressions. The syntax resembles what is used in Texas Instrument calculators. An example of a quadratic expression is x^2-2x+1. This syntax seems feasible for a probability and statistics class. However, the author is aware of the many difficulties students have in learning calculator syntax. In probability and statistics,

novice students often have difficulty placing enough parentheses in formulas to ensure that calculations are performed in the correct order of operation. The formulas for a z-score and the standard deviation of the sample means are just two examples at the root of student mistakes.

The author is also indebted to Dr. Larry Husch and Dr. Earl Fife for their short course on putting mathematics on the Internet ("Putting mathematics, 1999). They demonstrated a variety of approaches to both incorporating symbols into static Web pages and making interactive student worksheets. Course supplements for mathematics courses at University of Tennessee illustrating these techniques are available for view ("Visual calculus").

REFERENCES

Army bares $600 million program to educate soldiers. (2000, July 11). The Knoxville News-Sentinel, pp. 1, 9.

As teacher in the classroom, Internet needs fine-tuning. (2000, July 7). The New York Times, pp. 1, 14.

Best practices: Implementing the seven principles: Technology as lever. (1997). [Online]. Available: http://www.tecweb.org/eddevel/de95.html

Boettcher, J., & Cartwright, G. P. (1998, July 7) Designing and supporting courses on the web. [Online]. Available: http://contract.kent.edu/change/articles/sepoct97.html.

Brody, N. (1992). Intelligence, 2nd Ed. New York: Academic Press, Inc.

Brooks, D. W. (1997). Web-teaching: A guide to designing interactive teaching for the World Wide Web. New York: Plenum Press.

Connick, G. P. (Ed.). (1999). The Distance Learner's Guide. Upper Saddle River, NJ: Prentice Hall. (Companion Web site: http://www.prenhall.com/dlguide)

Graham, S., & Weiner, B. (1996). Theories and principles of motivation. In D. C. Berliner & R. C. Calfee (Eds.), The handbook of educational psychology (pp. 63-84). New York, NY: Macmillan.

Ohio college wants to offer online degrees. (2000, July 7). The Knoxville News-Sentinel, p. 4.

Partridge, J. E., & Osborne, L. (1999, March). Designing and using World Wide Web study pages to support student learning outside of the classroom. NACTA Journal, 43, 43-46. (National Association of Colleges and Teachers of Agriculture)

"Putting mathematics on the Web." (1999). [Online]. Available: http://archives.math.utk.edu/WPT/barrett/

Schweizer, H. (1999). Designing and teaching an on-line course: Spinning your Web classroom. Boston, MA: Allyn and Bacon.

Shraw, G., & Brooks, D. Helping students self-regulate in chemistry courses: Improving the will and the skill. [Online]. Available: http://129.93.84.115/Chau/SelfReg.html.

Shraw, G., & Brooks, D. Improving college teaching using an interactive, compensatory model of learning. [Online]. Available: http://129.93.84.115/Chau/CompMod.html .

Teare, R., Davies, D., & Sandelands, E. (1998). The virtual university: An action paradigm and process for workplace learning. New York: Cassell.

Visual calculus. [Online]. Available: http://archives.math.utk.edu/visual.calculus/

Web scholar earns degree long distance. (1999, December 14). Community College Times, pp. 1, 11.

What makes a successful online student. (2000, June). [Online]. Available: http://illinois.online.uillinois.edu/IONresources/onlineoverview/StudentProfile.html .

Software: WebBoard by Duke Engineering and O'Reilly and Associates, Inc. (software@oreilly.com)

Additional References of Interest

Rising Use of Technology Including Internet in Instruction
Green, K. (1999). Campus Computing Survey
http://www.campuscomputing.net/summaries/1999/index.html

Indicators of Engaged Learning
"Learning with Technology Profile Tool", North Central Regional Educational Laboratory
http://www.ncrtec.org/capacity/profile/profwww.htm

Instructional Technologies to Support Traditional Teaching Techniques
LS151: "Teaching and Learning with Technology: Developing a Teaching Enhancement Plan," Derco & Little, ITC.
http://www.it.utk.edu/itc/courses/ls151/techniques.html

"Step by Step Guide to Using Instructional Technology in Teaching", Jane Knight, London Guildhall University
http://itc.utk.edu/~jklittle/it/steps.html

Online Resources to Learn More about Instructional Technology
"The Effective Uses of Technology", Berger & Meyers, 1999. Indiana University.
http://www.bus.indiana.edu/isweb/techn/effuse.htm

"Digital Technology and its Impact on Education," Hardin & Ziebarth, 2000. University of Illinois.
http://www.ed.gov/Technology/Futures/hardin.html

"Quality On-the-Line: Benchmarks for Success in Internet-based Education," 2000. Institute for Higher Education.
http://www.ihep.com/quality.pdf

"Going Online: Guidelines for Faculty in Higher Education," Verneil & Zane. Look at Vol. 6, No. 3, 2000 in the following:
http://www.aace.org/pubs/ijet