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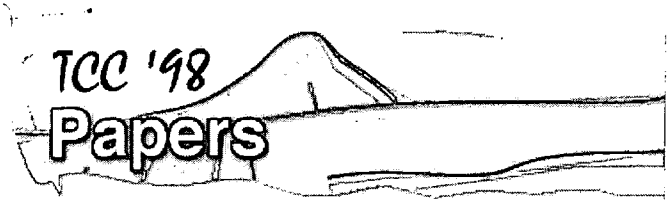
ABSTRACT

This paper chronicles experience in designing graduate-level statistics instruction for delivery via the internet. The paper begins with a summary of course content and specific procedures for instructional interaction via the internet. Special challenges posed by both the course content and the Internet mode of instruction are identified, and strategies for resolving the challenges are provided. Also included are comparisons of internet-based delivery of graduate-level statistics with the more traditional face-to-face mode of instructional interaction. Finally, some extensions, applications, and future directions for Internet-based quantitative instruction are outlined. (ASK)



"GO FIGURE": THE SURPRISING SUCCESSES OF TEACHING STATISTICS COURSES VIA INTERNET

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INTRODUCTION

"All things are difficult before they are easy." This quote by Thomas Fuller ideally describes the dilemma often inherent in trying new ways of doing things. The temptation may be great to "stick with the tried and true" rather than to challenge custom or tradition.

Statistics and computers have customarily been viewed as "tough stuff" by students. Typical reactions include anxiety, avoidance and low confidence in one's abilities to master these skills. At first glance, combining the two might seem to pose insurmountable challenges to the instructor and student alike.

Surprisingly, though, the exact opposite occurred when I pilot-tested two graduate-level statistics courses to be delivered to students via Internet. Far from perceiving the instructional experience as "cold" or "impersonal," students singled out the freedom and flexibility to custom-tailor instructional interaction to individual needs. They also praised the curricular materials for their clarity. In particular, they noted the instructor's responsiveness to individual students' questions and concerns.

This paper chronicles my experiences in curricular development and delivery of graduate-level statistics instruction via Internet. The paper begins with a summary of course content and instructional interaction via Internet. Next, some special challenges in adapting statistical instruction to the 'Net are presented and discussed. Internet-based delivery of graduate-level statistics are compared with the more traditional live face-to-face mode of instructional interaction. Finally, some extensions, applications and future directions for Internet-based quantitative instruction are outlined.

PAVING THE WAY FOR THE CYBER-JOURNEY: PLANNING FOR QUANTITATIVE INSTRUCTION VIA INTERNET

The pilot test of courses via Internet began as an idea in the spring of 1994. Our master's and doctoral degree programs in Educational Leadership at Northern Arizona University, Flagstaff, Arizona, serve a geographically dispersed and diverse student population. Our students live and work in scattered and often isolated rural reservation locations throughout the state. During the school year, their jobs as teachers and administrators place further restrictions upon their availability to meet commitments of traditional, centrally located classes. Even periodically traveling to an interactive television studio for intensive class meetings would pose an undue hardship for many of them. How could instructional interaction be optimally structured and delivered to best meet their needs?

We believed that a pilot test of instructional delivery via Internet presented a potential solution. With this procedure, students were not restricted to fixed class meetings on predetermined dates and times at often-distant sites. They could access their lessons, assignments, and even instructor from the comfort of home and their computer screens.

The pilot test of such Internet-based instruction started with a cohort of about 15 graduate students. They registered for "Introduction to Statistics" to be delivered online.

At that time it was recommended, although not required, that students sign up for a computer account with the America Online (AOL) Internet service provider. The main reason for this recommendation was AOL's relative ease of use, particularly compared with access to more traditional Internet providers at that time. With the icon-driven graphical user interface of AOL, it was my hope that students would quickly master "the computer essentials" such as logging on as well as sending and receiving e-mail. In turn, I believed that this ease of use would quickly eliminate their "computer anxiety," freeing them to concentrate on the statistics course concepts themselves.

The course curriculum consisted of ten learning modules and related assignments. Each module took the place of a chapter in a textbook, or a set of class notes in a more traditional live interactive session. Specific topics covered in the introductory graduate-level statistics course included the following: --Scales of measure; --The concept of centrality; --The concept of variability; --Frequency distributions; --The concept of estimation; --The concept of hypothesis testing; --The concepts of relationships and differences among measurements.

The objective of each learning module was to present the preceding concepts as intuitively as possible. Numerous real-life examples were discussed, compared, and contrasted in their actual contexts. The goal was to for each student to "develop a real feel" for what these concepts were intended to accomplish, **before** doing any sort of **formulaic number-crunching**.

Each learning module ended a related assignment. The assignment was intended to assess, in a mastery-learning sense, students' understanding and ability to apply the concepts.

ROAD-TESTING OUR STATISTICAL CYBERSPACE ADVENTURE: HOW THE STATISTICS INSTRUCTION TOOK PLACE

Figure 1 illustrates the sequence of actions that comprised such Internet-based statistical instruction and interaction. These actions will be explained more fully in the accompanying text, below.

Obtain AOL account

Exchange startup e-mail message with instructor

Download 10 learning modules and related assignments

E-mail instructor with any questions, comments or concerns as relevant

Complete assignments individually or in groups by required due date

E-mail completed assignments to instructor

Participate in weekly live chat sessions with classmates and instructor

Figure 1. Sequence of Steps for Internet-Based Instructional Interaction in Graduate-Level Statistics Course via Internet

As mentioned earlier, students were required to have access to **any** Internet Service Provider of their choosing. For those with limited exposure to the Internet at that time, AOL was recommended as a relatively user-friendly means of accessing the Internet. Students were informed of the monthly AOL user fee. However, it was also pointed out to them that they would not be buying a textbook. Instead, they would have the learning modules and related assignments electronically delivered to them. The AOL fee for the duration of the course was expected to be far less than the typical cost of a graduate-level introductory statistics textbook, a prediction subsequently borne out by actual student experience.

Students would begin by successfully logging into AOL and sending me an e-mail message. I would then proceed to transmit the 10 learning modules to them as AOL file attachments. Due to the proliferation of

a variety of word processors, I had these modules available in several alternate Macintosh and Windows formats.

Students would download and print these learning modules and related assignments. They were welcomed to work on the assignments individually or in study groups, as they wished. They would complete and transmit their solutions to me electronically, as AOL file attachments. I would download these, annotate my comments in bold/italics to help them stand out for ready review, and return my comments to the students online. The students soon realized that I was online several times a day. This facilitated efficiency of response to assignments and questions, as I would generally return assignments and/or responses to questions within 24 hours.

To further facilitate interaction with me and their peers, I also scheduled a series of weekly **live chat** sessions. These were the equivalent of office hours. We would all log in at 6:00 p.m. each Sunday evening and access a predetermined **chat room** that I had set up in advance. Each participant in the chat room, student or instructor, interacted with the others by typing. What was typed by one of us could be viewed by all. This procedure provided a forum for asking questions, sharing concerns and ideas, and the like. Students would respond to one another as well as to me, while I provided overall guidance in keeping the chat focused. For additional information on planning and conducting online graduate instruction, please see Dereshiwsky (1995).

'THE LAW OF AVERAGES?...OR MURPHY'S LAW?' SPECIAL CHALLENGES POSED IN ONLINE STATISTICS INSTRUCTION

As mentioned in the introduction, any instructor of statistics is well aware of its "fearsome" nature in the minds of students. A built-in challenge for any instructor of quantitative methods, regardless of the mode of instruction (traditional classroom vs. Internet), is to concurrently defuse the anxiety and build students' self-confidence in their ability to master the building blocks of the material.

With regard to developing and delivering the statistics instruction online, I particularly noted the following special challenges and designed strategies to meet them. Figure 2 illustrates these challenges as well as my responses.

(C) Students' challenge to master difficult quantitative concepts

(R) Provide numerous graphically illustrated examples in learning modules

(C) Students' questions and concerns

(R) Be online several times a day and respond via e-mail and telephone within 24 hours generally

(C) Students' need for additional reinforcement of material presented in learning modules

(R) Allow and encourage group work on assignments; provide chat sessions as dependable weekly mode of interaction with one another as well as instructor

(C) Students' need to self-pace and 'stay on track'

(R) Specify definite due dates for assignments and encourage group work

C) Instructor's need to convey a 'real person behind the RAM'

(R) Use 'emoticons' in e-mail messages; create a weekly newsletter to 'create a sense of family' and keep everyone connected

Legend: (C): Challenge (R): Response

Figure 2. Special Challenges in Planning and Implementing Statistics Instruction Online

The primary challenges illustrated in Figure 2 are all too painfully familiar to any statistics instructor: getting past the fear and helping students build their own belief in their ability to systematically master the concepts of statistics. Admittedly, the traditional environment provides some 'visual cue advantages.' I can always 'scan the room for frightened faces' and other indicators of confusion. However, such 'clues' are not possible in the online environment where "all we see is our computer screens." How then can the online instructor effectively deal with these concerns?

I found the answer lies primarily in two strategies:

1. **Ensure that the learning modules have numerous, additional extra examples, replete with visual inserts and real-life applications, of important concepts such as centrality, variability, estimation, etc.** To put it bluntly, "think overkill" in terms of thoroughly illustrating each application, each step in a sequence of logic, and you've got the idea.
2. **Create multiple avenues of instructor accessibility**. As mentioned in the preceding section, I quickly established myself as a 'constant online presence.' Students learned that I was online several times a day. As a result, they learned to count on my 24-hour turnaround of questions and assignments online. Furthermore, they saw that if a question could not be satisfactorily resolved via e-mail exchange, I would immediately pick up a telephone and interact with them 'live' on their learning needs. This was a particular boon for our students at distant locations, who by their own admission would have found it difficult to travel to campus for office hours. In like manner, most students had relatively convenient access to a FAX machine at home or work in case we needed to use one.

Before beginning this grand cyberspace adventure in statistics instruction, I confess I had nightmares of students "staring at a cold, impersonal computer screen" if they were stuck on a concept or question. At the same time, I worried about not being able to "see signs of distress:" the furrowed brow, the upset look, etc. How would I know if they were lost and needing help?

As it turned out, these concerns were unfounded. With regard to the first point, above, students praised the learning modules for their organization, clarity and completeness. They felt these materials gave them a solid "real-world grounding" in the meaning of the statistical concepts. In addition, they repeatedly commended my 24-hour responsiveness, accessibility and multiple avenues of contact. Far from feeling "abandoned in cyberspace," they would voice comments such as "I feel as though I'm forming a one-to-one partnership with you on my learning needs" and "I know if I need help, you're only a mouse click away."

In particular, I established myself as a "real person" via the positive- thinking stories that I shared in our weekly newsletter to the network, as well as my judicious use of humor and emoticons in my e-mail messages to individual students. Rather than seeing me as the stereotype of the "monotone mumbling, face-to-chalkboard" quantitative professor, they were first and foremost very well aware of the "person behind the professor" with whom they were interacting. This too, I believe, greatly helped defuse the natural fears associated with learning statistics, and particularly in such a novel interactive environment as AOL and the Internet.

The "proof of the pudding" was in the way I have been characterized by students on my course evaluations in both the traditional and Internet-based courses. Time and again, I am characterized **identically** on the open-ended portions of the evaluation forms...**even by students who have not yet met me in person**...by the Internet-based students as by those who have taken these courses with me in the traditional face-to-face interactive classroom environment.

Allowing group submissions of assignments had some distinct parallels to the traditional mode of classroom instruction. For one thing, when I have taught statistics in the live and in-person environment, our usual modus operandi would be to work through a concept as a group, and then break up into smaller groups to practice some applications of this concept (i.e., additional examples or problems to complete).

As I would circulate among the groups, time and again I would overhear a student explain a concept to his/her group better than I thought I had! The benefits of such small group practice and application in reinforcing the concepts are clear--and, as I learned, entirely replicable in the cyberspace environment.

Due to the fact that our graduate students live and work in various locations throughout the state, they naturally form such 'cohorts' in the blocks of classes and study activities that they work on together at that one location. The cyberspace environment allowed them to apply these 'distance-based cohorts' to create study groups in which they met regularly to go through the materials and assignments at mutually convenient days, times and locations. This allowed them to continue to enjoy the benefits of the interactive, face-to-face group environment, while at the same time providing them with much greater freedom and flexibility to 'set their own pace' than in the more traditional 'fixed day/time/duration' class meetings. It also allowed flexibility in that students who preferred to work alone, or perhaps with a maximum of one teammate, could also do so. Thus, the Internet approach facilitated truly 'custom-tailoring' the instructional experience to more ideally fit each student's individual scheduling, pacing and interactive preferences.

The allowance for group work also helps prevent a 'clear and present danger' familiar to everyone who has taught in the Internet environment: procrastination. Let's face it: some students do appear to need the 'indirect pressure' of the periodic fixed face-to-face meetings with their instructor as a subtle reminder to stay focused. Having a group or teammate to study with can provide a partial answer. Students who study in groups will most likely develop a parallel sense of responsibility to meet time and task commitments to their fellow group members/teammates. This will help them to stay on track with due dates. Clear and specific due dates for assignments, staggered evenly throughout the semester, are another helpful procedure to help prevent procrastination by students.

Figure 3 summarizes the experiences in teaching statistics online as compared with the more traditional environment. For further discussion of helpful strategies in planning online instruction, please see Dereshiwsky (1997).

- Greater responsiveness to individual students' questions, concerns and needs;
- Greater freedom and flexibility to custom-tailor instructional interaction to suit individual students' needs; * Comparable mastery of concepts;
- Particularly helpful for students at remote locations, students with disabilities (i.e., hearing impaired), those with unpredictable work, family and/or travel responsibilities. Figure 3. Results of Internet-based Statistics Instruction as Compared to the Traditional Classroom Environment.

'WHERE THE INFO-HIGHWAY MAY LEAD US': CURRENT AND FUTURE APPLICATIONS OF STATISTICS CYBER-INSTRUCTION

The success of the 1994 pilot test of teaching graduate-level introductory statistics online led to the following expansions and applications:

- Development of a comparable graduate-level intermediate statistics course offered online for the first time in 1994, with many of the introductory statistics students also opting to take this advanced course via Internet;
- Comparable development of a doctoral-level research design course offered online; * Comparable development of qualitative analysis coursework online;
- Curricular development of combination live and online instruction. (Please see Dereshiwsky and Plett (1997) for an example of designing and implementing a graduate-level introduction to research course taught in such a combination live-meeting-and-periodic-Internet-interaction mode.)
- Conducting doctoral dissertation advisement, including individual interaction with dissertation candidates at distant locations on all phases of the document, from formulation of an initial idea, to expansion of individual chapters and even intensive interaction on data analysis needs. I interacted on virtually a daily basis with one of our doctoral students who had moved from Arizona to Wisconsin to accept employment on a complex multivariate regression analysis for Chapter Four of his dissertation. He subsequently commented that this mode of dissertation advisement online was, if anything, **more** reliable than having to wait for office hours or an appointment. On the contrary,

he shared that online interaction was far more dependable and efficient. He knew he could count on having an update from me in his incoming e-mail every day on his prior work, and likewise he could send me his next portion of analysis every night knowing it would be waiting for me in my own e-mail first thing the following morning. This particular student subsequently went on to win a prestigious dissertation award from a national educational research association. For more on conducting dissertation advisement via Internet, please see Dereshiwsky and Packard (1997).

- Adding a Web-based component to the e-mail interactive facility of Internet instruction. My teaching partner, Dr. Wally Rande, and I are currently pilot testing the use of an interactive Web site with our graduate-level Introduction to Research students. This Web site has facilitated students' downloading their learning modules and assignments, as well as providing a 'universal' place for them to post messages to one another and hold live chat sessions regardless of individual Internet service provider.

Many horizons for expansion still remain. The following are but a few such ideas:

- Developing and pilot-testing comparable Internet-based statistical instruction in such upper-level 'specialty' areas as nonparametric statistics and multivariate statistical methods;
- Combining the quantitative and qualitative components into a **multimethod research** course at the master's and/or doctoral level;
- Creating statistics labs, comparable to current lab sessions held for students in the traditional environment, via the interactive chat facility of Internet.

'LET ME COUNT THE WAYS:' CONCLUDING COMMENTS REGARDING THE ONLINE STATISTICS INSTRUCTIONAL EXPERIENCE

As I mentioned at the outset, I initially approached this challenge of developing and delivering online statistical instruction with much trepidation. Actually, my fears were not unlike the fears of students beginning their own statistics instruction or computer use. "Will I be able to do it?" "Will it work?" and primarily, the stereotypes of "statistics as tough stuff" compounded by the image of a "cold, impersonal computer" haunted me as I undertook this challenge.

Not only were those initial concerns largely unfounded...but frankly they were soon replaced by some joyful self-discovery on my part regarding what can be accomplished via online instruction. Students appreciated the greater freedom and flexibility to "learn when the time was right for them." At the same time, they praised the learning modules for their clarity, organization and helpfulness in mastery of statistical concepts. Above all, they quickly got a sense of me as "a real, caring person:" one who truly wanted to forge a one-to-one partnership with them on their learning needs.

Based upon my successful experience in curricular development and instructional delivery of quantitative concepts online, I would unconditionally and most enthusiastically recommend it to any instructors toying with the notion of road-testing their particular subject area online. I predict that the risk of the novel channel of communication will soon be more than offset by a number of comparative benefits of this universal instructional medium. To summarize my experience and advice to others, I can only quote Arthur Clarke: "The only way to discover the limits of the possible is to go beyond them into the impossible."

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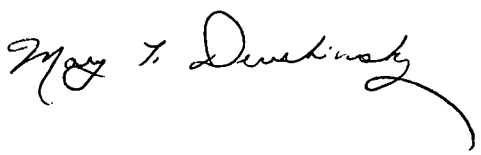

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