Application For Indiana Higher Education Telecommunications System Grant-1997
Interactive Use of the Internet for Statistics

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Abstract

The primary goal of this project will be to allow students to complete course requirements and interact with the subject matter and instructor at times convenient to them rather than in a regular classroom setting. More specifically, this project will provide interactive material for a statistics course, using hypertext links, java applets and interactive animation on demand, by way of the internet and CD-ROM. Although the course to be developed in this manner is a basic statistics course at Purdue University North Central, it is felt the procedures developed in this project can be easily extended to other courses at other Universities. A grant of $12,000 is requested for specialized computer software and time to allow two faculty members at Purdue University North Central to develop this project during the summer of 1998 for implementation in the fall 1998 academic term.

Some Key Words: asynchronous learning, internet, CD-ROM, hypertext, java, applets, animation, statistics.

Needs To Be Addressed and Learners To Be Served

The internet is presently used by Kuhn and Montgomery as a readily accessible electronic bulletin board to store not only class notes, homeworks and test solutions but also to post updated test scores throughout the academic term for their courses at Purdue University North Central (PU/NC). Although this passive use of the internet has proven to be successful, this grant will be used by Kuhn and Montgomery to improve the internet presentation of course material by making it more interactive through the use of hyperlinks, java applets and Shockwave animation. In particular, it is hoped this project will allow students at PU/NC to complete requirements of the course without needing regularly scheduled time commitments which could conflict with the students other responsibilities.

This type of asynchronous learning is particularly relevant to the students at PU/NC as they are commuters who would benefit from the flexibility offered by a course given over the internet. We anticipate serving students who live and work in the general geographical area of PU/NC but who, because of work schedules, cannot find the time to physically attend weekly classes or office hours. It is possible, though, that any student who has access to the internet (or even just a CD-ROM) could participate in this course.

Rationale For Choice of Course

We chose statistics as the subject for this project for two main reasons. Statistics involves the exploration and manipulation of data and java applets can facilitate this. Statistic courses presently make heavy use of technology and many students in such courses are expected to learn how to use sophisticated graphing calculators such as the TI-83 and specialized statistical software such as Minitab, Mystat and SAS. A transition to the internet is a logical next step.

Of the four different introductory statistics courses taught at PU/NC, the particular course, Elementary Statistical Methods, was chosen for a few reasons. The type of student taking this course is expected to have a fairly good, although not sophisticated, knowledge of the use of computers. In particular, Kuhn requires the use of the TI-83 calculators in this course. Elementary Statistical Methods is a popular course, given each term on a regular basis, at PU/NC and, furthermore, is the typical introductory statistics course taught at other universities in the United States. Elementary Statistical Methods is the most familar to Kuhn, who has been teaching this course for the past 13 years.

Technology Used

We plan to connect, via web pages written in Hypertext Markup Language (HTML), the `passive' parts of the Elementary Statistical Methods course, presently on the internet, with the proposed `active' parts of the course. In particular, a student will be directed, at appropriate points in the lecture notes, to either java applets, interactive animation, TI-83 labs or some evaluation procedure, such as a quiz or homework. Hyperlinks will also be provided to direct the students back from the applets, animation or labs to corresponding points in the lecture notes. We intend to use Macromedia's Dreamweaver to write the HTML pages. This tool was chosen because of its tight integration with BareBone's BBEdit which is software that has a commanding lead in HTML editing (see WebWeek October 20, 1997).

Java applets will be used to provide interactive content in a number of ways. Java applets will be used to generate data which can be used in conjunction with the student's TI-83. The applet can also supply the correct results of these explorations, allowing the student to confirm their own work without the need to contact the instructor. It should be emphasized that we do not propose to use java to rewrite *sophisticated* statistical routines, such as appear in the statistical packages SAS or SPSS. Java applets will also be used to provide interactive homeworks and quizzes that can be performed on the internet by the student. We intend to use Metrowerk's Codewarrior to write and compile the Java applets. This tool was chosen because of Montgomery's familiarity with the product.

Shockwave animation will be used to provide interactive demonstrations. These animations are responsive to user input, allowing the students to back-up in a presentation or change some of the focus of a presentation to those parts which they found were left unclear by the text and lecture notes. We intend to use Macromedia's Director 6 to produce the Shockwave animations. This tool was chosen because of its commanding lead in animation creation (see WebWeek, October 20, 1997).

A Usenet newsgroup will be created which will allow the student to interact with each other and Kuhn while they are away from campus. Students will be able to post questions which would then be answered by other students or the instructor. The newsgroup can also be used as a forum in which the students from diverse geographical locations can contact one another in a more informal setting than that found in the classroom.

While some of this interactivity could come through scripting the Common Gateway Interface (CGI) in a language such as Perl, a CGI-based approach, however, would require the student to have access to the internet and would place an undue burden on the server at PU/NC. By choosing to present the interactive element though the use of HTML, Java and Shockwave, we gain the advantage of platform independence and server independence. This allows much of the course content (in particular, the web pages, Java applets and Shockwave animations) to be available on a CD-ROM. In this way, a student will only need to be connected to the internet for turning in homework, taking quizzes, checking their marks, or conversing with the instructor. This would allow this course to be taken off campus provided the student has access to a computer with either internet access or a CD-ROM and provisions are made for taking the final exam.

Finally, the applications needed to view the produced content are all free: Netscape and Microsoft freely distribute their Java-enabled browsers for educational uses, Macromedia freely distributes its browser plug-in for viewing Shockwave animations and Adobe freely distributes its browser plug-in which can be used to view and print the class notes. As a result, students will be able to access all of this content at no cost to them.

Instructional Design Plan

The amount of material and pacing of the proposed statistics course will be designed as though a student were taking the traditional 16 weeks of instruction at PU/NC. It is recommended that a student take the course at the specified pace, although they would be free to proceed at a faster pace.

In addition to the 16 weeks of lecture notes and TI-83 labs presently on the internet, it is anticipated there will be a number of java-based labs, 15 java-based homeworks and quizzes which serve to better illustrate or evaluate the lecture notes or TI-83 labs. The components of the proposed internet and statistics course

will be tied together by hyperlink connections. The text by Johnson, ***Elementary Statistics*** , Duxbury, 1996, and the TI-83 calculator will also be required for this course (as for the traditionally taught course).

There will be 8 biweekly homeworks presented by a java applet. Students may submit their solutions to these homeworks by filling out forms given on the internet. If submitted over the internet, these homeworks are automatically marked and returned to the student. Solutions to all homeworks will appear on the internet shortly after the due date of the homework. Information regarding how the student is performing relative to the rest of the class will also be made available on the internet.

There will be 7 biweekly quizzes administered by java applets. These quizzes will be much like the homeworks, in that students will be able to access preparatory quiz questions at any time during the term. They may take the quizzes on the internet in the same manner as the homework, but there will be a time limit enforced by the applet.

Other relevant points include:

The deadlines for quizzes and homeworks serve to make sure the student is keeping pace with the course material. They also provide the opportunity for students to proceed at quicker than the required pace.

The only time a student will be required to be on campus for this courses will be for the final exam to be held at PU/NC during the final exam period (although even this requirement may be waived if a suitable proctor can be found).

All course materials, including the CD-ROMs, will be available at the PU/NC campus bookstore. Registration for this course will be made possible by using the internet facilities presently available at PU/NC.

Students will be given the instructor's office telephone number and email address. Weekly office hours will be set up for any student who wishes to drop by campus to visit with the instructor. A class newsgroup will be set up to allow students to post and respond to questions from other students and the instructor.

The design of this course, in general, presupposes that a student is, for the most part, self-guided. Aside from the proctored final exam, the student can easily find ways of cheating on quizzes and homeworks. The final exam, by necessity, will weigh heavily in the final assignment of a grade given to a student taking this course.

Interactive Content

The centerpiece of this proposed statistics course is the java applets and the interactive animation. The applets can provide a variety of data and will run the statistical methods in parallel with the student so that the student may check his or her work. Examples of the statistical methods which may be explored are:

stem-and-leaf plots, histograms, ogives and box and whisker plots;
various summary statistics such as the average, standard deviation and median;
scatterplots and the correlation coefficients;
linear regression lines;
counting techniques which involve factorials, permutations and combinations;
expected values and variance for distributions (such as the normal and binomial distributions);
probabilities and percentiles for the standard and nonstandard normal;
sampling distributions determined exactly from simple discrete distributions
confidence intervals;
hypothesis tests;
contingency tables;
analysis of variance.

Interactive animation can provide demonstrations of concepts such as:

the effects of scaling and transforming data on scatterplots and correlation coefficients;
sample space, outcome and events;
the union and intersection of events (using Venn diagrams);
discrete probability distributions;
the central limit theorem.

Course Evaluation Plan and Peer Review

We plan to evaluate the proposed statistics and internet course in three ways.

First, we will carry out a study which compares the current method of teaching this course to the proposed method of teaching this course. The comparison will focus on the final exam scores achieved by both groups of students.

Second, questionnaires will be sent to the students taking the internet course asking for their opinions. These opinions will be compared to the opinions submitted by the traditionally taught students.

Third, one or more of the faculty in the Mathematics and Physics department at PU/NC who are familiar with the course as it is currently taught (such as Professors Schwingdorf and Lauer) will be asked to evaluate the proposed approach to teaching this statistics course.

Project Schedule

Most work on this project will take place during May, June and July of 1998. Implementation of a pilot version of this course will occur in the fall of 1998 at PU/NC. The tentative project schedule is:

Now until April 1998:
- investigate other course implementations offered by internet
- plan, in detail, the web site layout, java applets, interactive animation, homeworks and quizzes
- collect and learn the software required for the project

May, June and July 1998:
- create the interactive content

Fall 1998:
- implement a pilot version of the statistics course (internet content *supplemental* to regular course)

January 1999:
- evaluate the pilot course and make appropriate modifications for the Spring semester course
- report to IHETS
- publish results

Spring 1999:
- implement full internet version of statistics course

Development Personnel

Two faculty members from the Mathematics and Physics department at PU/NC will be involved in this project: Jonathan Kuhn, the lead faculty, and Aaron Montgomery.

Jonathan Kuhn (Assistant Professor of Statistics, PhD Statistics, University of Toronto, 1994) will provide the main expertise in statistics and also will provide secondary support producing the site content.

Aaron Montgomery (Visiting Assistant Professor of Mathematics, PhD Mathematics, University of Wisconsin-Madison, 1996) will provide the main expertise in java programming.

One page summaries of each faculy member's experiences are also attached.

Sincerely,

Jonathan Kuhn. Aaron Montgomery.

Final Project Narrative, Final Budget and Initial Evaluation For the Indiana Higher Education Telecommunications System Grant – 1997

Interactive Use of the Internet for Statistics

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Abstract

The primary goal of this project has been accomplished in this grant: to allow students to complete course requirements and interact with the subject matter (an introductory statistics course, Statistics 301) and instructor at times convenient to them rather than in a regular classroom setting.

A LaTeX/Encapsulated PostScript package, *PDFflash*, was developed for this grant. The PDFflash package was used to write interactive tutorials, called *Interactive Exercises*. A *Workbook* of the course material was also substantially improved from versions developed previous to the grant. Distance learning students, guided by the printed Workbook, carried out tutorials in the Interactive Exercises, given on either the Internet or CD–ROM.

A Java applet/C++ Graphic Interchange Format package was also developed for this grant. This package allowed distance learning students to take timed quizzes over the Internet.

The entire grant of $12,000 was used for specialized computer software and hardware as well as time that allowed two faculty members at Purdue University North Central to develop this project during the summer and fall of 1998 and spring 1999 for implementation in, not only the fall 1998 and spring 1999 academic terms, but also, it is anticipated, future terms.

Initial feedback seems to indicate that students have some difficulty in initially configuring their computers to properly access the Workbook, timed quiz package and, particularly, the Interactive Exercises. Aside from the rough start up, Internet students seemed to perform as well as class students. In particular, an initial statistical analysis shows that there is no statistical difference in the average homework scores of Internet students and class students.

The web page address of this Internet course is:

http://faculty.purduenc.edu/jkuhn/courses/301s99/301s99.html

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This document includes a final narrative report, final budget and an initial evaluation of the project.

1 Final Narrative

This final narrative section has three subsections. The first subsection gives a description of the instructional design plan. The second and third subsections provide a summary of the work and technology, respectively, used to carry out the instructional design plan.

1.1 Instructional Design Plan

Statistics course. The instructional design plan described here was implemented for an introductory statistics course, Elementary Statistical Methods course, Statistics 301, at Purdue University North Central (PU/NC) in the fall 1998 and spring 1999 academic terms.

Mostly PU/NC students, few off–campus students. We anticipated serving students who lived and worked in the general geographical area of PU/NC but who, because of work schedules, could not find the time to physically attend weekly classes or office hours. We thought it possible, though, that any student who had access to the Internet could participate in this course. In fact, in the fall 1998 term, there were, at the beginning of term, six Internet students and fifteen regular (class) students who took the Elementary Statistics Methods course. Two Internet student were from off–campus: one was associated with Indiana University Purdue University Indiana and the other was associated with Ball State. The other Internet students were from PU/NC, but, who, for various reasons, decided to undertake the course over the Internet. In the spring 1999 term, there was, as of the beginning of February, one Internet student, associated with the West Lafayette campus at Purdue University student and eighteen regular students.

Interactive use of Internet. The internet had been used, before the grant, by Kuhn and Montgomery as a readily accessible electronic bulletin board to store not

only class notes, homeworks and test solutions but also to post updated test scores throughout the academic term for their courses at Purdue University North Central (PU/NC). Although this passive use of the Internet had proven to be successful, this grant was used by Kuhn and Montgomery to improve the Internet presentation of course material by making it more interactive, in essentially two ways. First, course material was presented in a question and answer tutorial format, called Interactive Exercises, on the Internet and CD–ROM. Second, timed quizzes were conducted on the Internet.

Internet students and class students treated the same. Although it was possible to develop a Statistics course meant for Internet students only, the Statistics 301 course was, in fact, developed to accommodate both Internet and class students, simultaneously, as members of one course. The instructional plan was designed to treat the Internet and class students in as equal a way as was possible. The same workbook, interactive exercises, quizzes, homeworks and final were given to both the Internet students and class students. Grading and office/telephone hours were the same for both.

Workbook and Interactive Exercises. A Workbook was substantially improved upon from versions previous to the grant and Interactive Exercises were developed for this course. The Workbook consists of a series of exercises, where each exercise consists of fill–in–the–blank, multiple choice, true/false and matching type problems. The Workbook is printed out by both Internet and class students. The Interactive Exercises, posted on the Internet (and during the fall 1998 term, on CD–ROM format), provide answers to the problems given in the Workbook. An Internet student sits in front of the computer with the Workbook and, with the help of the answers provided by Interactive Exercises, works his/her way through the course material. For a class student, on the other hand, the Workbook is displayed directly from the Internet, via a portable computer and overhead projector, onto a screen for class viewing. The class student attends class with the Workbook and fills in the answers as provided by class discussion and the instructor during class time. Of course, a class student also has the option to access the answers provided by the Interactive Exercises on the Internet.

Internet students and class students covered same material. The amount of material and pacing of the statistics course, dictated, essentially, by the Workbook and Interactive Exercises, is designed as though a student was taking the traditional 15 (spring term) or 16 (fall term) weeks of instruction at PU/NC. It is recommended that an Internet student take the course at the specified pace, although they are free to proceed at a faster pace. Internet and class students were to spend at least 3 hours per week on the workbook and 6 hours outside of class hours either doing homeworks or preparing for quizzes. The web page for the statistics 301 course is designed to

encourage Internet students to follow the weekly pace of the class students.

Internet students emailed homeworks. Internet and class students printed off 7 or 8 (depending if it was fall or spring) homeworks posted on the Internet. Internet students then submitted their answers to these homeworks by email to Kuhn, the instructor of the statistics course. Kuhn marked these homeworks and returned the marked homeworks to the Internet students. Class students submitted their hand–written homeworks directly to Kuhn, who marked these homeworks and then returned the marked homeworks during a later class.

Internet students emailed quizzes, then took timed java applet quizzes from the Internet. In the fall, Internet students printed quizzes off of the Internet. On their honor, Internet students completed these quizzes within the stated time limits. Quiz answers were emailed to Kuhn, who marked and returned the marked quizzes via email to the Internet students. Class students were given the same quizzes during class time. In the present spring term, *both* Internet and class students were given biweekly quizzes administered by timed java applets on the Internet. The quiz answers submitted are posted in an appropriately secured location of the Internet for Kuhn to view and mark.

Final exam is proctored. The only time an Internet student was required to be on campus for this course was for the final exam, held at PU/NC during the final exam period. This requirement was waived for off–campus Internet students who arranged to take exams at learning centers of their affiliated academic institutions. All course materials, including the CD-ROMs, are made available at the PU/NC campus bookstore.

Attached material. Please see the attached course syllabus, Course Information for Statistics 301, and the printout of the web page for the Statistics 301 course. The original proposal, *Application For Indiana Higher Education Telecommunications System Grant–1997; Interactive Use of the Internet for Statistics* is also attached.

1.2 Work Summary

A summary of the work performed for this grant is given in this subsection.

- *February to April, 1998.* These first few months were spent planning, in greater detail, the instructional design plan and the related the web site layout. At this point, it was thought the instructional design would involve printed notes with passive and interactive animated demonstrations of topics in the course material. Hardware and software was purchased on this basis. Division of responsibilities was clarified: Kuhn was to look after the preparation of course material and Montgomery was to look after programming aspects.

Montgomery spent time learning to use the software/hardware necessary to produce animated demonstrations: CodeWarrior, Photoshop, Director and a Digital Camera. In particular, he started work on a Shockwave animation for demonstrating the use of the TI–83 calculator, which is used in Statistics 301.

- *May, 1998.* Kuhn, the instructor, became convinced an instructional design with extensive question and answer tutorials was superior to an instructional design which involved printed notes with a few animated demonstrations. A question and answer design could be developed over a few month period to cover *all* the material in the Statistics 301 course, whereas a few animated demonstrations could be developed in the same time to highlight only a small part of the course. It seemed easier to him to insert animated demonstrations, at a later date, into the well defined structure of a question and answer design than it would be to attempt to string a few animated demonstrations together in some sort of coherent order. A question and answer design fit much better with the way Kuhn presented course material in a class situation. This type of a design also allowed Internet and class students to be treated in a very similar way.

  It was decided the main priority was the preparation of the question and answer Workbook and Interactive Exercises.

  As a consequence, Montgomery began to look into the software related to creating the Interactive Exercises: LaTeX, PostScript, JavaScript and PDF. Although alternatives were considered, in particular, the use of Graphic Interchange Format (GIF) files, it was decided that PDF files with Form capabilities was best suited for the task. It was believed PDF, rather than GIF, files could better handle the *mathematical* symbols used in the Statistics 301 course.

- *June to August, 1998.* Kuhn wrote up LaTeX files which were used to create PDF files for the Workbook. Montgomery wrote the LaTeX/Encapsulated PostScript package PDFflash for the Interactive Exercises.

- *August, 1998.* In this month before the fall 1998 term started, Kuhn and Montgomery raced to get the Interactive Exercises up and running on the Internet and on CD–ROM.

  Kuhn used PDFflash to write up the Interactive Exercises. He created self extracting files for each interactive exercise, using WinZip, and posted these files on the Statistics 301 web page. He created CD–ROMs which could be used by students in the fall 1998 term instead of the Internet to access the Interactive Exercises. He attended to software production problems related to the posting and downloading of the Interactive Exercises on the computers at PU/NC. He made sure the Workbooks, which included CD–ROMs, were printed up and made available in the PU/NC bookstore before term started.

Montgomery helped in the creation of the final PDF version of each Interactive Exercise by converting intermediate Device Independent (DVI) files into PDF ones. He helped in the creation of the final version of each Interactive Exercise by adding hyperlinks between problems using Adobe Acrobat Exchange.

- *September to December, 1998.* Kuhn taught the Statistics 301 course using the Workbook and Interactive Exercises. There were six Internet students, although one dropped out before the end of term. He wrote a pamphlet, called *Purdue University North Central, Statistics 301, via the Internet with Prof. Jonathan Kuhn*, to help Internet and class students get started on the Internet. This pamphlet is attached. He also prepared and submitted an *Application To Use Human Research Subjects* to Purdue University's Committee On The Use of Human Research Subjects to conduct an experiment which compared homework and test scores for Internet and class students. The application was accepted and is attached.

  Montgomery developed a Java applet/C++ Graphic Interchange Format package to be used to created timed quizzes over the Internet. He configured a Macintosh computer, called *Agate* and provided by PU/NC Information Services, to act as a World Wide Web (WWW) server for these quizzes. He debugged the PDFflash package.

- *January and February, 1999.* Kuhn taught the Statistics 301 course at second time. This time not only the Workbook and Interactive Exercises were used, but also the timed Internet quiz package. He continuously updated both Workbook and Interactive Exercises throughout this time. He wrote up this report, *Final Project Narrative, Final Budget and Initial Evaluation.* He conducted the first part of the experiment to compare quiz and homework scores of Internet and class students. He conducted a student survey of the opinions of the class students on the use of the Internet in the Statistics 301 course. He arranged to have a colleague in the Mathematics and Physics section, Professor Schwingendorf, determine the class student's opinions of the way the Statistics 301 course was being taught. The results of these various evaluations are given in a later section of this report.

  Montgomery debugged the Java applet/C++ Graphic Interchange Format package and began the next version of this package. He resumed work on the Shockwave animations used to demonstrate how to use the TI–83 calculator. He helped write up this report.

1.3 Technology Summary

Two complete software packages and one partially completed software package have been developed for the Statistics 301 course. The two completed packages are a LaTeX/Encapsulated PostScript package, PDFflash, for the Interactive Exercises and a

Java applet/C++ Graphic Interchange Format package for the timed Internet quizzes. The partially done package is a Shockwave animation for demonstrating the TI–83 calculator.

Production of the PDFflash files required a TeX implementation, Macromedia Freehand, the Artz Graphic Tablet and Adobe Acrobat. This work can be found at Montgomery's web site:

http://faculty.purduenc.edu/agm/web/stats/index.html

The Java applet/C++ Graphic Interchange Format package was produced using Metrowerk's CodeWarrior, Mathemaestheitc's Resourcerer, Jasik's Debugger, VOODOO Source Code Control and Seapine's TestTrack. This work can be found at Montgomery's web site given above. In addition, the server used in this work can be found at:

http://agate.cc.purduenc.edu/

The Shockwave animation was created with Adobe's Photoshop, Equilibrium's DeBabelizer, the Olympus digital camera and Macromedia's Director. This work can be found at Montgomery's web site given above.

2 Final Budget

Final Budget is given below.

IHETS Budget Narrative

	IHETS/IPSE	University	Totals
Salaries and Wages:			
Jonathan Kuhn: Summer Salary	$ 3,000		$ 3,000
8 % F.T.E. Academic Year		3,478	3,478
Aaron Montgomery: Summer Salary	3,000		3,000
8 % F.T.E. Academic Year		2,484	2,484
Subtotal Salaries and Wages	6,000	5,962	11,962
Fringe Benefits:			
Jonathan Kuhn @ 27.57%		1,786	1,786
Aaron Montgomery @ 18.05		990	990
Total Fringe Benefits	-	2,776	2,776
Supplies and Expenses:			
Development Software:			
Metrowerks CodeWarrior (PC)	500		500
Macromedia Director (Mac and PC)	2,000		2,000
Macromedia Dreamweaver (Mac and PC)	1,000		1,000
Macromedia Freehand (Mac)	400		400
Adobe Photoshop (Mac)	560		560
Books:	500		500
CD-RO CD-ROM Recorder and 100 CD-ROMs	1,000		1,000
Subtotal Supplies and Expenses	5,960	-	5,960
Totals	$ 11,960	$ 8,738	$ 20,698

.

Most items in this final budget have been mentioned previously. However, software purchased and not mentioned, include Macromedia's Dreamweaver and GoLive's CyberStudio. This software is intended to be used for producing Hypertext Markup Language (HTML) for the Statistics 301 web site at a later date. A Zip drive was purchased to enable the Workbook and Interactive Exercise files to be easily transferred between home and University computers.

A CD-ROM writer was *not* purchased, as originally proposed, as we found an available machine at PU/NC.

3 Initial Evaluation

We evaluated (and, in fact, are still evaluating) the use of the Internet in the Statistics 301 course in three ways. First, we are in the middle of carrying out a statistical experiment which compares homework scores for Internet and class students for the Statistics 301 course in the spring 1999 term. Second, questionnaires were filled in by students in the Statistics 301 class in the spring 1999 term. Third, Professor Schwingendorf, a faculty member at PU/NC in the Mathematics and Physics section, evaluated how effectively the spring 301 statistics class was being taught using the Internet and wrote up his results in a *Small Group Instructional Diagnosis* report.

After summarizing the results from these three sources, some personal observations, as an instructor, are given.

3.1 Statistical Experiment

This experiment involves a random division of the Statistics 301 students into classroom students and Internet students for as many as three one week periods out of the 16 weeks of the term. By chance, some students may not be assigned to receive any Internet teaching, while others may be asked to be Internet students for all three of the one week periods. An Internet student would not be expected to attend class, but to receive all instruction over the Internet, on computers at PU/NC campus, if need be, for the one week periods they have been assigned.

For the first week chosen, the average and standard deviation of the homework scores (out of 6) for the four Internet students and eleven class students were given as follows.

	Internet	class
$\bar{x}$	2.5	2.364
s	2.345	1.899
n	4	11

A 95% confidence interval for the *difference* in average homework scores for the Internet and class students was found to be,

$$(-3.33, 3.60),$$

which strongly indicates, since this interval includes zero, the Internet student homework scores are, on average, *no different* than the class student homework scores.

The complete statistical analysis conducted, thus far, for this project, is attached, and includes the following items.

- *Application For Approval To Use Human Research Subjects*
- *Research Participant Consent Form*

- *Interactive Use of the Internet for Teaching Statistics – Report 1*
- *Interactive Use of the Internet for Teaching Statistics – Report 3*

3.2 Questionnaire

This report summarizes the results of a questionnaire distributed to the *class* (not Internet) students of Statistics 301 on the 15th of February, 1999. Sixteen of eighteen students completed this questionnaire.

- *Getting on the Internet.* Most class students felt the one class instruction at beginning of term was enough on how to use the 301 web page. They felt it was easy to find appropriate class notes, homeworks and quizzes on the 301 web page. They also felt it was easy printing this course material off of the Internet. Students found installing Acrobat Adobe Reader and Forms on their home computers quite difficult to do.

- *Workbook and Interactive Exercises.* Eleven of the sixteen *class* students found the Workbook useful when doing either homeworks and quizzes; only one student did not find the workbook at all useful for homeworks or quizzes. Only a few *class* students used the Interactive Exercises. Most students had some difficulty with the wording used in the Workbook. Most students had some difficulty with the wording used in the Interactive Exercises, but not as much difficulty as with the wording in the Workbook.

- *Homeworks and Quizzes.* About half of the sixteen class students found it convenient to print the homeworks off of the Internet; two students found it extremely inconvenient to do so. About half of the students liked being able to print off the solutions to the homeworks from the Internet; three did not like this at all and a few did not realize they could do so. Although six (class) students would like to submit homeworks by email, the other students were generally opposed, to varying degrees, to this idea. Many, ten students in fact, did not like doing the quizzes on the Internet. Many students found the quizzes difficult to read; only three students had no difficulty reading the quizzes.

- *Miscellaneous.* Only two of the sixteen class students checked out the 301 web page before taking the course. Essentially all students liked their grades being posted on the Internet. Six of the students sent emails to the instructor. Six of the students felt the use of the Internet improves the Statistics 301 course. Only two students felt the Statistics 301 course could be conducted *entirely* on the Internet; most students, to varying degrees, disagreed with doing this.

The questionnaire and all results, is attached: *Interactive Use of the Internet for Teaching Statistics – Report 2*

3.3 Small Group Instructional Diagnosis Report

Professor Schwingendorf, a faculty member at PU/NC in the Mathematics and Physics section, evaluated how effectively the spring 301 statistics class was being taught using the Internet and wrote up his results in a it small group instructional diagnosis report.

With regard to the first of two questions, *What do you like about this course?*, the Statistics 301 students gave the following comments.

- The ability to check class grades on the Internet.
- The Workbook is very useful (students like it much better than the text).
- The availability of the calculator labs on the Internet.
- The instructor's quick response to email from students.

With regard to the second question, *What specific suggestions to you have for changing this course?*, the Statistics 301 gave the following suggestions.

- Give *hard–copy* paper and pencil quizzes rather than on the Internet. The Internet would be fine except that the *interface* is bothersome and the noise in the open lab can be a problem when taking a quiz.
- Have an Internet computer literacy prerequisite for the course in the catalog.

The complete *Small Group Instructional Diagnosis Report* is attached.

3.4 Personal Observations, As An Instructor

Student and instructor need to be computer literate. Both student and instructor have to be computer literate, to be fairly skilled in the use of the Internet, before being able to deal the course material. Even though the Internet is fairly user–friendly, to a student with no or little computer background, it can be quite intimidating. Taking the time at the beginning of the term, to take the class to the computer lab and taking them through the use of the Internet seems very helpful. Warning students of the use of the Internet in the syllabus and through student advisors *before* the class starts, is also recommended.

A lot of time is required by the instructor to carefully prepare course material for the Internet. It is probably safe to say the amount of work required to prepare course material for the Internet is much more than is required to teach a course by blackboard. All course material was typed using LaTeX, a mathematical word processing package. Pictures were drawn using Illustrator and Freehand. A lot

of time is required by the instructor in becoming familiar with these packages. The Workbook Exercise package, PDFflash, is difficult to use. The Internet students relied very heavily on the Interactive workbook. Many typographical errors were pointed out by these students and the Workbook was correctly appropriately.

A lot of time is required by the Internet students to successfully complete the Statistics course material. Based on an informal survey of the Fall Internet students, it would appear that Internet students appeared to spend a larger amount of time on the course material per week than class students. Internet students seemed to spent widely varying amounts of time on the material per week, ranging from 3 hours, say, up to 20 hours, depending on the material covered in a particular week. The present version of the Internet still requires a lot of reading. Animated demonstrations of various topics in the course would seem to be a next logical step.

Internet students seem to improve the overall quality of students. The class students and the Internet students, because of the posting of homework and quiz scores, were very aware of each other's performance. This seemed to provide some incentive for both groups to work harder than they might have, had there not been Internet students.

The Internet organizes students. The use of the Internet is wonderful in distributing course material and for organizing students. Students cannot lose their homeworks or notes or solution sets because all of these items can always be found on the Internet.

Internet students have difficulty meeting deadlines. Internet students seem to have much more difficulty handing in their homeworks in on time, than class students.

Application For Approval To Use Human Research Subjects

1 Application Narrative

1.1 Brief Rationale For The Proposed Research

A basic statistics course, Elementary Statistical Methods (Statistics 301), given at Purdue University North Central (PU/NC), is presently being conducted over the Internet. It appears as though the use of the Internet allows students to successfully complete requirements and interact with the subject matter and instructor at times convenient to them rather than in a regular "real–time" classroom setting, in other words, to allow asynchronous learning. To more objectively evaluate this Internet approach to learning, it is hoped that a statistical study can be undertaken to compare classroom performance with Internet performance.

1.2 Specific Procedures To Be Followed

This study would involve a random division of the classroom statistics students into classroom students and Internet students for as many as three one week periods out of the 16 weeks of the term. By chance, some students may not be assigned to receive any Internet teaching, while others may be asked to be Internet students for all three of the one week periods. Internet students would be expected to not attend class, to receive all instruction over the Internet, on computers at PU/NC campus, if need be, for the one week periods they have been assigned.

This statistical study would compare homework, quiz and final scores of classroom students with the same scores of Internet students.

No extra credit and/or inducements will be used in the study. In fact, both classroom students and Internet students will be treated in as similar a manner as is possible as far as grading and office/telephone hours is concerned.

By necessity, the investigator would also be the instructor of the statistics course that is being studied.

This study will, if permitted, take place in the Spring 1999 term as well as the Fall 1999 and Spring 2000 terms.

1.3 Type Of Subjects To Be Employed

The type of subject employed in this study will be the students who take the Spring 1999, Fall 1999 and Spring 2000 classes in Statistics 301 at PU/NC.

No effort will be made to influence either the ethnic or gender make–up of the class.

Interactive Use of the Internet for Teaching Statistics - Report 1
Statistics 301 - Elementary Statistical Methods - Spring 1999
18 January

This report explains how the three one week periods were chosen and how the students where divided into two groups of Internet and class.

Choosing the three one week periods. The TI–83 calculator was used to choose three one week periods out of the fifteen weeks of term. The first two weeks, weeks 1 and 2, the last week, week 15, and the spring break week were eliminated as possible weeks to be chosen.

A seed of 7 was used and the commands typed into the TI–83 were: randInt(3,14,3). That is, three weeks were chosen at random, from weeks 3 to 14. As a consequence of this, the three one week periods chosen were:

1. **week 5**: February 8, 10 and 12
2. **week 9**: March 15, 17 and 19
3. **week 14**: April 19, 21 and 23

Choosing the Internet students. The TI–83 calculator was used to choose students who would receive Internet training (and so, also, class training) for the three one week periods given above. The sixteen students were numbered 1 to 16. Class teaching was designated as 0 (zero) and Internet teaching was designated as 1 (one).

To decide who was an Internet student and who was not, for the first one week period (week 5), a seed of 3 was used and the commands typed into the TI–83 were randInt(0,1,16). That is, the 16 students were designated as either 0 (class) or 1 (Internet) for week 5. In a similar way, the 16 students were designated as either class or Internet for the other two weeks, week 9 and week 14, where seeds 21 and -5 were used, respectively. As a consequence of this, the following students were designated Internet students.

1. week 5: **2, 3, 8, 10** and **12**
2. week 9: **1, 2, 3, 4, 6, 7, 9, 10, 11** and **12**
3. week 14: **9, 11, 12, 13** and **14**

YOU ARE STUDENT _____

A student may drop out of the study (and remain in the class) at any point during the term without penalty.

1.4 Procedures For Recruitment Of Subjects

Students will be told of the statistical study before entering the course, by the academic advisors.

Students will be told of the statistical study during the first two lectures of the academic term. Research participant consent forms will be distributed during these first two lectures.

Students will be asked, if they wish to participate in the study, to return their signed research participant consent forms to the instructor by the third lecture.

1.5 Procedures For Payment of Subjects

No subjects will be paid during this study.

1.6 Confidentiality

Any work published as a consequence of this study will not not identify individual students. All records concerning this study which identify an individual student could appear on the computer in my office, on my computer at home or on a Zip disk. This data will kept for an indefinite period of time.

1.7 Potential Risk to Subjects

Investigator is Instructor

It is a concern that the investigator is also the instructor of the course. Because of this, the students could view the study as being non–voluntary, as being coerced into participating in the study. This may have a detrimental effect on a student's grades.

Random Assigment

Random assignment prevents a student from choosing whether they wish to be either a classroom student or an Internet student. A student will be asked to receive instruction in a different way and, in particular, be asked to not attend class, but to receive instruction solely from the Internet on a computer. This may have a detrimental effect on a student's grades.

1.8 Benefits To Be Gained By The Individual And/Or Society

If this study showed that Internet performance was comparable or, at least, not too much worse than classroom performance, than this would lend credibility to asynchronous learning over the Internet. It would, at PU/NC, in particular, allow students who live and work in the general area of PU/NC but who, because of work schedules, are not able to find the time to physically attend weekly classes, to complete their degree requirements at times more convenient to their schedules.

1.9 Investigator's Evaluation Of The Risk-Benefit Ratio

Investigator is Instructor

The ideal situation would be to ask a faculty member, other than the investigator, to teach the statistics course, with both the classroom and Internet students. Furthermore, it would be best if a third party assigned the students at random to both the classroom and the Internet, and so allowed the investigator to assess the two groups without knowing which group was which, until *after* the results of the statistical analysis were known.

This just does not seem to be possible at PU/NC. It would be difficult to ask one of the other few faculty members in the Mathematics and Physics Section at PU/NC, none of whom are both statisticians and who are experienced enough in the specific way the Internet is being used, to teach the classroom/Internet statistics course, to allow the investigator to assess the course from an outside point of view. It would be awkward, at best, to ask one of the statisticians from the West Lafayette campus, 50 miles to south of PU/NC, to conduct the course. The investigator appears to be the only individual at the PU/NC campus qualified enough to carry out both the course and the statistical study.

Random Selection

Random assignment offsets any possible confounding factors which might influence the conclusions of the study. For example, random assignment would eliminate the possibility that academically or technologically superior students opt for Internet instruction over classroom instruction, say, and so bias the results of the study in favor of the Internet students.

The random assignment is designed to be as non–intrusive as possible. Rather than assign students to classroom and Internet methods for the *entire* term of 16 weeks, they are assigned for *at most three* weeks of the 16 week term. The relevant weekly homeworks and quizzes results would be used for comparison purposes.

If random assignment is not used, an observed study analysis could be used but would be more complicated and most likely less valid than the randomized experiment

suggested here. In an observed study, to control for the possibility that academically superior students opt for Internet instruction over classroom instruction, say, it would be necessary to identify and compare the better and also the poorer students in both the classroom and Internet groups. Not only would it be necessary to control for academic ability, but also it would be necessary to control for any other extraneous factors which may be thought to influence how a student performs in a classroom.

An observed study might be possible if the number of students were large and if complete (elaborate) information was known about these students. At PU/NC, we have neither of these two: the class sizes are small (20 to 30 students) and many students are, for the most part, part–time older commuter students taking a few courses. It is probable, at the very least, a very carefully designed, elaborate and intrusive questionnaire, used over multiple years, would be necessary as part of any kind of an observed study.

1.10 Procedures to Obtain Informed Consent

Copies of the Informed Consent form, attached, will be distributed to the students during the first two lectures. After having had the opportunity to read these forms over at home, the students will be asked to sign and return this forms by the third lecture.

1.11 Written Copy Of Informed Consent Form Provided To Subject

Please see the attached Research Consent Form.

1.12 Supporting Documents

There is a supporting letter from the Section chair, Dr. Chilukuri, which was attached in the first application.

No questionnaires will be used in this study. The tests and homeworks given during the study are the same tests and homeworks ordinarily given as a part of the Statistics 301 course. These tests and homeworks will be provided if required.

RESEARCH PARTICIPANT CONSENT FORM
Interactive Use of the Internet for Teaching Statistics
Jonathan Kuhn
Mathematics and Physics Section, PU/NC

Purpose of Research

This statistical study would compare homework, quiz and final scores of a group of classroom students with the same scores of a group of Internet students to be able to evaluate the Internet teaching method that will be used this term in the Statistics 301 (Division 1) course.

Specific Procedures to be Used and Duration of Participation

This study would involve a random division of the Statistics 301 students into classroom students and Internet students for as many as three one week periods out of the 16 weeks of the term. By chance, some students may not be assigned to receive any Internet teaching, while others may be asked to be Internet students for all three of the one week periods. Internet students would be expected to not attend class, to receive all instruction over the Internet, on computers at PU/NC campus, if need be, for the one week periods they have been assigned.

Benefits to the Individual

No student will be paid during this study. No extra credit and/or inducements will be used in the study. However, the test and homework scores of each group of students, classroom and Internet, will be adjusted so that neither group fares worse than the other.

Confidentiality

Any work published as a consequence of this study will not not identify individual students. All records concerning this study which identify an individual student could appear on the computer in my office, on my computer at home or on a Zip disk. This data will kept for an indefinite period of time.

Voluntary Nature of Participation

You do not have to participate in this research project. If you do agree to participate, you can withdraw your participation at any time without penalty.

Human Subject Statement

If you have any questions about this research project, contact

Jonathan Kuhn
Mathematics and Physics Section, Purdue University North Central,
Westville, IN 46391–4197
(219) 785-5563 (work) or (616) 556-9856 (home)

If there are concerns about the treatment of research participants, contact the Committee on the Use of Human Research Subjects at Purdue University, ENAD 328, West Lafayette, Indiana. 47907. The phone number for the Committee's secretary is (765) 494-5940.

I HAVE HAD THE OPPORTUNITY TO READ THIS CONSENT FORM, ASK QUESTIONS ABOUT THE RESEACH PROJECT AND AM PREPARED TO PARTICIPATE IN THIS PROJECT.

_____ _____.

Participant's Signature Date

_____

Participant's Name

_____ _____.

Researcher's Signature Date

Interactive Use of the Internet for Teaching Statistics - Report 1
Statistics 301 - Elementary Statistical Methods - Spring 1999
18 January

This report explains how the three one week periods were chosen and how the students where divided into two groups of Internet and class.

Choosing the three one week periods. The TI–83 calculator was used to choose three one week periods out of the fifteen weeks of term. The first two weeks, weeks 1 and 2, the last week, week 15, and the spring break week were eliminated as possible weeks to be chosen.

A seed of 7 was used and the commands typed into the TI–83 were: randInt(3,14,3). That is, three weeks were chosen at random, from weeks 3 to 14. As a consequence of this, the three one week periods chosen were:

1. **week 5**: February 8, 10 and 12
2. **week 9**: March 15, 17 and 19
3. **week 14**: April 19, 21 and 23

Choosing the Internet students. The TI–83 calculator was used to choose students who would receive Internet training (and so, also, class training) for the three one week periods given above. The sixteen students were numbered 1 to 16. Class teaching was designated as 0 (zero) and Internet teaching was designated as 1 (one).

To decide who was an Internet student and who was not, for the first one week period (week 5), a seed of 3 was used and the commands typed into the TI–83 were randInt(0,1,16). That is, the 16 students were designated as either 0 (class) or 1 (Internet) for week 5. In a similar way, the 16 students were designated as either class or Internet for the other two weeks, week 9 and week 14, where seeds 21 and -5 were used, respectively. As a consequence of this, the following students were designated Internet students.

1. week 5: **2, 3, 8, 10** and **12**
2. week 9: **1, 2, 3, 4, 6, 7, 9, 10, 11** and **12**
3. week 14: **9, 11, 12, 13** and **14**

YOU ARE STUDENT _____

Questionnaire for Statistics 301
Interactive Use of the Internet for Teaching Statistics
Elementary Statistical Methods - Spring 1999
16th February

Please fill out this (single answer) multiple choice questionnaire on the use of the Internet in the teaching of Statistics 301. A 1 (one) indicates you strongly *agree*, whereas a 5 (five) indicates you strongly *disagree*. Please check *not applicable* (NA) where necessary. Any and all comments are very much welcome–write them on the back of this questionnaire. Thanks!

1. Getting on the Internet

	agree (1)	(2)	(3)	(4)	(5)	NA
I only use the computers at PU/NC for this course.						
I think the one day instruction was enough to figure out the 301 web page.						
It is easy to *find* homeworks and quizzes on the 301 Web Page.						
It is easy to print out course material from the Internet.						
I had little trouble setting up my computer at home for this course.						
I had little trouble installing and using Adobe Acrobat Reader and Forms.						
I had little trouble installing and using Microsoft Explorer.						

2. Workbook and Interactive Exercises

	agree (1)	(2)	(3)	(4)	(5)	NA
I use the Workbook in class.						
I like the Workbook displayed in class by computer projection.						
I find the Workbook useful when doing homeworks or quizzes.						
I use the Interactive Exercises to answer Workbook questions.						
I like the wording of the questions in the Workbook.						
I like the wording of the answers given in the Interactive Exercises.						

3. Homeworks and Quizzes

	agree (1)	(2)	(3)	(4)	(5)	NA
It is convenient printing homeworks off of the Internet.						
I would like to submit homeworks over the Internet.						
I like being able to print off the solutions to the homeworks.						
I like taking quizzes on the Internet.						
It is easy to read the quizzes on the Internet.						

4. Miscellaneous

	agree (1)	(2)	(3)	(4)	(5)	NA
I checked out the 301 web page before taking the course.						
I like my grades posted on the Internet.						
I send emails to the instructor.						
I think the use of the Internet improves the Statistics 301 course.						
I think it very possible to conduct this course *entirely* by the Internet.						

Interactive Use of the Internet for Teaching Statistics - Report 2
Statistics 301 - Elementary Statistical Methods - Spring 1999
15th February

This report summarizes the results of the questionnaire distributed to the Statistics 301 class on the 15th February. There are 18 students in the class; sixteen completed the questionnaires. The questionnaire was broken into four categories. The results of these categories are given below.

Getting on the Internet. The computers at PU/NC have been set up for easy access of 301 course material. Computers at home most likely had to be altered to be able to access the 301 course material.

Most students rely, at least in part, on the computers at PU/NC for accessing the course material on the Internet. Only five of the 16 did not use the computers at PU/NC at all.

Those who attempted to set up their computer at home, had a fair bit of difficulty doing so. Although they found setting up the web browser, Explorer, easy to do, they found installing Acrobat Adobe and Forms quite difficult.

Most students felt the one class instruction at beginning of term was enough on how to use the 301 web page. They felt it was easy to find appropriate class notes, homeworks and quizzes on the 301 web page. They also felt it was easy printing this course material off of the Internet.

Workbook and Interactive Exercises. After a brief introduction to a topic, students work on answering fill–in–the–blank, true/false, multiple choice questions given in a *Workbook* on this topic during class time. This Workbook is displayed by computer projection from the Internet onto an overhead screen throughout class time. Answers are also provided by *Interactive Exercises* given on the Internet. The answers provided by the Interactive Exercises although useful for class students to refer to later are really intended for use by Internet students who use them in place of the answers given during class time by the instructor.

All, essentially, sixteen students used the Workbook during class. All, essentially, liked the projection of the Workbook on the overhead screen. Eleven of the sixteen found the Workbook useful when doing either homeworks and quizzes; only one student did not find the workbook at all useful for homeworks or quizzes.

Only a few students used the Interactive Exercises.

Most students had some difficulty with the wording used in the Workbook. Most students had some difficulty with the wording used in the Interactive Exercises, but not as much difficulty as with the wording in the Workbook.

Homeworks and Quizzes. Homeworks and quizzes are posted on the Internet. Class students are expected to write their answers to these homeworks and submit

them to the instructor in class. Internet students submit their answers by email to the instructor. Quizzes are done both by class and Internet students on the Internet.

About half of the sixteen students found it convenient to print the homeworks off of the Internet; two students found it extremely inconvenient to do so. About half of the students liked being able to print off the solutions to the homeworks from the Internet; three did not like this at all and a few did not realize they could do so. Although six (class) students would like to submit homeworks by email, the other students were generally opposed, to varying degrees, to this idea.

Many, ten students in fact, did not like doing the quizzes on the Internet. Many students found the quizzes difficult to read; only three students had no difficulty reading the quizzes.

Miscellaneous. Only two of the sixteen students checked out the 301 web page before taking the course.

Essentially all students like their grades being posted on the Internet.

Six of the students sent emails to the instructor.

Six of the students felt the use of the Internet improves the Statistics 301 course.

Only two students felt the Statistics 301 course could be conducted *entirely* on the Internet; most students, to varying degrees, disagreed with doing this.

Interactive Use of the Internet for Teaching Statistics - Report 4
Statistics 301 - Elementary Statistical Methods - Spring 1999
22nd March

This report summarizes the results of the questionnaire distributed to the Statistics 301 class on the 22nd March; the results of this evaluation are compared to the results of the previous evaluation, done earlier in the term. In fact, only the differences between this evaluation and the first will be given here. There are 18 students in the class; nine completed the questionnaires. The questionnaire was broken into four categories. The results of these categories are given below.

Getting on the Internet. The results between this and the first evaluation were very similar. A few more students were accessing the course over the Internet exclusively from home than from the campus. Only three of the 9 did not use the computers at PU/NC at all.

Workbook and Interactive Exercises. The results between this and the first evaluation were very similar. As before, all, essentially, students used the Workbook during class. As before, very few used the Interactive Exercises to help in answering the questions.

Homeworks and Quizzes. The results between this and the first evaluation were very similar. However, more students in fact, *liked* doing the quizzes on the Internet this time, as compared to last time.

Miscellaneous. The results between this and the first evaluation were very similar. More students sent emails to the instructor this time than last time.

Interactive Use of the Internet for Teaching Statistics - Report 3
Statistics 301 - Elementary Statistical Methods - Spring 1999
20th February

This report presents the results of a two sample t test which compares the average homework scores of Internet and class students for one week, week 5, of term. This report finds that there is *no statistical difference* in the average homework scores.

Assumptions The students in this experiment were those enrolled in one, of two, sections of Statistics 301 at Purdue University North Central in the spring 1999 term. Only those students who *volunteered* to be included in the study were used and, more than this, students were able to drop out of the study at any point in the term.

There were, at the time of this study, a total of nineteen students in the statistics 301 class. Four students were excluded from the experiment. One student was an Internet student by choice. Two more students were class students by choice. A fourth student, although in the experiment to begin with, for reasons of having difficulties with the Internet, dropped out of the experiment.

We would like the results of this study to be used to infer conclusions about *all* students who *might* take Statistic 301 at Purdue University North Central or, for that matter, more generally, at Purdue University, or even a "typical American University", say. To the extent that the 15 students in the experiment are somewhat representative of these more general populations, the results in this experiment can be extended to these more general populations.

The fifteen participating students were assigned at random to either Internet or class instruction. Four were assigned to Internet instruction and eleven were assigned to the class instruction. Students were chosen to be Internet students or not, as best as possible at random using the random number generator of a TI–83 calculator, in an attempt to offset any possible confounding factors which might influence the conclusions of the experiment.

A two sample t test was used to compare the average homework scores of the Internet and class students. A t test, rather than z test, was used because of the small sample sizes involved in the experiment. This test requires that the homework scores of the two groups of students were independent of one another and that the population of homework scores follow a normal distribution. In fact, since it is probably the case students talk to one another about homeworks and the distribution of homework scores tends to have a longer tail for lower scores, these assumptions were likely violated and so the results of the two sample t test are somewhat suspect.

Data The homework scores (out of 6) for the sample of four Internet students and eleven class students was given by:

Internet (1)	5.5	0	1.5	3							
class (2)	4	3	3	4	4.5	0.5	0	0	5	1	1

Consequently, the average and standard deviation of the homework scores for Internet students and class students were:

	Internet (1)	class (2)
$\bar{x}$	2.5	2.364
s	2.345	1.899
n	4	11

Analysis We are interested in knowing whether the average homework scores for the Internet students, $\bar{X}_1$, is the same or different than the average homework scores for the class students, $\bar{X}_2$. We took the *difference* of these two averages, $\bar{X}_1 - \bar{X}_2$. Roughly, if this difference is close to zero, we will decide that the averages are the same; otherwise, we will decide the averages are different.

Both 95% confidence intervals and tests of the estimated difference in the Internet effect, are determined. The 95% confidence interval for the difference in average homework scores for the Internet and class students is found to be, if the standard deviations are *not* pooled,

$$(-3.33, 3.60),$$

and if the standard deviations *are* pooled,

$$(-2.40, 2.68).$$

This means, with 95% confidence, the Internet student homework scores are, on average, *no different* than the class student homework scores.

Similarly, a test revealed the chance, or p–value, of observing a difference in average homework scores for the Internet and class students, assuming the actual difference in average homework scores is zero, if the standard deviations are *not* pooled, to be,

$$\text{p–value} = 0.92,$$

and if the standard deviations *are* pooled, to be,

$$\text{p–value} = 0.91.$$

Since the p–value is so large, it can almost surely be concluded the difference in average homework scores must be zero.

Conclusions This experiment clearly demonstrates that for this one Statistics 301 class at Purdue University North Central, there is no statistical difference in the average homework scores between Internet and class students.

Interactive Use of the Internet for Teaching Statistics - Report 5
Statistics 301 - Elementary Statistical Methods - Spring 1999
26th March

This report presents the results of a two sample t test which compares the average homework scores of Internet and class students for one week, week 10, of term. This report finds that there is *no statistical difference* in the average homework scores.

Assumptions The assumptions here are the same as they were for the first comparison of homework grades. There were, at the time of this study, a total of eighteen students in the statistics 301 class. Two students were excluded from the experiment: these students were class students by choice. A third student who was excluded from the first study, for reasons of having difficulty with the Internet, was included in this study–by this time, she had figured out the Internet.

Data The homework scores (out of 6) for the sample of four Internet students and eleven class students was given by:

Internet (1)	4	0	3	4.5	5	0	3	2	5.5	1.5
class (2)	3.5	2.5	2.5	0	5.5	3.5				

Consequently, the average and standard deviation of the homework scores for Internet students and class students were:

	Internet (1)	class (2)
$\bar{x}$	2.85	2.92
s	1.959	1.800
n	10	6

Analysis The 95% confidence interval for the difference in average homework scores for the Internet and class students is found to be, if the standard deviations are *not* pooled,

$$(-2.173, 2.0394),$$

and if the standard deviations *are* pooled,

$$(-2.175, 2.0417).$$

This means, with 95% confidence, the Internet student homework scores are, on average, *no different* than the class student homework scores.

Similarly, a test revealed the chance, or p–value, of observing a difference in average homework scores for the Internet and class students, assuming the actual difference in average homework scores is zero, if the standard deviations are *not* pooled, to be,

$$\text{p–value} = 0.95,$$

and if the standard deviations *are* pooled, to be,

$$\text{p–value} = 0.95.$$

Since the p–value is so large, it can almost surely be concluded the difference in average homework scores must be zero.

Conclusions This experiment clearly demonstrates, just like the first study, that for this one Statistics 301 class at Purdue University North Central, there is no statistical difference in the average homework scores between Internet and class students.