

Project Summary For Career Grant Proposal 1999
Effective Distance Learning On The Internet
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The primary goal would be to develop and evaluate effective ways of using the Internet 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.

The main part of this work would involve developing an interactive homework software package and an interactive test software package for the Internet. These two packages would continue the work begun previously with a software package created for an interactive workbook (meant to be used by an Internet student in the same sense a classroom student would take class notes). In addition, all three interactive packages (workbook, homework and test), would be improved to make them better mimic a classroom situation, by including animations, sound and video clips.

As a second important part of the work, statistical and observational evaluations would be undertaken to compare academic achievement of classroom students with Internet-based distance learning students. These evaluations will assess not only the Internet-based distance learning approach developed by Kuhn, but also the approaches developed by others. The statistical analyzes would involve the use of software packages such as SAS and S-plus, as well as, if necessary, novel statistical procedures to carry out the various comparisons.

The Internet-based distance learning software would be applied to number of statistics and mathematics courses at Purdue University North Central (PU/NC). This software could easily be applied to other courses given not only at PU/NC, but also at other Universities as well.

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Effective Distance Learning On The Internet

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Introduction

Purdue University North Central (PU/NC) is a small Baccalaureate College II regional campus of Purdue University, located in northwest Indiana. Around seventeen hundred of the thirty-three hundred students at PU/NC are part-time. A full-time faculty of around ninety and a part-time faculty of one hundred and thirty-five support nine different academic sections, including, for instance, Biology and Chemistry, Letters and Language, Technology and Engineering, General Business and Mathematics and Physics. Only one of these sections, Mathematics and Physics, is an originating site for distance learning courses over the Internet.

What Has Been Done

For the last two academic years, 1997-98 and 1998-99, many of the statistics courses in the Mathematics and Physics section, including those meant for the liberal arts, business and biologists, have used the Internet as a “passive” readily accessible electronic bulletin board to store not only class notes, homework and test solutions but also to post updated test scores throughout the academic semester. In addition, for the 1998-1999 academic year, more advanced “interactive” use has been made of the Internet ([Kuhn 1999b](#)) for an algebra-based statistics course, called Elementary Statistical Methods (ESM), in essentially two ways. First, class notes were presented in a question-and-answer tutorial format, called an interactive workbook, on the Internet. Second, timed quizzes were conducted on the Internet. The ESM course was given simultaneously as both a classroom course as well as a distance learning course, distributed over the Internet.

A preliminary statistical experiment ([Kuhn 1999a](#)) was undertaken in the spring of 1999 to compare classroom performance with Internet performance. This study involved a *random* division of the *classroom* statistics students into “classroom” students and (temporary) “Internet” students for as many as two one week periods out of the fifteen weeks of the semester. By chance, some students were assigned not to receive any Internet teaching, while others were asked to be (temporary) Internet students for both of the one week periods. The (temporary) Internet students were 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 had been assigned. This initial statistical study compared homework scores of classroom students with the same scores of (temporary) Internet students and found there was no statistical difference between the scores of these two groups.

What Would Be Done

The main bulk of the work for this grant would involve developing an interactive homework software package and an interactive test software package for the Internet. These two packages would continue the work begun with the software package created for the interactive workbook. In addition, all three interactive packages (workbook, homework and test), would be improved to make them better mimic a classroom situation, by including animations, sound and video clips.

As a second important aspect of the work, statistical and observational evaluations would be under-

taken to compare academic achievement of classroom students with Internet-based distance learning students. These evaluations will assess not only the Internet-based distance learning approach developed by Kuhn, but also the approaches developed by others. The statistical analyzes would involve the use of software packages such as SAS and S-plus, as well as, if necessary, novel statistical procedures to carry out the various comparisons.

The Project, Purdue University North Central and Beyond

The basic purpose of this project would be to develop and assess the validity of a particular approach, described in greater detail below, to Internet-based distance learning. However, throughout the duration of the grant, enough software and hardware would be acquired to have the basis for a statistical consultant service at PU/NC at the end of the grant period, which would be run by Kuhn. In addition, enough software and hardware would also be acquired to have the basis for a distance learning service at PU/NC at the end of the grant period, if such a service was desired at PU/NC at that time. A mentoring program, run by Kuhn, would be set up at PU/NC which would involve students from PU/NC who would participate, according to their abilities, in the software development and/or statistical analyzes.

Internet distance learning is relevant to PU/NC because it may encourage students from outside the geographical vicinity of PU/NC, with its small population base, to take courses at PU/NC. This Internet-based distance learning work could certainly be easily extended to other courses given not only at PU/NC, but also could be extended to other Universities as well.

L^AT_EX-Based Interactive Portable Document Format

A L^AT_EX-based interactive PDF approach to distance learning on the Internet appears to have a number of advantages over other approaches, as explained below. After identifying these advantages, which pertain mostly to the interactive workbook part of this proposal, the discussion will turn to how this approach could be incorporated into a proposed interactive homework software package and an interactive test software package. Then it will described how passive and interactive animations, video and sound clips would be added to the interactive workbook, homework and test packages. Lastly, a brief description of the thorny issue of how a distance learning *student* can *answer* an interactive question using mathematical notation on the Internet may be tackled.

Interactive Workbook, As It Is Now

Combining interactivity with the display of mathematical notation is important for online distance learning courses that use mathematical notation. The interactive PDF tutorials in the interactive workbook are meant to mimic a classroom discussion situation. The interactive PDF tutorial program responds in either a positive or negative way to an Internet students' answers to a variety of questions, including multiple choice (multiple and single answer), fill-in-the-blank, true/false and matching type problems. The fact that the interactive PDF workbook is L^AT_EX-based allows both the program questions and responses to student answers to be very explanatory and, in particular, to freely use mathematical notation.

The interactive workbook approach to teaching was first used by Kuhn in the fall of 1994 as a visiting faculty member at the Statistics department at the University of Michigan, under the guidance of M. Aliaga and B. Gunderson. Their book, Interactive Statistics, has just recently been published, (Aliaga and Gunderson 1999). Print-based interactive workbooks are not just restricted to the field

of Statistics. In the field of Physics, for instance, Socratic Physics, Volume 1 has also just recently been published, (Mathew and Mathew 1999). The interactive workbook is essentially an Internet version of these print-based question-and-answer tutorial workbooks.

Much of the material which appears on the Internet today for education is presented using, for the most part, the Hypertext Markup Language (HTML). For example, the (non-interactive) lecture notes for the online statistics course at,

<http://courses.ncsu.edu/ST370>,

are written in the HTML language. Any mathematical notation that appears in the text is given as small “pictures”, Graphics Interchange Format (GIF) files, within the HTML structure. Both the printed-based and screen-based versions of the interactive workbook described in this paper, on the other hand, are a collection of PDF files where the text *and* mathematical notation are, together, an intrinsic part of these files. In other words, statistical class notes written in HTML must appear as text pages with small GIF files awkwardly (it might be argued) sprinkled throughout, whereas statistical class notes written in PDF appear with text and mathematical notation appearing naturally together.

Both HTML and PDF are presentation formats; that is, they describe documents that can be read, but not edited. However, HTML is essentially a *structural* language, whereas PDF is essentially a *layout* language (Thomas Merz 1998). The HTML language, and its predecessor Standard Generalized Markup Language (SGML), is designed to focus on how to arrange “large” elements like the “heading”, “paragraph” or “listings” on a particular web page and how these elements on the same or different web page are interrelated to one another through hypertext links. The PDF language, and its predecessor, PostScript (PS) (Adobe 1999c), (McGilton and Campione 1992), however, is designed to ensure that typographically and graphically complex documents (such as documents using mathematical notation) will be preserved both on screen and in print. Extensive use of PDF has been employed for print-based interactive workbooks in all of the (mostly Statistics) courses Kuhn has given on the Internet for the last two years, at,

<http://faculty.purdue.edu/jkuhn/courses>

An enhanced interactive form of PDF (Adobe 1999a) has recently emerged to give PDF some of the structural flavor of HTML and which has, in fact, allowed the development of the interactive workbook. This most recent version of PDF allows for HTML elements such as hypertext links, not to mention the interactive check boxes, popup menus, text fields and radio buttons, to be placed in the screen-based interactive workbook. The Elementary Statistical Methods (ESM) course uses this interactive form of PDF and can be found at,

<http://faculty.purdue.edu/jkuhn/courses/301s99/301s99.html>

Others who use the interactive PDF in course presentation on the Internet are Story (1999), and Arnold (1999). Although Story, in particular, has made extensive use of interactive PDF, he has used it for the somewhat limited purposes of creating Internet-based quiz or homework tutorials which serve to only support classroom activity and which is not used in distance learning over the Internet. This contrasts with the interactive workbook, where interactive PDF is used to create the screen-based version of the workbook and plays a central role for the distance learning students who take the ESM course over the Internet.

A software package, *interactiveworkbook*, gives the user the ability to write L^AT_EX documents which, ultimately, create interactive question-and-answer PDF tutorials meant to be used by Internet distance learning students. This software package is written mostly using L^AT_EX, but also involves PostScript and JavaScript, (Flanagan 1998). This package was written by Kuhn, but was adopted from a previous software package called *pdfflash*, (Montgomery 1998), and has been used in one statistics course called Elementary Statistical Methods (ESM). This work was funded by the Indiana Higher Education Telecommunications System grant 652 9395-2956.

Homework and Test Packages On The Internet

Recall, the *interactiveworkbook* program responds in either a positive or negative way to an Internet students' answers to a variety of questions, including multiple choice (multiple and single answer), fill-in-the-blank, true/false and matching type problems. Since both homework and tests are also essentially of a question-and-answer nature, it would seem reasonable to suppose that the interactive workbook would serve as an initial prototype for both an interactive homework package and, more particularly, an interactive test package on the Internet.

The only difference between the interactive workbook and an interactive homework is, in the latter case, a student submits their solutions to the instructor over the Internet, whereas, in the latter case, a student would *not* do this. Although students would be able to access the interactive homework questions at any time during the semester, they would be required to submit their answers to these homeworks by previously specified regular deadlines throughout the semester. These homeworks would be automatically scored and these scores would be immediately returned to both the student and instructor. Marked solutions to all student answers to a particular homework would appear on the Internet for student perusal and comment shortly after the deadline for the particular homework. Information regarding how the student is performing relative to the rest of the class would also be made available on the Internet.

An interactive test would be very similar to an interactive homework. Like an interactive homework, students would be able to access the interactive test at any time during the semester. However, unlike an interactive homework, they would be required to submit their answers to a particular test within a fixed time limit of starting this test. Everything else mentioned above about an interactive homework, would also apply to an interactive test. In particular, these tests would be automatically scored and these scores would be immediately returned to both the student and instructor. Marked solutions to all student answers to a particular test would appear on the Internet for student perusal and comment shortly after the deadline for the particular test. Information regarding how the student is performing relative to the rest of the class would also be made available on the Internet.

The L^AT_EX-based interactive Portable Document Format (PDF) work done by Story (1999) might be useful in the development these two interactive packages. Another possible Internet test software package, *Test Pilot* (Duncan 1999), might also be useful as a starting point in developing these two packages. A preliminary primitive timed Internet quiz software package, written by Montgomery (1998), is available at PU/NC and might be helpful. This Java/C++ Common Gateway Interface (CGI) package requires a Macintosh Server which uses a WebStar AppleEvent protocol and Java 1.1 compliant browser.

The interactive homework package and interactive test packages would be initially applied to the Elementary Statistical Methods (ESM) course. However, a mentoring program, run by Kuhn, would be set up at PU/NC which would involve one or more students and/or staff from PU/NC who would participate, according to their abilities, in applying these packages to other courses taught by Kuhn.

It would seem necessary to use a powerful Unix server, capable of carrying out the various timed event considerations for both the interactive homework package and interactive test package and for dealing with a possible large number of students using the interactive homeworks and tests.

Enhancements to the Interactive Workbook, Homework and Test Packages

To make it better mimic classroom discussion, passive and interactive animations, video and sound clips could be added to the interactive workbook, homework and test packages.

The term “interactive” is often used in a way different than described in this proposal. In particular, the interactive components on a web page usually refers to Java-applet-based animated pictures where the user can change the animation by manipulating one or more parameters. It appears that many college departments use the Internet in Java-applet-based interactive ways to present course material. For example, R. W. West and R. T. Ogden have developed a number of interesting and clever interactive animations for demonstrating various statistical concepts (West and Ogden 1998). Animations similar to these could be added to the interactive workbooks, homework and tests.

Although the purpose is *not* to rewrite *sophisticated* statistical routines, such as appear in the statistical packages SAS or S-plus, some examples of animated, video or sound clip interactive demonstrations that may be created for the Elementary Statistical Methods course are given below.

- stem-and-leaf plots, histograms, ogives and box and whisker plots,
- various summary statistics such as the average, standard deviation and median,
- scatter plots 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.

Animations, video or sound clips similar to these would be used for the other courses taught by Kuhn.

Software and hardware packages that could be useful in creating animations include, for example, Adobe Photoshop, Adobe Illustrator, Equilibrium DeBabilizer, Macromedia Director, the Artz Graphic Tablet and the Olympus digital camera, say. Macromedia Dreamweaver and GoLive CyberStudio would be useful for the video clips and Shockwave Streaming Video and a microphone would be useful in creating sound clips.

Possible Consideration of the Problem of Student Input of Mathematical Notation

As pointed out previously, one advantage of using L^AT_EX-based interactive Portable Document Format (PDF) for distance learning on the Internet is ability for an *instructor* to easily *create* interactive question-and-answer tutorials which use mathematical notation. However, there still remains the thorny issue of how a distance learning *student* can *answer* an interactive question using mathematical notation on the Internet.

This issue can be avoided by simply never requiring that a student submit mathematical notation over the Internet. Rather than ask a student to simplify an algebraic equation, the student could be asked, instead, to choose the correct algebraic simplification from five choices, say. This particular alternative does not seem to be a good one since the student would receive little practice in the manipulation of mathematical notation.

Assuming a student is required to submit mathematical notation over the Internet, two situations arise. Either the student answer is submitted, via email, say, to the instructor, for the instructor to mark, or the student answer is marked automatically, by the computer.

If a student answer is submitted to the instructor through the Internet, there are number of options. The student can send a text file, where symbols available on the keyboard mean different mathematical operations; for example, “2^2” could mean two squared. The student could write answers in either Word or L^AT_EX or some other word processing language which can handle mathematical notation and then submit these documents as is, or, possibly, in PDF, to the instructor. Consequently, although somewhat awkward for both student and instructor, it is possible for the two to communicate in this case.

If a student answer is to be marked automatically by the computer, however, there does not appear to be an easy answer. The World Wide Web Consortium, which manages HTML, is in the process of preparing Mathematical Markup Language (MathML) (Sutor and Dooley 1998), a text-based language, kind of like a L^AT_EX-influenced HTML. The computer company IBM has produced a plug-in for Netscape Navigator and Microsoft Internet Explorer called *techeplorer Hypermedia Browser* (Sutor and Dooley 1998) which uses a preliminary version of MathML. The Internet-based test package, *Test Pilot* (Duncan 1998) also uses a text-based language to describe mathematical notation. A possible method that might be considered in the project would be to allow students to submit PDF files which would be read and automatically interpreted by the computer.

The Project and Purdue University North Central

Throughout the grant period, a mentoring program, run by Kuhn, would be set up at PU/NC which would involve up to two paid students per winter or spring semester from PU/NC who would participate, according to their abilities, in the software development. Enough software and hardware would also be acquired to have the basis for a distance learning service at PU/NC at the end of the grant period, if such a service was desired at PU/NC at that time.

Statistical and Observational Evaluations

Statistical and observational evaluations would be undertaken to compare academic achievement of classroom students with Internet-based distance learning students. These evaluations will assess not only the Internet-based distance learning approach developed by Kuhn, but also the approaches developed by others. The statistical analyzes would involve the use of software packages such as SAS and S-plus, as well as, if necessary, novel statistical procedures to carry out the various comparisons.

Previous Relevant Observed Studies and Controlled Random Experiments

Many studies on education are observed studies, rather than random controlled experiments. Although conclusions from both observed studies and random controlled experiments must be tentative and qualified, this is particularly true for observed studies. In an observed study, every student would be able to decide whether they want either Internet distance learning or classroom teaching, say; whereas, in a controlled random experiment, students would be assigned *at random* to either one of these two teaching methods.

The studies conducted in Schwingendorf, McCabe and Kuhn (1999), Schwingendorf (1999) and Bookman (1999) were observed studies. In the first paper, comparisons were made between students who were taught introductory calculus courses using the Calculus, Concepts, Computers and Cooperative Learning (or C⁴L) pedagogical methodology and students taught in the traditional way (TRAD). Students either were directed or self-selected themselves, or some combination of the two, into the C⁴L calculus courses. This led to the possibility that academically superior students opted for the C⁴L program over the TRAD program, say, and so, possibly, biased the results of the study in favor of the C⁴L program.

The typical solution to the problem of the nonrandom assignment of students in observed education studies is to “chip away at it” by making separate comparisons between smaller more homogeneous groups, defined by possible extraneous confounding factors, or, in other words, to *control* for confounders. This was done in both Schwingendorf, McCabe and Kuhn (1999) and Bookman (1999).

Identifying and quantifying *all* important confounders in observed studies is difficult, if not impossible. In the Schwingendorf, McCabe and Kuhn (1999) paper, for example, it was felt “predicted grade point average of a student”, “major course of study of a student” and “gender of a student” were the three important possible confounders. Having identified these variables, the main statistical model used in the comparison of the C⁴L and TRAD programs was an additive multivariate multiple regression model. The confounders and variable of interest, the program effect, were used to explain a response variable such as the average final grades of students.

The study conducted in Kuhn (1999a) was a controlled random experiment. This study involved a *random* division of the *classroom* statistics students into “classroom” students and (temporary) “Internet” students for as many as two one week periods out of the fifteen weeks of the semester. By chance, some students were not assigned to receive any Internet teaching, while others were asked to be (temporary) Internet students for both of the one week periods. The (temporary) Internet students were 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 had been assigned. This initial statistical study compared homework scores of classroom students with the same scores of (temporary) Internet students using a two sample *t* test and found there was no statistical difference between the scores of these two groups.

Although, from a purely statistical point of view, a controlled random experiment should provide less tentative results than an observed study, there are still problems with this kind of an analysis. Random selection would almost certainly imply assigning at least some of these students into programs against their wishes. For most, if not all students, how well they perform academically is an overriding concern and so to place them in a course in which they have doubts about could possibly bias the results of the experiment. To assign a student at random into one or the other programs without this students’ knowledge (consent) raises ethical issues. Furthermore, an approach which did not inform students they were being assigned at random to different programs would have to ul-

timately lead to bias anyway because the various programs would probably be different enough that students would quickly become aware of these differences. In the study described in Kuhn (1999a), students were told of the statistical study before entering the course, by academic advisors, and also during the first three lectures of the academic semester. Research participant consent forms, submitted and passed by the Committee on the Use of Human Research Subjects at Purdue University, were distributed during these first three lectures.

Qualitative information is often a valuable supplement to both the quantitative observed study and controlled random experiment. For example, identifying and formulating the possible confounders in the observed study in Schwingendorf, McCabe and Kuhn (1999) is essentially a qualitative exercise.

Proposed Evaluations

After developing the Internet-based distance learning software package as described above, the statistical and observational studies that would be undertaken would include but not necessarily be restricted to the following questions.

- Do Internet students score as high as classroom students in tests, homework and final examinations?
- Does the trend in Internet students' test and homework scores remain the same over a period of time (a semester, over a few year period)?
- Is the retention rate (ratio of number of students who attempted the course to the number who passed the course, including only those students who wrote the final examination) for Internet students as high as the retention rate for the classroom students?
- Do Internet students complete a course in the required one semester time as frequently as classroom students?

Quantifiable questions such as these have been asked in previous statistical studies on education, such as, for example, in Schwingendorf, McCabe and Kuhn (1999) and Bookman (1999).

Both observed studies and controlled random experiments would be used in the statistical evaluation. Simple tests and confidence intervals, analysis of variance, and analysis of covariance, and linear and nonlinear regression statistical procedures would be used. Various explanatory variables which would be investigated in the statistical analyzes are given below.

- Do the Internet students perform better in one statistic course than in another?
- Do different instructors influence how well an Internet student performs?
- Do different Internet-based distance learning software packages influence how well an Internet student performs?

Surveys and other qualitative evaluations would be used for other, harder to quantify, questions such as comparing conceptual understanding, confidence levels and involvement, computation skill level and general attitudes between Internet students and classroom students.

A computer server and various software packages such as SAS, Splus, Minitab, Mathematica and GLIM would be purchased. Other Internet-based distance learning software packages, such as, say, the software package developed by company Real Education, would be purchased (installed on the distance learning server) and compared against Kuhn's Internet-based distance learning software package.

Throughout the grant period, a mentoring program, run by Kuhn, would be set up at PU/NC which would involve up to two paid students per winter and spring semesters from PU/NC who would participate, according to their abilities, in the statistical analyzes. Enough software and hardware would have been acquired by the end of the grant period to have the basis for a statistical consultant service at PU/NC, which would be run by Kuhn, who is a statistician.

Mentoring Program

A mentoring program would be run by Kuhn throughout the grant period. Nature of student activities, research environment, student recruitment and selection and, finally, project evaluation for this mentoring program are given below.

Kuhn would meet with the mentored students on a weekly basis and plan with them around three hours of activities per week. He would closely supervise the mentored students for as much as three hours per week, to begin with, but, as the semester progressed and depending on the student, allow the mentored students to undertake activities without such close supervision. For the software development aspect of the grant, students would attempt but not necessarily be restricted to the following activities.

- Use HTML to create web pages.
- Write documents using \LaTeX .
- Write programs using PostScript commands.
- Write programs using JavaScript.
- Write programs using CGI.
- Write programs using Java.
- Develop animations and videos using Adobe Photoshop and Illustrator, Macromedia Director and Dreamweaver.

For the statistical analysis aspect of the grant, students activities would include such things as setting up an experiment, data collection and the following analyzes: simple tests and confidence intervals, analysis of variance, and analysis of covariance, and linear and nonlinear regression statistical procedures. Most mentored students would help in the software development aspect of the grant and use their skills to help Kuhn develop and post interactive Internet-based course material.

Although Kuhn has never mentored students in the way described in this proposal, he has taught undergraduate and graduate students in statistics and mathematics courses since the fall of 1985. Mentored students would work on PC computers tied into computer servers provided by this grant. These computers would be located, most likely, in one of the computer labs at PU/NC.

All students at PU/NC would be encouraged to apply to become a mentor by academic advisors and by flyers posted throughout the PU/NC campus, as well as on the PU/NC web site. Kuhn would choose the mentors from those that apply. Different mentors would be used each semester.

A questionnaire, filled out by mentors at the end of each semester, and the number of applications for mentor positions would be used to gauge the success of the mentor program. This information would be used to improve this program.

Project Schedule

This project would be conducted over four years, beginning in June of 2000. Although work on this project would be conducted all year round, most work would occur during the summers. Mentoring would occur during the winter and spring academic terms. Although both software development and statistical analyzes would be conducted over the four years, the significant software development would be carried out mostly in the first three years.

- *summer 2000:*
 - develop and test the \LaTeX -based interactive test and homework packages
- *winter 2000 and spring 2001:*
 - implement the \LaTeX -based interactive test and homework packages for one introductory statistics course at PU/NC called Elementary Statistical Methods (ESM)
 - carry out preliminary statistical analysis
- *summer 2001:*
 - develop animations, sound and video for the ESM course at PU/NC
- *winter 2001 and spring 2002:*
 - continue to develop animations, sound and video elements for the ESM course at PU/NC
 - continue preliminary statistical analysis
 - mentor students in software development and/or statistical analysis for ESM and other courses taught by Kuhn
- *summer 2002:*
 - install and test at least two other Internet-based distance learning packages
- *winter 2002 and spring 2003:*
 - compare, by statistical and observational analysis, at least two other Internet-based distance learning packages with the Internet-based learning package developed by Kuhn
 - continue to mentor students in software development and/or statistical analysis for ESM and other courses taught by Kuhn
- *summer 2003:*
 - continue to develop and test software development and/or statistical analysis for ESM and other courses taught by Kuhn
- *winter 2003 and spring 2004:*
 - compare, by statistical and observational analysis, at least two other Internet-based distance learning packages with the Internet-based learning package developed by Kuhn
 - continue to mentor students in software development and/or statistical analysis for ESM and other courses taught by Kuhn

15 July 1999

National Science Foundation,
DIS-FastLane Cover Sheet,
CAREER: NSF 99-110
4201 Wilson Boulevard,
Arlington, VA. 22230

Dear Sir/Madam:

Purdue University North Central, and particularly, the Mathematics and Physics Section, supports Dr. Jonathan Kuhn's Career Development Plan in the following ways.

- His usual four course load for the winter and spring semesters will be reduced by one course, to three courses, over the four years of the grant.
- PU/NC will provide space for the two computer servers, five PC computers and two printers requested in the proposal. PU/NC will also help Kuhn connect this computer equipment into the PU/NC network computer system.

Internet distance learning is relevant to PU/NC because it may encourage students from outside the geographical vicinity of PU/NC, with its small population base, to take courses at PU/NC.

Dr. Jonathan Kuhn began his tenure-track appointment with PU/NC on August 18, 1997. This is his first tenure-track appointment.

I have read and I endorse this Career Development Plan.

Yours sincerely,

Edward Bednar,
Vice Chancellor for Academic Services,
Purdue University North Central.
15 July 1999

Budget Justification For Career Grant Proposal 1999
Effective Distance Learning On The Internet

J.R.D. Kuhn,
Mathematics and Physics Section,
Purdue University North Central, Westville, IN 46391-4197

The basic purpose of this project would be to develop and assess the validity of the proposed LaTeX-based interactive PDF approach to Internet-based distance learning. However, throughout the duration of the grant, enough software and hardware would be acquired to have the basis for a statistical consultant service at PU/NC at the end of the grant period, which would be run by Kuhn. In addition, enough software and hardware would also be acquired to have the basis for a distance learning service at PU/NC at the end of the grant period, if such a service was desired at PU/NC at that time.

This project would be conducted over four years, beginning in June of 2000. Although work on this project would be conducted all year round, most work would occur during the summers. Student mentoring would occur during the winter and spring academic terms. Both software development and statistical analyzes would be conducted over the four years. Significant software development would be carried out mostly in the first three years.

Year 1, 2000-2001. This first year would involve not only collecting the initial software and hardware, but also developing the LaTeX-based interactive test and homework packages. No student mentoring would take place this first year.

- \$20,000. A computer server, possibly a Unix-based machine, would be used as the basis for the various distance learning software packages.
- \$5,000. One PC microcomputer, fully equipped with appropriate software, to be used by Kuhn in the software development and/or statistical analysis of the LaTeX-based PDF interactive Internet-based distance learning course.
- \$5,000. Printer able to support LaTeX-based PDF interactive Internet-based distance learning course.
- \$10,562. Kuhn's compensation for grant work.
- \$10,000. Computer and consultant services.
- \$1,000. Books and journal subscriptions.
- \$4,000. Travel to conferences.

Year 2, 2001-2002. This second year would be spent introducing animation, sound and video into at least one Internet distance learning course. Mentoring would begin. Computer server for statistical software packages would be delivered and installed.

- \$20,000. A computer server, possibly a Unix-based machine, would be used as the basis for the various statistical software.
- \$10,000. Statistical software packages.

- \$10,000. Up to two mentored students in both the winter and spring semesters, at \$2,500 each, would help Kuhn, according to their ability, develop and post course material on the Internet for distance learning.
- \$5,000. Printer able to support L^AT_EX–based PDF interactive Internet–based distance learning course, for mentored student computers.
- \$10,000. PU/NC would receive and maintain two PC microcomputers, fully equipped with appropriate software, at \$5,000 each, to be used by the mentored students.
- \$10,984. Kuhn’s compensation for grant work.
- \$3,500. Compensation to PU/NC for course reduction.
- \$1,000. Books and journal subscriptions.
- \$4,000. Travel.

Year 3, 2002–2003. The third year would be spent comparing Kuhn’s Internet distance learning software package with other purchased distance learning software packages. The statistical analysis would begin.

- \$50,000. At least two other, most likely commercial, distance learning software packages (to be installed on the previously purchased distance learning computer server) would be used to compare with Kuhn’s distance learning software package. This money would include any computer consultant fees needed to support these other distance learning software packages.
- \$10,000. Up to two mentored students in both the winter and spring semesters, at \$2,500 each, would help Kuhn, according to their ability, develop and post course material on the Internet for distance learning.
- \$11,424. Kuhn’s compensation for grant work.
- \$3,500. Compensation to PU/NC for course reduction.
- \$1,000. Books and journal subscriptions.
- \$4,000. Travel.

Year 4, 2003–2004. The fourth year would be spent continuing to compare Kuhn’s Internet distance learning software package with other distance learning software packages. The statistical analysis would continue.

- \$10,000. Up to two students in both the winter and spring semesters, at \$2,500 each, would help Kuhn develop and post Internet course material as well as help in the statistical analysis.
- \$11,881. Kuhn’s compensation for grant work.
- \$3,500. Compensation to PU/NC for course reduction.
- \$1,000. Books and journal subscriptions.
- \$4,000. Travel.

Bibliography Sketch for Career Grant Proposal 1999
Effective Distance Learning On The Internet

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Educational Background

1994, Ph.D., Statistics, University of Toronto, Toronto, Ontario, Canada.
1987, M.Sc., University of Cambridge, Cambridge, England, UK.
1982, M.A.Sc., University of Waterloo, Waterloo, Ontario, Canada.
1981, B.A.Sc., Systems Design Engineering, University of Waterloo, Waterloo, Ontario, Canada.

Academic Positions

Assistant Professor, Purdue University North Central, September 1997 to present,
Visiting Assistant Professor, University of Minnesota, September 1996 to August 1997,
Visiting Assistant Professor, University of Michigan, September 1994 to August 1996,
Part Time Lecturer, University of Toronto, September 1991 to December 1991,
Contractual Lecturer or Part Time Lecturer, York University, September 1985 to April 1991.

Grants, Honors and Awards

IHETS Grant, \$11,960, March 1998-February 1999,
Minor Research / Ad-Hoc Grant, York University, \$500, January 1986,
President's NSERC Fund, York University, \$500, December 1985,
Committee on Research, Grants and Scholarships, York University, \$500, November 1985
NSERC Postgraduate Scholarship, \$11,000 for 1983-84, 1984-85, and \$3700 of \$7400 offered before
going to York,
Overseas Research Students Award, £1800 per annum taken off University of Cambridge fees, 1983-
84, 1984-85 (and 1985-86 but unable to accept because of move to York),
University of Cambridge Mathematics J. T. Knight Prize Essay, "Two Mathematical Problems in
Risk Sensitivity", £60, 1984,

Ontario Graduate Scholarship, received $\frac{2}{3}$'s of \$6000 per annual award before going to Cambridge, 1982-83,
University of Waterloo Faculty of Engineering Scholarship, 4 awards from September 1981 to December 1982, \$2000 total,
The Sanford Fleming Foundation Teaching Assistantship Award, \$300, 1982.

Publications Related to Grant

Kuhn, J. R. D., (1999a) "An Interactive Workbook For Internet and Classroom Students", submitted to *Journal of Statistical Education*, June 1999.

Kuhn, J. R. D., (1999b) "interactiveworkbook: L^AT_EX-Based Interactive PDF on the Web", submitted to *TUGboat*, June 1999.

Schwingendorf, K. E., McCabe, G. P. and Kuhn, J. R. D., (1999) "A Longitudinal Study of the C⁴L Calculus Reform Program: Comparisons of C⁴L and Traditional Students", submitted to *Research in Collegiate Mathematics Education*, March 1999.

Kuhn, J. R. D., (1997) "Using The Internet In The Administration of Undergraduate Statistics Courses", *American Statistical Association 1997 Proceedings of the Section on Statistical Education*, 204-207.

Other Publications

Kuhn, J. R. D., (1994) *Parameter Forcing*, PhD Thesis, University of Toronto.

Whittle, P. and Kuhn, J. R. D. (1986) "Hamiltonian Formulation of Risk Sensitive Linear / Quadratic /Gaussian Control", *International Journal of Control*, Vol 43, no. 1, 1-12.

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Kuhn, J. R. D.; Hipel, K.W. and Fraser, N. (1983) "A Coalition Analysis With Applications to the Zimbabwe Conflict", *IEEE Transactions on Systems, Man and Cybernetics*, Vol. SMC-13, No. 3.

Previous Collaborators

Fraser, Donald; York University and University of Toronto (PhD supervisor, although this proposed grant has essentially nothing to do with my PhD work),
Montgomery, Aaron; Purdue University North Central (co-PI on IHETS grant),
Schwingendorf, Keith; Purdue University North Central (co-author on a paper).

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West, R.W. and Ogden, R.T. (1998), "Interactive Demonstrations for Statistics Education on the World Wide Web", *Journal of Statistics Education* [Online],6(2). (<http://http://www.stat.ncsu.edu/info/jse/v6n2/west.html>)