Technology in the Agricultural Economics Classroom: Are we on the Right Path?

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#### **Technology in the Agricultural Economics Classroom: Are we on the Right Path?**

The popular press subscribes to the notion that a technological revolution in the production of education is well underway. For example, the Wall Street Journal (March 12, 2001) featured a special section, devoted to e-education, that leads with the caption "The Web is transforming education - what we learn, how we learn, where we learn." The primary focus of the lead report in this section is on university-business alliances used for putting university courses and programs online. Beyond the business-strategy focus, this section reports on the success of online instruction at University of Minnesota, Crookston campus where specialization in technology-integrated courses has occurred (Ramstad, 2001). This section also features a story of unfulfilled expectations of instructional technology ("Online classes can be tough to find, hard to sign up for and a bore once you get there," Hamilton, 2001). Apart from its reporting on university-business alliances, this special report differs little from a similar one published in the Wall Street Journal five years earlier (Nov. 13, 1995). The potential reported for new instruction technologies such as multimedia, networks and distance education to revolutionize education in all arenas including K-12, colleges and universities, and corporate training are largely the same. The potential benefits offered by these new technologies include improved retention, reduced boredom, and lower costs of education. Less tangible benefits include higher student achievement; improved attitudes and self esteem and enhanced quality of student teacher relationships.

In fulfilling on-campus teaching obligations, agricultural economics faculty may be somewhat removed from concerns about university-business alliances for putting courses online; but we are not isolated from the new technologies available for delivering course content. Colleges and universities have been continually investing in classroom renovations. These renovations frequently leave in their wake improved seating (more comfortable and flexible), white boards, presentation computers, video projectors, Elmo projectors, DVD players, videocassette recorders, enhanced sound systems, and high speed network ports. Agricultural and resource economics classrooms are sometimes the ones renovated, putting new instructional tools at our disposal. As agricultural economists have adopted computers for various instructional uses, and as many agricultural economics departments have installed and supported computer labs, and as some departments have become involved in distance education for specific curricula, it seems plausible that new instructional technologies, in particular internet delivery of course content to the student, might also be adopted and supported.

While these new instructional technologies are becoming increasingly available, their use in agricultural economics may not be as widespread as one would believe. Certainly new teaching techniques are reported to have not made inroads into economics instruction. In reporting on a national survey on teaching undergraduate economics, Becker (1997, p. 1348) states, "In contrast with other disciplines that have moved to a broad teaching repertoire, economics continues to be taught by the lecture method in all undergraduate courses." A similar conclusion is reported in Becker and Watts (1996) that " ... as a group, college economics teachers rarely use innovative teaching techniques." These findings are especially surprising in light of the fact that the economics literature (surveyed by Becker and Watts, 1995) reports the effective use of various teaching techniques including (a) classroom games, simulations and laboratories, (b) economic experiments, (c) writing assignments, (d) assignments based on economics in literature and drama, (e) the use of Nobel lectures as a teaching tool, (f) teaching economics with the popular and

business press, (g) case studies and (f) cooperative learning exercises. Internet applications in economics instruction have been reported and specific applications seem to be beneficial (Vachris, 1999; and Agarwal and Day 1998).

The objective of this paper is to address the question posed in its title. However, we proceed by sidestepping the title question because of its normative implications and address instead three related questions framed more positively. These questions are (1) What path are we on? (2) Where are we on the path? and (3) Where does this path lead? We will address these questions by examining Internet utilization in agricultural economics instruction. We will attempt to determine how the Internet is currently being used in agricultural economics instruction and the extent of that utilization. Identifying how the Internet is being used will allow us to identify the benefits available from this utilization as well as to identify the benefits that cannot be obtained from these applications. Finally, we will turn our attention to Internet applications that are lacking in agricultural economics instruction and discuss their potential benefits.

# Methodology: What path are we on? Where are we on this path?

The "What path are we on?" and "Where are we on that path?" questions are considered simultaneously because both are addressed with a survey methodology. "What path are we on?" has a qualitative dimension. Its answer requires us to determine broadly how Internet technology is being used in agricultural economics instruction. Of particular interest is the type of material communicated via the Internet, the intended use of this material and how this use relates to more traditional methods of distributing instructional materials. "Where are we on the path?" has a quantitative dimension. Its answer will be couched in terms of the Internet's "market

penetration" or "share" in our instructional programs. One method of gathering the type of information required to answer these questions is to simply find the agricultural economics course websites and to click through the various links while recording the quantity and type of material found at each site. An equivalent but far less tedious technique automates the process with the use of a web crawler.

Web crawlers (also know as spiders, robots, or bots) are computer programs that follow the hyperlinks found in web pages in pursuit of some purpose. The best-known applications are web search forms that, when submitted, return web pages containing key words or search phrases. A variant of these programs checks the availability of the files specified in hyperlinks. This application might be of interest to professional webmasters who oversee huge sites and would be interested in identifying broken links. Over 200 web crawler programs are cited at www.robotstxt.org/wc/robots.html and many can be downloaded and used for free. A straightforward web crawler algorithm consists of these steps (Thomas, 1997):

- 1. Create a queue of Internet addresses to be searched.
- 2. Pull an address out of the queue and fetch the page found at that location.
- 3. Scan the Hyper Text Markup Language looking for addresses.
- 4. Add any new addresses found to the queue.
- 5. If the queue contains any unvisited addresses, then go to step 2. Else stop.

One web crawler accomplishes these steps in one (long) line of computer code. This algorithm becomes more complex if search-directing logic is added.

The web crawler written by Thomas (1997) was used because of its simplicity, clear documentation, free availability, and adaptability resulting from its implementation in the Perl

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programming language (Wall, Christiansen, and Schwartz, 1996). This program will be used for two purposes; to locate course websites, and to survey the websites found. The Thomas program was modified to automate its searching and surveying activities. First, the program was incorporated in a program loop so that it would run iteratively, with each iteration starting at a different address. Starting address corresponded to either the location to begin a search or the location of a course website to survey. The program was also modified so that addresses from a separate list could be excluded from visitation. This exclusion prevents links back to the instructor's, department's, college's and university's web sites from being followed. Third, the program was modified to record, for each visited page, the page address, the page title, the linkpath from the starting point to the page, and the address and associated text for each link in the page. This output comprises the search results, and provides data with which to categorize the visited web sites. Finally, the program was modified to limit the number of links followed from the starting point. This prevented the program from running needlessly through pages that were of no interest.

The major steps in our survey procedure are (1) determine what agricultural and resource economics courses are taught, (2) find agricultural and resource economics course websites corresponding to those courses, and (3) analyze the content of the agricultural and resource economics course websites. The details of implementing this survey follow.

Academic units that conduct agricultural and resource economics instruction were identified using the 2000-2001 AAEA directory. This directory lists 104 academic units (departments, divisions, schools, and colleges) that conduct agricultural economics instruction. Ninety-seven of these units are located in the U.S. and seven are located in Canada. If the

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instructional unit has a website, it was located through the parent university website. Parent university websites are available from www.google.com.

Information about the courses taught by the academic units, including course number, title, and description, was retrieved from online university catalogs. To reduce the number of courses to be analyzed and more clearly define the underlying population, the focus was narrowed to undergraduate-level courses. Also, to establish a sample within which data processing could be tested, the scope was further limited to the twenty Western U.S. Land Grant departments of agricultural and resource economics (table 1). To ensure comparability across departments, only agricultural economics courses were surveyed. This means that economics courses taught in departments of agricultural economics that also teach agricultural economics (U.C. Davis, Montana State U., N.D. State U.) were excluded. Courses taught by the Department of Agricultural and Land Resource Management at the University of Alaska were excluded because they differ substantially from courses offered by the other agricultural economics departments. After these exclusions, 444 courses were left in our target population.

Websites for these courses were sought as follows. (1) If a menu of online course links was given on the departmental or university website, then the addresses in these links were used. This menu was assumed to contain a complete listing of course websites for the department. (2) If course website links were not given on the departmental website, then departmental faculty profiles were searched to find either links to course websites or links to personal web sites that contain links to course websites. The web crawler performed these searches. For input the crawler was given a starting address corresponding to either the departmental listing of course

web sites or faculty profiles on the departmental website. The web crawler output, consisting of addresses, titles, link paths, and within-page links (both URL and text descriptor) for each page searched, contained course website addresses.

The course website addresses served as starting points for the web crawler survey of agricultural economics course web sites. Course websites were summarized as the web crawler recorded page titles, link paths to the page, addresses, and within-page link-text and addresses for each page in each course website. Finally, individual course web sites were visited to ensure that recorded site summaries corresponded to the actual site contents.

Additional issues became apparent during this phase. Courses with titles such as Special Topics, Internship, Senior Seminar, and Independent Study do not have regularly scheduled class meetings. Websites for these courses would not be expected, and if websites exist, the objectives of materials would not be comparable with the objectives of web materials for traditional courses. The exclusion of these special topics courses brings the target population size down to 367. Likewise, off-campus courses offered through distance education programs would not be comparable to traditional on-campus agricultural economics courses so they are not included. Still further reductions were required. Neither method for finding course web sites worked for the University of Hawaii, Manoa. Because it could not be determined whether no sites existed or whether the search strategy failed, the University of Hawaii's agricultural economics courses were excluded from the course count. Course websites at North Dakota State University and New Mexico State University were hidden behind password protection. Because course materials could not be accessed, their intended use could not be determined so the courses from these two

universities were also excluded form the course count. After all exclusions, the sites found and analyzed came from an underlying population of 293 courses.

Table 2 provides a (preliminary) summary of the instructional materials found on agricultural economics course web sites. The 293 courses described above is the base against which course counts should be compared. Web pages were found for 139 courses. Not all of these pages were valid hits. Three sites appeared to be abandoned because they have not been updated in the several years. Fifteen other course links take the user to empty sites. Because there is no evidence that these sites were abandoned, we assume (optimistically) that these sites are still in use even though there is no content to analyze.

The frequency of various categories of course website content is summarized in table 2. A course syllabus was found most frequently (106 occurrences) but in half of these cases (53) the course syllabus/outline was the only item found. This raises the issue of what constitutes a course web site. The remaining 86 (=139-53) courses had web sites that consisted of more than a syllabus and outline. These sites contained various combinations of homework assignments, class notes, old exams and solutions. The data in table 2 provide an estimate of Internet supported instruction's share of the agricultural economics market. The 86 course websites relative to the pool of 293 courses in the sample population gives an estimated 29.4 percent of agricultural economics courses that use web sites.

Within each course website, the link-text indicates the intended instructional role (homework, past exams, etc.) of the document conveyed by the link. The type of document conveyed by the link indicates the intended student use of the document. For example, past exams link almost exclusively to Microsoft Word documents (\*.doc), PostScript document files

(\*.pdf). The obvious intended use of these files is that they be downloaded and printed by students. Homework problems linked to Microsoft Word documents (\*.doc), PostScript document files (\*.pdf), and dead end HyperText Markup Language files (\*.htm) indicating that these files were also intended for download, viewing and ultimately printing. In contrast, had these links lead instead to cgi (Common Gateway Interface) or to asp (Active Server Page) files, then student interaction would have been the intended use. The lack of interactive links indicates that the intended use of the bulk of website content was for it to be downloaded and printed. While having this material on the website increases its instantaneous availability to students, the same end result is achievable with the traditional teaching method of reproducing and distributing the material.

Lecture notes available as either Microsoft Word or Postscript documents are obviously intended for download and print. Lecture notes were also distributed frequently as PowerPoint (\*.ppt) and HTML files with no further hyperlinks. The match of topics and headings indicates that the files are related, with the original PowerPoint files saved in HTML format to provide the student with a choice of format. A further presumption is that the PowerPoint files were presented in lecture. While the opportunity for students re-view lecture slides might be beneficial, printing and reproducing the PowerPoint slides accomplishes the same effect. Multimedia events embedded in the PowerPoint files were not detected.

Class readings are typically stored as Postscript documents. Their placement in a course website serves as a convenient substitute for placing the materials on reserve at the library. A growing number of libraries are discontinuing reserve services. Other applications found include providing links to other course-related internet materials (not "my favorite sites"), grade reporting

through links to the university registrar, the use of spreadsheets for online examples, and the use of a threaded discussion manager in three courses offered by one department.

# Where Does this Path Lead?

The survey results clearly indicate that the path we are on is one where the intended use of online agricultural and resource economics course materials is that they be downloaded and printed by students. More succinctly, course websites are intended mainly to serve as a source of class handouts. Our location on this path has been estimated with online documents being available for thirty percent of our courses. Where this path leads will be addressed by identifying the costs and benefits of this use of online instruction materials. Implicit in this discussion is that advancements will be made in market share but that the application methods of Internetbased instructional will remain constant.

A production function provides the most convenient and familiar conceptual framework for analyzing the impact of web-based instructional materials. The most basic application of production functions to learning is the learning curve, which represents the relationship between time spent on an activity and the resulting learning. A more general model provides a framework for analyzing teaching and learning of university-level agricultural economic concepts (Dahlgran, 1990). Even greater generality is achieved with a multiple-input/multiple-output learning production model of the form

$$F(Y, X, Z) = 0,$$
 (1)

where Y is a vector representing instructional outputs, X is a vector representing the student's learning inputs, and Z is a vector representing the instructor's teaching inputs. More specifically,

the student's decision variables, X, consist of time allocated to various course activities, such as reading, attending lectures, working homework problems, studying for examinations, writing papers, applying course concepts, etc. In designing the course, the instructor controls the categories in which a student can allocate time to the course but the student controls the amount of time spent in each pursuit. For example, the instructor controls the number of exams, homework problems, case studies, simulations, course materials, etc., but the student controls the amount of time spent learning in each of these activities. The instructor's inputs, Z, include time spent preparing lectures; preparing other class materials; learning, understanding, and organizing course content; and learning about and creating alternative content delivery methods. Internet delivered course content is included in Z. The outputs of this production process, Y, include items that are valued by either the instructor or the student. These might include student learning at various cognitive levels (knowledge, comprehension, application, analysis, synthesis, and evaluation as described by Bloom et. al., 1956), course grades, student attitudes, and student credit hours. Each student as well as the instructor differently values the various dimensions of output and input. The student then seeks to maximize r Y - w X subject to (1) where r represents the valuation placed on each element of Y by the student and w represents the student's opportunity cost of time.

The impact of Internet-based teaching materials can be evaluated by considering them as instructional inputs that were formerly not available to students. Accordingly, let  $Z = (z_1, z_2)$  where  $z_1$  represents Internet provided inputs. Prior to the development of the Internet inputs this vector would be represented as  $(0, z_2)$ . The impact of Internet-provided course materials is determined by comparing  $Y^*|z_1=z_1$  to  $Y^*|z_1=0$ , where  $Y^*$  represents the optimized value of Y.

Our survey revealed that most of the web-based course material consisted of online documents apparently intended for downloading and printing by the student. We have argued that the end result of this application was not much different from copying and distributing material to students either in class or for later pickup. Hence, Internet-based instruction applications simply provide a "new" input that is a near-perfect substitute for an "existing" input. The near-identical nature of the "new" and "existing" inputs means that both have the same marginal product regardless of the employment level of the other. It follows that the combined employment of the "new" and the "existing" inputs will be identical to the employment of only the "existing" input. Consequently, output is unaffected by the choice of the "new" versus the "existing" inputs, and it seems unlikely that Internet applications such as the ones we found will have much impact on learning.

An alternative comparison focuses on the cost and availability of Internet-delivered course materials based on the argument that materials on course websites are more readily available and/or less costly to obtain than those distributed by traditional means. This argument assumes that the student has access to a computer, an Internet connection, a printer, and paper. Given the availability of the first three components, then the comparison is between the opportunity cost of time spent logging on, accessing, downloading, and printing the document versus the opportunity cost of the time spent obtaining the document through traditional means. The traditional method of instructional document acquisition typically requires classroom attendance where the student receives other joint inputs that are not available with downloaded course materials. These other inputs should be charged a portion of the opportunity cost of time spent acquiring the documents. After the opportunity cost of time has been correctly allocated,

it is not clear that for students who rely on dial-up connections and are routinely on campus, internet-distributed course materials have the opportunity time-cost advantage.

Though minimal, the cost of materials (paper, ink, toner) to the student is less for traditionally distributed materials than for online materials because departments have traditionally borne the costs of reproducing instructional materials while students bear the entire cost of obtaining Internet documents. Some fee-for-print firms, including universities, charge up to ten cents per page printed.

As a final consideration, Internet-delivered documents are always available but the availability of each document is a concern only once, typically, so that the convenience advantage for online documents is likely to be negligible.

In summary, agricultural economics Internet-delivered instructional materials appear to directly substitute for traditional instructional materials. If this is the case, then economic principles dictate that there will not be any learning enhancement associated with adopting Internet-delivered materials. On the input cost side, the Internet-delivered materials must be less costly to the student, and the student's supply of time must be somewhat elastic in order for learning to increase. It is not clear that these conditions exist.

# **Concluding Comments**

This study finds discrepancy between the optimistic case for online education described in the Wall Street Journal and current practices in agricultural economics. We found that webbased course offerings are rather limited. About thirty percent of all regularly scheduled agricultural economics courses have websites and only about a third of those sites are comprehensive. This suggests a number of possibilities. The first is that agricultural economics is behind other disciplines in developing Internet-based instructional applications. This may be either because either agricultural and resource economics subject matter is not amenable to Internet enhancement or because the rewards for implementing this technology are insufficient. In either case, it appears that instructors have carefully assessed the costs and the benefits of Internet implementation and have made rational choices. Another possibility is that the popular press, in reporting anecdotal evidence, has exaggerated the state of online instruction.

Second, teaching innovations reported to be the most productive are those that involve students as active rather than as passive learners. Current web-based instructional applications, which have a primary purpose of providing students with convenient access to instructional documents, do not represent a break from the passive learning model. Furthermore, Internetbased instructional materials appear to substitute easily for traditional instructional materials offering limited potential for increasing the quantity and quality of learning. It therefore seems that Internet-based technologies that make students active learners, that do not substitute directly for traditional instructional methods, and that capitalize on the Internet's information processing and dissemination capabilities offer the greatest potential for enhanced learning. Examples of Internet tools that satisfy these criteria are threaded discussion managers, and website indexing and searching engines. These tools are readily available in web authoring programs such as Microsoft's FrontPage.

Continuing with the active/passive learning distinction, the focus of the websites surveyed is on one-way communication from the instructor to the student. Website interactivity, or two-way communication beyond the notion of email links, takes the student out of the passive

learner mode. Interactive technologies such as active server pages (ASP) and common gateway interfaces (CGI) were not found. These applications allow online forms to be filled out, the input processed and recorded at the server, and results communicated back to the student. The scarcity of these applications is understandable in light of the difficulty of their implementation but they seem to offer the greatest potential benefits.

In conclusion, this paper begins by asking, "Are we on the right path?" The implication was that the right path leads to greater student learning and higher quality learning. The evidence points to the conclusion that we may be on the right path but that it is too early to tell.

University	Department
Univ. of Alaska	Agricultural and Land Resource Management
Univ. of Arizona	Agricultural and Resource Economics
Univ. of California, Davis	Agricultural and Resource Economics
Univ. of California, Berkeley	Agricultural and Resource Economics
Colorado State Univ.	Agricultural and Resource Economics
Univ. of Hawaii, Manoa	Agricultural and Resource Economics
Univ. of Idaho	Agricultural Economics and Rural Sociology
Kansas State Univ.	Agricultural Economics
Montana State Univ.	Agricultural Economics and Economics
North Dakota State Univ.	Agricultural Economics
Univ. of Nebraska, Lincoln	Agricultural Economics
New Mexico State Univ.	Agricultural Economics and Agribusiness
Univ. of Nevada, Reno	Applied Economics and Statistics
Oklahoma State Univ.	Agricultural Economics
Oregon State Univ.	Agricultural and Resource Economics
South Dakota State Univ.	Business Economics
Texas A&M Univ.	Agricultural Economics
Utah State Univ.	Economics
Washington State Univ.	Agricultural Economics
Univ. of Wyoming	Agricultural and Applied Economics

Table 1. Departments Surveyed for Agricultural and Resource Economics Course Web Sites.

Underlying courses <sup>a</sup>	293
Sites found	139
Not current	3
Vacant, under construction/revision	15
Website features	
Syllabus/course outline	106
Syllabus/outline only	53
Past examinations and keys	34
Homework assignments	29
Lecture notes	29
Class readings	12
Links to related material	16
Course grade reporting	13
Course announcements	3

Table 2.Characteristics of agricultural and resource economics course websites. (Western U.S.<br/>departments only)

<u>a</u>/ Excludes special topics/problems, independent study, seminars and internships. Also excludes departments where all course web material is protected as the content could not be examined and analyzed. Excludes the economics courses for departments that offer economics as well as agricultural economics courses.

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