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Research in Economic Education

In this section, the *Journal of Economic Education* publishes original theoretical and empirical studies of economic education dealing with the analysis and evaluation of teaching methods, learning, attitudes and interests, materials, or processes.

PETER KENNEDY, Section Editor

The Impact of the Internet on Economic Education

Rajshree Agarwal and A. Edward Day

Use of the Internet in economic pedagogy is growing, but it has not received much attention in the economic education literature. Almost no studies have measured the impact of using Internet technology on student learning and retention, perceptions of instructor effectiveness, and changes in attitudes toward economics. We report the results from classroom experiments that tested the influence of Internet use on economic education.

Using Internet resources to enhance economic courses has two principal advantages for students. First, these resources offer a new medium of interaction that complements classroom instruction and facilitates learning. Second, they offer students the opportunity to learn and use Internet technology and yield positive externalities for future academic and career paths.

INTERNET USE IN EDUCATION

Recent technology has made possible several new methods of transmitting information. Internet methods can be classified into two broad categories: (1) computer communication and conferencing and (2) information access, retrieval, and use. Computer communication and conferencing methods include e-mail, mailing lists, newsgroups, interactive messaging or "chat" sessions, and video conferencing. Information available on the Internet can take a number of different forms, including text, data, graphs, and pictures. The tools of the Internet provide

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efficient methods of accessing information, including File Transfer Protocol (FTP), Telnet, Gopher, and the World Wide Web.[1]

A number of studies in education and communication technology have focused on the use of these methods.[2] The overwhelming conclusion of these studies is that the effectiveness of Internet use comes from the potential of greater interaction between the instructor and the students and in the hands-on learning of new concepts. The Internet represents an information revolution, and its use in pedagogy is beneficial whenever interaction, discussion, research, or transmission of information are involved.

The literature is primarily descriptive. Few experiments have been carried out to determine if Internet-enhanced courses affect student learning and understanding. One of the exceptions is Gregor and Cuskelly's (1994) experiment using a bulletin board discussion method. They observed high participation in the discussion. Their findings support the hypothesis that students find value in electronic communication, that is, better access to the instructor, more interesting assignments, and future use of e-mail in their academic and professional careers.

We addressed the lack of statistical evidence in the literature by attempting to provide measures of performance and to test whether these measures are affected by the use of the Internet. Although the results pertain to Internet use in economic education, they are also relevant to Internet use in other fields of education.

HYPOTHESES

In Agarwal and Day (1996b), we discussed the significant costs to instructors and students that result from incorporating the Internet into a course. Objective evaluation and rational decisionmaking warrant some measure of the benefits of Internet use. The literature suggests that Internet use has an impact on economic education in three crucial areas: student learning and retention of concepts, student perceptions of instructor effectiveness, and attitudes toward economics.

Use of the Internet, however, implies significant learning costs for some students because they are being exposed to the technology for the first time.[3] The beneficial results of the technology on learning and retention could be offset by the time costs of learning the new technology. Increases in student workload caused by Internet requirements and resistance to learning and using the technology could result in lower scores in instructors' evaluations and in student attitudes toward economics. The impact of the Internet in each of the three areas could be either positive or negative. We tested the following null hypotheses against two-tailed alternatives:

1. Internet implementation in economics courses has no impact on student learning and retention.
2. Internet implementation in economics courses has no impact on student evaluations of instructor effectiveness.
3. Internet implementation in economics courses has no impact on student attitudes toward economics.

Student Learning and Retention of Economic Concepts. The use of Internet technology in economic education should increase student learning and retention because computer communication and ease of information retrieval through the Internet allow higher development of critical thinking and problem solving, foster independence and autonomy, and permit greater interaction. These opportunities should be reflected in the measures of learning and retention.

Student Perception of Instructor Effectiveness. E-mail, mailing lists, and chat software promote instructor-student interaction, and Web-page dissemination of information provides easy access to class syllabi, schedules, lecture notes, projects, and assignments. The Internet should improve student perceptions of instructor effectiveness, which would be reflected positively in the instructor's class evaluations.

Student Attitudes toward Economics. Computer conferencing can increase interaction and discussion about economic issues, and information retrieval and use can increase students' ability to apply economic theory to the real world. The discussion and assignment of projects that demonstrate the relevance of economic concepts can effectively improve student perceptions and attitudes toward economics.

METHOD

To test the hypotheses, we conducted experiments with economics classes we taught in the spring and summer terms of 1996.

Construction of the Experiment Data Set

We conducted our experiments in two sections of graduate microeconomics and two of undergraduate macroeconomics that we taught over two semesters. Two sections served as the control group and two as the Internet enhanced-group. The test and control sections were roughly of equal size, approximately 40 each in the graduate sections and 65 each in the macroeconomics sections.[4] We took measures to minimize the differences between the test and control group caused by factors other than Internet use. Any differences caused by the instructor's teaching style were removed by having the same instructor teach both the test and control groups of a course.[5] The sections were assigned randomly as test and control. To avoid selection bias, we did not inform the students prior to registration that the sections had different work requirements. The same text, classroom instruction style, tests, and similar homework were used in both groups.

We collected data on student characteristics that might affect performance. The mean age, GPA, and proportions for gender and race for each of the four sections are provided in Table 1. We conducted tests to check differences between the control and Internet groups for each of the two courses in the experiment.[6] Except for race in the undergraduate macroeconomics course, no significant difference existed between the control and Internet groups. The students in the two groups seemed to be homogeneous in their characteristics.

TABLE 1
Demographic Characteristics of Control and Internet Groups

Variable	Internet group		Control group	
	Mean	*SE*	Mean	*SE*
	Graduate microeconomics			
Gender[a]	0.68	0.088	0.65	0.073
Race[b]	0.65*	0.037	0.63*	0.078
Age	29.65	6.921	28.05	5.323
GPA	3.238	0.709	3.344	0.410
	Undergraduate macroeconomics			
Gender[a]	0.57	0.062	0.50	0.062
Race[b]	0.73	0.048	0.76	0.053
Age	22.65	5.130	21.72	4.971
GPA	2.81	0.948	2.80	0.705

[a]Proportion of males.
[b]Proportion of whites.
*Significant at the .05 Type I error level.

Internet Elements Implemented in the Internet Group

Many elements of the Internet can be used to supplement traditional teaching techniques. In Agarwal and Day (1996a), we reported a cost-benefit analysis of different Internet tools and, based on these considerations, offered suggestions on preferred tools. We chose Internet elements for the test group that minimized student costs in terms of both learning time and expense. Internet tools that required specialized software or state-of-the-art computers were avoided in favor of universal tools that were user friendly and relatively cheap to access.

We chose a subset of Internet tools that formed, in our opinion, the core set of elements: e-mail and a class discussion list for computer communication and conferencing and the World Wide Web for information access, retrieval, and use. Each of these tools allowed us to exploit the benefits of the Internet without substantially adding to student and instructor costs. As research in this area continues and the costs of incorporating the other Internet elements (such as streaming audio and video) decline, more of the Internet can be included in teaching.

E-mail accounts are available to all students at our university. We generated class mailing lists for each test section. To ensure that each class list addressed problems and concerns relevant to the individual class section, we kept the class mailing list as a closed discussion list. This close-knit environment enabled students to feel free to express opinions and helped establish personal contact during class time. Students received handouts regarding use of e-mail and the mailing list but no formal training on learning the Internet tools. We encouraged students to address their problems using the Internet to us and provided a list of help facilities available throughout the campus.

E-mail and the class mailing list were used successfully to address student questions regarding course material. Answers were posted on the mailing list,

which benefited the questioning student as well as others who had the same question, thus reducing the number of times the same question had to be answered. Some students began to participate actively almost immediately, typically those who had had prior experience with the technology. Other students increased their participation over the course of the semester. By the third or fourth week of the semester, students were interacting among themselves, asking and answering each other's questions. Students asked for help on using the Internet, concepts taught in class, application of the economic concepts to news articles from local and national newspapers, and general classroom housekeeping issues (such as due dates and topics covered).

The World Wide Web was used for disseminating class-related information and for completing Web projects that required students to access and download information through the Internet.[7] Information such as syllabi, class schedule, projects, and assignments were made available to the students through instructor Web pages. Projects related to microeconomics ranged from using demand-supply analysis for critically evaluating economic activity to analyzing market structure based on information on Web pages of firms in different product markets. Macroeconomics-related projects included downloading information on the consumer price index, federal budget data, and international comparisons of economies. Each project had two major emphases—the use of economic data and information and their relevance to the economic theories taught in class. An Internet project for calculating cost of living of different U. S. cities, for instance, allowed the students to observe the differences in nominal and real income and the effect of inflation on economic activity.[8]

As students' familiarity with the technology increased, so did their interest. They began using the Internet for reasons other than the course requirements. Enterprising students surfed the Web on their own initiative and shared tidbits of economic information on the class mailing list. Students often expressed amazement regarding the wealth of economic information "out there" and the varied ways in which they could begin using their economic knowledge and Internet skills for future classes.

MEASURES OF PERFORMANCE

Student Learning and Retention of Economic Concepts

Differences in student learning and retention resulting from Internet implementation were measured using the Test of Understanding College Economics III (TUCE), developed by the National Council on Economic Education, and the student's final course grade (Saunders 1991). The TUCE, administered as part of the final exam, counted for 5 percent of the student's grade in the graduate course and as extra credit in the undergraduate course. The standardized TUCE has been extensively normalized, and the questions cover micro and macroeconomics thoroughly. The test can be given to graduate and undergraduate students and is, perhaps, one of the best measures of student performance available. A major drawback of the TUCE is that it often tests knowledge of material that may have

been peripheral to that covered in a course. There is no good way for students to prepare for this test. In any case, it would have been inappropriate for the instructors to have taught the course with the TUCE questions in mind. The students' grades were used as an additional measure of their performance.

Clearly, retention and learning of economic concepts are a function of more than the instruction method used. Several individual characteristics are important explanatory variables for student performance. To control for differences in learning caused by these factors, we included demographic characteristics such as age, gender, and race to account for differences in learning. Student GPA was also included as a measure of academic quality.

Student Perceptions of Instructor Effectiveness

We used the standard instructor evaluation form required for every course. The form, developed by the State University System of Florida, was modified to include more questions by faculty, students, and the administration for our study. The evaluations were administered during the final week of the course. Student responses were anonymous, and the integrity of the evaluations was maintained by ensuring that the instructors did not have access to the evaluations prior to their scoring or to the submission of student grades. The form consists of 16 questions that require the rating of the instructor on a five-point Likert-type scale and 4 questions that allow students to write responses to specific concerns. Thirteen of the 16 rating questions deal with student perceptions of instructor effectiveness, and 3 address administration and routine task issues such as timeliness of return of exams, relevance of textbooks, and so forth. We focused on the 13 questions that deal with student perceptions of instructor effectiveness.

Student Attitudes toward Economics

To test the attitudes of the student toward economics, we administered pre- and postsurveys of Attitudes toward Economics, developed by the National Council on Economic Education (Soper and Walstad 1983). This survey instrument consists of 14 questions evenly divided between those that test positive and negative attitudes toward economics. Students respond on a five-point Likert scale.

DATA ANALYSIS AND RESULTS

We used regression analysis to test the hypothesis that the Internet has no impact on student learning and retention of economic concepts and compared the mean responses to analyze the other two hypotheses.

Student Learning and Retention of Economic Concepts

The following regression models were used to test student learning and retention as measured by one of the two dependent variables: scores received on the standardized TUCE and final grade in course.

$$\text{TUCE} = \alpha_1 + \alpha_2 I + \alpha_3 G + \alpha_4 R + \alpha_5 A + \alpha_6 \text{GPA} + \alpha_7 L + \varepsilon \quad (1)$$

$$\text{Grade} = \beta_1 + \beta_2 I + \beta_3 G + \beta_4 R + \beta_5 A + \beta_6 \text{GPA} + \beta_7 L + \upsilon \quad (2)$$

where

TUCE = student score on TUCE examination
Grade = final student grade in course
I = internet variable (0 = control group, 1 = Internet group)
G = gender (0 = female, 1 = male)
R = race (0 = nonwhite, 1 = white)
A = age of student at last registration
GPA = student GPA at last registration
L = student level (0 = undergraduate, 1 = graduate)
α, β = the coefficients to be estimated
ε, υ = the error term

The results of these regressions are given in Table 2.[9] The data in the first two columns represent results from the TUCE regression and in the last two columns, the results from regressing grade on the independent variables. Race and age were insignificant for both measures of performance. The second columns under TUCE and Grade contain the regression estimates for the final specification of

TABLE 2
Regression Analysis for Performance on TUCE and Grade

Independent variable	TUCE		Grade	
	(1)	(2)	(1)	(2)
Constant	1.98	2.03	58.48	62.06
	(.3709)	(.1028)	(.0001)	(.0001)
Internet	1.14	1.15	1.91	2.03
	(.0294)	(.0281)	(.0104)	(.0070)
Gender	1.21	1.20	2.06	2.33
	(.0275)	(.0281)	(.0104)	(.0034)
Race	0.99		–0.46	
	(.0702)		(.3411)	
Age	0.11		0.09	
	(.0715)		(.1899)	
GPA	3.08	2.95	7.42	6.74
	(.0001)	(.0001)	(.0001)	(.0001)
Level	1.71	1.79	18.00	4.25
	(.0001)	(.0066)	(.0004)	(.0001)
Regression statistics				
Observations	206	206	206	206
Adjusted R^2	.40	.40	.56	.55
SE	4.25	4.24	5.81	5.87
F	18.00	28.15	33.82	64.37

Notes: (1) = Regression coefficients for all variables in the model. (2) = Regression coefficients for final specifications, excluding insignificant variables. Parentheses contain p values.

the model, where insignificant variables were dropped from the analysis. Students in the Internet group performed better on the TUCE exam and had higher final grades in the course. The coefficient of the Internet element was significant for both measures of performance at the 95 percent level of confidence. Thus, the hypothesis that Internet use in economics courses has no effect on student performance can be rejected in favor of a positive influence. Prior GPA was a strong determinant of performance, as was gender. As expected, graduate students tended to do significantly better than the undergraduate students.

An interesting side issue was whether Internet enhancements worked better for good versus poor students. We ran separate regressions for the graduate and undergraduate sections that included an interaction variable between prior GPA and the Internet group. The results showed a positive value for the interaction term (0.92 and 4.75 for Grade and 1.75 and 1.78 for TUCE in the undergraduate and graduate sections, respectively), although none of the coefficients was significant at the .10 Type I error level. The results cannot be interpreted as showing a weak indication that the Internet enhancements worked better for good rather than poor students, because other relevant factors might not have been taken into consideration, such as prior knowledge and familiarity with the technology and different learning styles. More research is needed before anything conclusive can be said about this hypothesis.

Instructor Evaluations for the Course

The differences across test and control groups between mean scores for instructor evaluations on a five-point Likert-type scale (1 = *poor* and 5 = *excellent*) for both courses are provided in Table 3. The positive impact of the Internet is clearly seen for the graduate group. For all questions, the ratings were signifi-

TABLE 3
Student Perception of Instructor Effectiveness

Instructor evaluation	Graduate micro		Undergraduate macro	
	Difference[a]	p[b]	Difference[a]	p[b]
Feedback to student for performance in course	0.62	.0067	0.40	.0583
Instructor interested in your learning	0.70	.0003	0.74	.0001
Use of class time	0.64	.0025	0.60	.0088
Instructor overall organization of course	0.42	.0177	0.52	.0142
Continuity between lectures	0.40	.0169	0.62	.0021
Pace of course	0.47	.0198	0.56	.0149
Communication of ideas and information	0.63	.0033	0.82	.0007
Express expectations for performance	0.48	.0125	0.51	.0070
Available to assist students	0.60	.0086	0.31	.1153
Respect and concern for students	0.60	.0019	0.30	.1097
Stimulation of interest	0.95	.0001	0.62	.0129
Facilitation of learning	0.50	.0111	0.93	.0001
Overall assessment of instructor	0.68	.0003	0.61	.0076

[a]Difference between Internet group mean and control group mean.
[b]p value associated with t test for testing difference = 0.

cantly higher in the Internet group than in the control group. The Internet group reported much higher stimulation of interest and better use of class time and communication of ideas and gave a better overall assessment of the instructor and her feedback and interest in the students. The undergraduate Internet group also had higher student perceptions of instructor effectiveness, and the students gave significantly higher ratings to the instructor for 10 of the 13 questions. The questions that reflected the greatest differences related to instructor interest and facilitation of learning and to communication of ideas and information.

Attitudes toward Economics

Pre- and postquestionnaires of the same survey were administered to both the Internet and the control groups to determine any changes in attitudes toward eco-

TABLE 4
Difference in Change of Attitude Toward Economics

Question[a]	Graduate micro Difference[b]	Graduate micro *p*	Undergraduate macro Difference[b]	Undergraduate macro *p*
Positive questions toward economics[c]				
I enjoy reading articles about economic topics.	0.83	.0025	–0.15	.3019
Economics is easy for me to understand.	–0.12	.3412	–0.09	.3709
I enjoy economics.	0.48	.0604	–0.18	.2848
On occasion I read an unassigned book in economics.	0.46	.0928	–0.26	.2803
I would be willing to attend a lecture by an economist.	1.28	.0001	–0.272	.1821
Economics is one of my favorite subjects.	0.92	.0046	–0.17	.2583
I use economic concepts to analyze situations.	0.43	.0437	0.01	.4841
Economics is practical.	0.17	.2780	–0.20	.2648
Negative questions toward economics[d]				
I hate economics.	–0.79	.0073	–0.06	.4092
Economics is dull.	–0.64	.0253	0.12	.3412
Economics is a very difficult subject for me.	–0.38	.1066	0.20	.1595
Studying economics is a waste of time.	–0.71	.0196	–0.07	.3976
Economics is one of my most dreaded subjects	–0.03	.4642	0.36	.1643
Economics ideas are dumb.	–0.21	.2125	0.29	.1668

[a]5-point scale with 1 = strongly disagree, and 5 = strongly agree.
[b]Pre- and postquestionnaires of the same survey were administered in each class. The difference between the post- and prescores represented the mean attitude changes. The numbers in the column represent the differences between the mean attitude changes across the Internet and the control groups. [postmean (Internet) – premean (Internet)] – [postmean (control) – premean (control)].
[c]High scores on positive questions indicate high affinity toward economics; thus, positive differences reveal that the Iinternet group had a greater change in attitude toward economics.
[d]High scores on negative questions indicate dislike of economics; thus, negaitve differences reveal that the Iinternet group had a greater change in attitude toward economics.

nomics subsequent to taking an economics course; changes were measured as a difference between the post- and prescores on each question (see Table 4). If Internet enhancement creates a better attitude toward economics, there should be positive differences on questions that reflect an affinity toward economics and negative differences on questions that reflect a dislike toward economics.

For the graduate students, the positive change in attitude was consistently higher for the Internet group than for the control group on all but 1 question, 10 of which were significant. The Internet-enhanced graduate group expressed a significantly higher likelihood of attending a lecture given by an economist, were more likely to consider economics as their favorite subject, used economic concepts to analyze situations more frequently, and disagreed about finding economics dull. This was not, however, true for the undergraduate students. Internet enhancement seemed to have no significant effect on attitude changes, and the changes were not consistent in any one direction. Thus, the results were mixed about the effect of Internet enhancements on attitudes toward economics.[10]

CONCLUSIONS

Internet enhancement of courses facilitates communication between the instructor and students, and easy access of information using the medium promotes use of economic data and real-world applications to enhance the teaching of theory. Both aspects of Internet use in economic pedagogy provide a real increase in the quality of education. The results of this study suggest beneficial effects of implementing Internet enhancements. The hypothesis that the Internet has no impact on student learning and retention is rejected in favor of a positive influence when scores on a standardized test and the final grade are considered as dependent variables. The hypothesis that the Internet has no impact on student perception of instructor effectiveness is rejected as well. There were mixed results on the effect of Internet enhancements on student attitudes toward economics; graduate students responded more favorably to economics with the use of the Internet, but no significant difference in mean attitude changes was apparent for the undergraduate group.

The point of using the Internet is to add value to the classes that we teach and to allow us to meet the challenges of teaching. Our experience revealed that Internet use significantly enhances economic education for two reasons. First, contact time with students substantially increases through e-mail and discussion lists. The instructor is able to communicate effectively with many students at the same time through the discussion list. Being able to correspond among themselves regarding the relevant theory and problems gives students an additional opportunity to focus on problem areas and seek help from each other. We believe the added communications element goes a long way in fostering both thought and interest in the subject matter. Second, the Internet assignments and use of the Web allow students to observe the real-life implications of the economic theory they learn in class. The hands-on experience provides a better understanding of the subject matter and makes the learning process more active.

With budgets coming under increasing pressure, finding new and innovative ways to increase our efficiency is obviously a growing need. We believe that the evidence supports using Internet tools as part of the education process.

The area is rich in future avenues for research. Similar studies need to be conducted in other universities before one can say with certainty that the Internet has a positive impact on economic education. In addition, knowing how Internet use affects students as they progress through the entire economics program, rather than just one course, would be useful. Another interesting question is whether the Internet is more effective for good versus poor students. Finally, Internet-enhanced "distributed learning" and "distance learning" courses represent innovative ways of reducing the costs of education, but the quality differences between these types of courses and traditional courses needs to be addressed.

NOTES

1. See Agarwal and Day (1996a) for the relative strengths and weaknesses of these methods.
2. The studies include Berge (1994), Bailey and Cotlar (1994), Boldt, Gustafson, and Johnson (1994), Monahan and Dharm (1995), Kearsley, Lynch, and Wizer (1995), Kuehn (1994), Manning (1996), Santoro (1994), and Zack (1995).
3. The picture will change dramatically in a few years given the emphasis on educational technology in high school today (Agarwal and Day 1996b).
4. We conducted the experiment for an undergraduate principles of microeconomics course. The results are not reported because of lack of adequate control for class size; the Internet group had 61 students and the control group, 13. This inequality posed problems in differentiating the effects of Internet enhancement.
5. Agarwal taught two sections of a graduate (MBA) course in microeconomics, and Day taught two sections of a principles of macroeconomics course.
6. GPA was measured on a continuous scale (0–4.0); gender and race were categorical variables whose values are defined in equation 1.
7. More information on our use of the World Wide Web can be found on our individual web pages at <http://www.bus.ucf.edu/eco/homepage/agarwal> and <http://e-day.bus.ucf.edu>.
8. Similar projects were assigned in the control group, but they were not actively encouraged to use the Internet. Although a few students in the control group inquired about using information from the Internet, the majority of the students in the group used traditional methods of research involving print media and library resources.
9. To determine if pooling data was appropriate, we performed an F test for a change in regression slopes coefficients between the graduate and undergraduate sections. The restricted model (no change in regression slope coefficients) could not be rejected, indicating no significant differences at the .05 Type I error level of significance between the two groups in both TUCE (F 5, 194 = 1.24) and final grade (F statistic 5, 194 = 2.20) results. Thus, pooling the data was deemed appropriate.
10. For the undergraduate microeconomics course with unequal class sizes, the differences in instructor evaluations across test and control did not reveal any significant impact of the Internet enhancements, although the mean attitude changes were significantly higher for the Internet group for 5 of the 14 questions. The Internet group gave a better evaluation of the instructor's feedback of performance than the control group did and reflected a better change in attitude in spite of the disadvantage of a larger class size. The advantages of smaller class size for the undergraduate microeconomics control group may have been somewhat offset by the Internet enhancement of the Internet group. Clearly, more data are needed to test the proposition that Internet use may be an effective way of circumventing negative features of larger class sizes.

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Conference Announcement

With the support of the National Science Foundation and the National Council on Economic Education and the endorsement of the American Economic Association Committee on Economic Education, the *Journal of Economic Education* and the University of Pittsburgh are cosponsoring a conference on integrating new technologies in the undergraduate teaching of economics. The eight presenters were selected from an international call for proposals. For more details and applications to attend, please see the *Journal of Economic Education* Web site at
http://www.indiana.edu/~econed/index.html