Do On-Line Students Analyze, Synthesize And Evaluate Better Than Face-To-Face Students? Preliminary Evidence

by

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Abstract

An asynchronous course in the introduction to economic analysis depends on mastery of content before students may progress to the next module. Each module is formulated with introduction, content, graded and non-graded assessment. Student success in a similar course over four semesters is pronounced with little withdrawal and mostly grades of A being received. This paper tells why the instructional design, the testing environment and the degree of student and professor interaction that leads to these observed outcomes.

The authors at the University of Akron are undertaking an experiment comparing the success rates of face-to-face to online courses. Student success on a first and final examination and a common writing assignment in two undergraduate economics courses with different instructional designs is examined. The study finds that the level of prior economic literacy, awareness of economic facts and trends, attitudes towards economics, and previous grades and academic characteristics are important in explaining student success. Previous research has shown that students in online courses do not do significantly worse than face-to-face students, but can not perform on as high a complex plane. Our study suggests that the online students do as well in complex tasks. The experiment is ongoing and will not conclude until end of the Spring Semester 2003.

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The economics profession and other disciplines are moving to the online world. Courses are ported to the web with and without regard to the appropriateness of the instructional design. An online course in the Department of Economics has apparently led to great student success and greater interest in the study of economics based on the grades received and the evaluations of the students.[1]

The authors are involved in an experiment, a head-to-head competition between the online and face-to-face offerings of a one-semester Introduction to Economic Analysis course offered in Fall 2002 and Spring 2003. The online design is a competency or mastery based learning design and the economics profession has dealt sparingly with this concept. The in-class design is based on traditional and active learning techniques. How students perform in each class will be examined and compared. In particular we hope to eventually answer:

(1) Are learning outcomes higher in a web-based course, that is, does the mode of delivery (in-class or web-based) have an influence on learning outcomes?

(2) Are students in an online environment as likely to do as well as in face-to-face classes? Will they be able to equal the complex problem solving of the face-to-face students?

(3) Will web-based students develop more favorable attitudes towards economics than the attitudes developed by students in the face-to-face class?

(4) Do student myths about economics affect their learning outcomes and attitudes towards economics?

The class under study is a three–credit general education principles of economics course (combined micro and macro) and is a required course for students in the College of Engineering. Experience in a similar online course at a graduate level seems to imply that students succeed at higher rates, become more interested in economics, and have a better attitude towards the field of economics. In fact, students' assessments and evaluations have led to questions of whether student learning is taking place at the same levels as in face-to-face classes since the student comments seem to be overwhelmingly positive in the online experience.

This paper is being authored during the early stage of experiment and final results will not be achieved until Summer 2003, but some suggestive evidence is possible based on the pre-test, initial survey responses and the scores achieved on a first set of exams, a writing assignment and a final exam. After a discussion of online and face-to-face instruction, and the research design, the results will concentrate on scores on a pretest of economic knowledge and a survey of awareness of economic realities, information gathering processes and attitudes towards economics.

Online Learning

Many online courses are offered with various elements of an instructional design. By online learning in this paper we mean a course that is 100% offered and completed on the Internet, and in particular this online course takes place in the WebCT course management system. Any casual reading of papers and articles on online learning reminds one immediately of the failures of such endeavors. These points of failure include high dropout rates, much more work for students and professors, professors facing the need to be programmers and trouble shooters, alienation of students, one-size fits none offerings, and in general frustration for professors and students.[2]

A problem of some offerings on the Internet is the porting of the same instructional design as used in a face-to-face class. This is a problem for at least two reasons. First, what is appropriate in a face-to-face class is not necessarily appropriate or easily portable to the online environment. Second, the face-to-face course may not have a well thought out instructional design, nor need it, since much of the flow of the course may be improvised

on the fly. Professors that simply try to replicate the face-to-face experience in the online environment are not guaranteed to offer the same level of student success as the face-to-face experience.

Face-to-face classroom-based learning

By face-to-face learning in this paper we intend to communicate a class held on a regular basis with students attending in a common classroom under the direction of a professor. The design of the course involves both lecture and active learning strategies. In many disciplines this is taken as granted, but according to Becker and Watts (2001), fully 83% of economics instructors at all institutions, across rank and across all subfields use a technique they call chalk-and-talk. They define chalk-and-talk as a course, primarily lecture, where nearly everything written or displayed is created during the class. Uses of collaborative and active learning techniques is a small percentage of offerings, however, this is growing. Thus the face-to-face offering in this experiment can be thought of as a best of breed face-to-face class presentation.

Mastery or Competency Based Learning

In this paper mastery learning and competency-based learning are defined in the following way. Mastery learning based classes require the student to achieve a certain level of mastery over the course material before the student is certified to progress to the next level. The entire course material is organized into several modules. In particular, a student reading over a few chapters of material that may make up a single module will be expected to complete an examination on that material at a sufficiently high level or have to repeat the examination. In an unconstrained environment the student will never move past a module in which they have not achieved mastery, e.g. achieving at least a certain percentage score. In a traditional semester system, with a desire to have student balance mastery learning with the constraints of a 15-week term, the students are limited on each module to a limited number of trials and will move forward regardless of score on the final attempt.[3]

Competency based learning is similar to the above in that the material over which the student must achieve mastery is based on course objectives within each module. The module objectives are those statements as general as “Incentives matter” or a specific as “consumers will increase their consumption of an item as its price falls, all other things being held constant.” In the online course the objectives of each chapter are formed into the objectives of the module. Multiple quiz questions are then chosen to match each objective as a test bank is assembled. The actual quiz that a student takes is randomly assembled by choosing questions from the testbank for each objective in order to test whether the student achieves competency over that objective. A mapping of questions to objectives ensures that each randomly generated 10-item quiz is qualitatively identical to every other quiz on that module across both students and attempts.

Combining mastery learning and competency learning, a student is expected to achieve mastery over the competencies (objectives) of the course. A student achieving mastery over the competencies will necessarily achieve a high course grade. Lower grades are those that result from not mastering the content after three attempts on various modules.

Instructional Design

In the face-to-face class the professor uses a combination of lecture and active learning techniques. In the online course the professor uses an instructional design based on mastery learning. The students in the face-to-face classes have the professor to lead them and have immediate access to him for both the “sage on the stage” style of presentation as well as his spontaneous comments and answers to questions posed by the students.

In the online class, the professor does not lecture in any way. There is provided to the student in each module a set of readings and presentation-type material to help guide the student in achieving mastery over the objectives of the module. The professor is in this case the “guide on the side” having prepared a path for the student to follow and being available to students for their questions. Required assessments that are graded and non-graded help the instructor and student navigate through the modules. The specific design of the online course is described in presentational materials available at http://gozips.uakron.edu/~myers/online.

The assessment component of the online course is the testing where students must complete a randomly assembled to the objectives module quiz with a perfect score or re-take it up to three times. The student receives the highest grade of the three attempts. After completion of the module quiz the student is required to complete a module evaluation which consists of four questions which are related to the classroom assessment techniques (CAT) of the minute paper and the muddiest point (Angelo and Cross (1993)). [4] Chizmar and Ostrosky (1998) used a similar CAT and find student success to be 6.6% higher in a pre-test/post-test experiment for those students that participated in the CAT.[5] This CAT is one of the principal reasons that student-professor interaction in the online course is so high and may promote active learning and certainly breakdowns the anonymity and fosters better communication between student and professor.[6]

When a course is successful in the face-to-face venue, the temptation is that instructors will port it to the web as is. It is our contention that each venue (face-to-face and online) requires appropriate and often quite different instructional designs, such that they are appropriate for that venue and for the strengths of the instructor.

Research Design

Two classes, one face-to-face and one online are set up to have certain similarities. The content is the same, the textbook is the same, the pre and posttests and all writing assignments are the same. Moreover, the instructors each have been teaching for over 20 years and thus have similar experience.

The model for this study is:

(1) Student success = f(initial endowments, economic awareness, attitudes towards economics, student characteristics, mode of delivery)

Student success is measured in this paper as scores on a first examination and on a writing assignment designed at a high level of complexity and on scores on subsets of a standardized final exam. These include scores on a pre-test, student GPA, and whether the student has taken the class before. [7] The pre- and post-test used in this analysis consists of 40 multiple choice questions that relate to the twenty *Voluntary National Content Standards in Economics* published by the Foundation of Teaching Economics (Seigfried (1996)). These standards represent the economic knowledge that students should know upon graduation from high school. They include such principles as "productive resources are limited, therefore people cannot have all the goods and services they want, they must choose some things and give up others."

A set of 120 questions covering each of the twenty standards was assembled using a test bank associated with a well-known principles of economics textbook. Each question was also rated with respect to the level of competency according to a standard that roughly translates into the lower three or four categories of Bloom's taxonomy: knowledge, comprehension, application, and analysis. The set of questions was then sent to five economists active in the teaching field for external validation. Each reviewer as asked to rate each question according to whether it fit the content standard and complexity level using a 5-point Likert scale. The three levels of complexity used in this standardized exam are referred to as recall and recognition, simple application, and complex reasoning.

Based upon this external assessment, 40 questions were selected covering all 20 standards. Thirteen of these questions were categorized as "knowledge," another 14 were rates at the "comprehension" level of competency and the remaining 13 at the higher "application" level. A post-test is similarly employed at the end of the class.[8] We suspect that students with more favorable initial endowments (including higher pre-test scores and GPA levels) will succeed at higher rates.

Economic awareness is measured by a twenty-item survey of economic facts administered to the students at the beginning of class. The idea posited is that students who score higher on the economic facts survey will be more aware of the economy around them. Two additional questions are asked about economic information gathering activities and intensity, and three questions measure attitudes towards economics. The attitude questions are modeled after Maki and Maki (2002) who find that stronger students benefit more from online courses and addressed a series of questions to the students at the beginning and the end of the class to assess the change in students' attitudes. At this juncture we have the initial attitudes measures. We suspect that students with greater awareness of the economy and more favorable attitudes towards economics will succeed at higher rates. Controlling for student characteristic differences within and between the classes will allow us to see the effect of

mode of delivery on student success. Student characteristics include information pulled from the students' academic record.

All data collection was then subject to the aegis of the Institutional Research Board for the Protection of Human Subjects at the University of Akron and all data used in this study derive from students that have given their signed written consent to be in the study. Few students selected to opt out of the study, 11 percent in the online course and ten percent in the face-to-face course.

Results

Table 1 describes the variables and expected signs for the regression of *examscore* and *writing2*. Table 2 shows the means and Table 3 the regression results. The results are suggestive. In future papers we will look at the post-test scores and attitudes as measures of success.

Data on 91 students are divided between 73 face-to-face and 18 online students of which 90 took the exams and 81 have all variables available in the *examscore* regressions and 71 students completed writing assignments and 66 have all variables available for the *writing2* regressions. The online students have been in college longer, more favorably disposed towards economics and spend a higher portion of their time on gathering news in business and economics. The face-to-face course contains a higher portion of males and of those who are freshman level and undecided about their major.

Success on the First Examination

The dependent variable, *examscore*, is the first measurement we have in the class of whether the students are learning economics. A comparison of the in-class exam over the first six chapters of the required textbook is added to the online students average performance over the first three modules that cover the same material. That material includes introductory sections, supply and demand and elasticity. Online student are allowed to repeat the randomized quiz for each of the modules up to three times or until they achieve 'mastery' by getting all ten questions right. For this reason one would expect the online students to score higher.

In a future paper we will examine the students' performance on a standardized final exam and in the next section will examine their performance on a common writing assignment, *writing2*. In those cases the online variable will have a more precise interpretation, but in the regression on *examscore* it simply controls for the differences in the course design and can not be interpreted as a 'fair' comparison.

The results meet our prior expectations on the variables. Initial endowments, awareness and attitudes are found to be important to student success, even if we cannot yet say whether online students learn at a higher rate. In fact the literature is full of reports that online students show no significant difference (Twigg (2001)). In a study in economics, Brown and Leidholm (2002) show that their online students do not do significantly worse, but do show lesser ability to answer complex multiple choice questions. We examine the complexity issue in the next section.

As a regressand in Model 1 (of Table 3) the pre-test score is shown to be very important in predicting success and the finding in Model 2 is reassuring. There we see that the type of pre-assessed knowledge is extremely important. Breaking down the pre-test results by level of complexity shows separate effects based on the type of initial economic specific endowment held by the student. Scoring high on recognition and recall questions have no effect, however being able to apply economic principles in a simple application is of great importance and being able to answer more complex problems is of the greatest importance in predicting student success.

Three survey variables about attitudes were asked of the students: about their interest in economics, whether they expect to like the course and whether they plan on taking more economics courses. The variables were entered in all combinations and the importance varied from the "like" variable on the low end to the "take more courses" variable on the high end in terms of statistical significance. Because of multicollinearity issues and a desire to have a more aggregate score the variable *attitudes* enters Models 1 and 2 and is very powerful adding 12.2 or 13.7 points respectively on the students' scores (100 point maximum) for those who answer "strong agreement" on the three variables.

Of the three categories of variables (endowments, awareness, and attitudes) clearly the awareness shows as the weakest albeit positive effect on student success. Those who scored as many as 10 correct answers (of 20 in total) would be expected to score from 6.9 to 9.1 percentage points higher on the assessment over the first 6 chapters. No combination of the two questions asked on business and economic newsgathering, as measured, ever achieved significance.

Controlling for student characteristics shows some interesting results. The first is that there is no apparent effect of race or gender, but in regressions where the pre-test is left out, there are significant and large effects. Thus, at least for the regression on *examscore* the importance is not ones gender or race, but rather the level of initial endowment in economics that they bring to the class.

All things equal, older students tend to do slightly worse and those undeclared or undecided in their major suffer almost a full letter grade (based on 10 points per letter grade) for taking economics so 'early' in their career. This later may reflect a lack of maturity which is a penalty with respect to student success.

Success on the Second Writing Assignment

A common writing assignment was designed to assess students at a complex level of competency as measured by Bloom's taxonomy. The assignment was written in a manner to test the students' ability to think on a higher plane, to research a problem, synthesize the analysis, and evaluate which of many facts are actually important to make recommendations to a student's hypothetical employer. In terms of Bloom's taxonomy, we viewed this exercise as requiring the student to demonstrate competency up to the "analysis/synthesis" level, but perhaps short of the highest "evaluation" category.

The actual problem was explained in a rather lengthy handout (or webpage), with starter references and the question(s) stated finally as:

> *Mr./Mrs. Economist, what is going on in the national economy and how does this compare and contrast with what is going on in our regional economy here in Ohio? How does all this affect your employer's business? What solutions would you suggest to your employer with regard to how s/he runs the business in coming months?*

Students had to research and identify trends in the national economy, trends in the Ohio economy, and then draw conclusions about what might be important for the local economy of the employer. Students could adopt any employer they would like and those working often tried to relate to their actual situation. The students' responses are graded according to a rather strict grading rubric. The rubric chosen is presented by Diane Ebert-May at flaguide.org and is a rubric for scoring essays. A copy of that rubric is included in the appendix.[9]

Models 3 and 4 show that our priors are met on the initial endowments, economic awareness and attitudes towards economics variables. In both models, it is the scores on the complex questions in the pretest that are important in determining the ability to write on such a complex task. Other economic specific knowledge is of more limited usefulness (and not significant). Student's GPA (general initial endowment) is significant in Model 3, but in Model 4, the addition of learned facets of the course are significant and the GPA score is shown to be unimportant. The learned facets include the prior scores on the first exam and a first writing assignment, which was a simple analytical/application essay. If any, the GPA has an indirect effect on the *writing2* score through its effect on earlier success measures.

Both economic awareness and attitudes towards economics are also important, even in the latter weeks of the class when this second and final writing assignment was administered. The students who succeed on the complex writing assignment all things equal are those who come into the course with a higher level of understanding of economic facts and who are predisposed towards the discipline. This suggests that high school economic education programs, for example, may raise the interest and knowledge of students coming into a university level course and therefore have a direct contributory effect on the students ability to do well and especially to succeed at higher levels of complexity.

Among the student characteristics, there is a suggestion that female students do significantly better and black students do worse. However, the effect of race, which is significant in Module 3, may actually be mitigated by the success on the earlier graded instruments (*examscore* and *writing1*). Hence the suggestion of the results is that earlier intervention for students at risk is most important.

Finally, the online students show no significant difference in the ability to think and write at a complex level. This finding is at odds with the conclusions drawn by Brown and Liedholm (2002) who found that their online students could not score as high as the face-to-face counterparts on complex problems. It may be that the differences are attributable to the fact that they used multiple-choice questions to measure this effect and we have used a essay/short paper written assignment.

Student Success on the standardized post-test

Table 4 reports the regression results for student success on the final exam. The final exam is given in its total and broken down into its components of recognition, simple application and complex application. At the top of the table you can see that generally the online students score higher than the face-to-face students and the scores are highest on the recognition and lowest on the complex; the exception being the curiously high score on complex for the face-to-face class. This and other indications within the analysis to date points out the sensitivity to the small sample in this research and we anxiously await being able to add a second semester's results to the database.

What is consistent in the results across all of the four models 5 to 8 is the strength of *age* and undeclared major. Those who do not have a declared major are uniformly at a disadvantage while those who are older have a significant advantage. This is not a proxy for being new in ones student career as the results are the same when the variable *Freshman* is included. It apparently is picking up some kind of seriousness or commitment to an academic career. Doing well on the pretest is a signal that one will do well on the final, while *GPA* is insignificant except in the complex equation suggesting that a higher general academic aptitude helps students succeed on the most complex questions. There is no evidence that economic awareness or attitudes towards economics held at the beginning of the term have any significant effects at the end of the term. Females appear to do worse in economics across the board, but the results are very weak.

Taking the class online once again is not significantly related to ultimate outcome. Online and face-to-face students score approximately the same after controlling for the important determinants of student success as given in our model. Further analysis, not shown here, suggests that there might be some evidence of an interaction effect between the variables *online* and *fem*. While the results are not strong, they suggest that for the complex final score alone, males in the online class score about 6 points higher and online females score over 20 points lower than their face-to-face counterparts. This will be a focus of reinvestigation when the current semester results are added to the database.

Conclusion

Students in the online and face-to-face course have similar failure and dropout rates (approximately 10 percent and 5.5 percent respectively), but due to the competency based mastery learning instructional design the final grades awarded show 72 percent of the online students earn B or better while only 45 percent do in the face-to-face class. Students completing the online mastery learning class earn higher grades and cover more content than their face-to-face counterparts. When subjected to multiple regression analysis based on a model of student success, where success is measured by commonly administrated instruments, online and face-to-face students do not score significantly differently. If Brown and Liedholm (2002) are correct that students in an online class, based on a similar instructional design to the face-to-face class, can not reason at as high a critical level, then this paper suggests a solution. A major premise of this study is that the instructional design for the online and the face-to-face class offerings need not be the same and indeed need to be tailored to the mode of course delivery. Mastery learning may be ideal for the online student and the results of this study suggest that complex reasoning is identical between the online and face-to-face students.

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Table 1: Variable Definitions and Prior Expectations

Success Measures	
Examscore	A percentage correct score (scaled as 100 for 100%) on questions asked over the first six chapters of the required textbook. This is created by the score on the first in-class examination in the face-to-face class and the average of the scores over the first three module quizzes in the online course. (Students who do better on this first examination are expected to score higher on the Writing2 assignment.)
Writing1	Number correct out of 10 points to a written assignment designed at the level of analysis of Bloom's taxonomy. Question was "An increase in the tax rate on cigarettes in Ohio is likely to be an effective way to reduce smoking, especially among the youth." (Prior expectation is that those who do well on this assignment will do better on the complex writing2 assignment.)
Writing2	Number correct out of 10 points to a written assignment designed at the level of synthesis in Bloom's taxonomy. Question was "what is going on in the national economy and how does this compare and contrast with what is going on in our regional economy here in Ohio? How does all this affect your employer's business? What solutions would you suggest to your employer with regard to how s/he runs the business in coming months?"
Initial Endowments	
Pre-test	percentage correct (scaled as 1 for 100%) on a 40 item pre-test administered at the beginning of the class (positive)
Recog_ptst	percentage correct (scaled as 1 for 100%) of the 13 items of the pre-test that assess recall and recognition (positive)
Apply_ptst	percentage correct (scaled as 1 for 100%) of the 14 items of the pre-test that assess simple applications of economic principles (positive)
Complex_ptst	percentage correct (scaled as 1 for 100%) of the 13 items of the pre-test that assess complex reasoning to economic principles (positive)
GPA	Cumulative GPA across all college work (positive)
Previous	Binary variable indicating having taken the course at least once before (no prior)
Awareness	
Survey	Number of correct answers from a 20-item survey of economic facts to assess the level of awareness of various trends and facts in the economy (positive)
News_high	Binary variable equal to 1 if the student reports collecting news about business and economics for 2 or more hours per week (positive)
Attitudes	
Attitudes	average of three variables: (1) pre_interest – whether the student reports being interested in economics, (2) pre_like – whether the student reports that they expect to like the economics class, and (3) pre_take_other – whether the student reports that they expect to take more economic courses after this one. The scales for each are 5=strongly agree, 4=agree, 3=no opinion, indifferent, 2=disagree, and 1=strongly agree (positive)
Student Characteristics	
Major	binary variables equal to one if the student is an engineering major (engmajor), an undecided or undeclared major (undecmajor), or other major (othermajor) (no prior)
Freshman	Freshman status (negative)
Credits	Total cumulative credits earned in college (no prior)
Fem	binary variable equal to 1 if the student is female (no prior)
Black	binary variable equal to 1 if the student is black (no prior)
Age	student's age during the first week of school (no prior)
Course modality	
Online	a binary variable equal to 1 if the student is taking the online course and equal to 0 if face-to-face (no prior)

Table 2: Means of Variables

	Combined		Face-to-face		Online		
Name	N	mean (Std dev)	N	mean (Std dev)	N	mean (Std dev)	
Examscore	90	78.00 (12.71)	72	75.51 (12.15)	18	87.96 (9.84)	***
Writing1	80	8.23 (1.03)	66	8.20 (1.07)	18	8.36 (0.84)	
Writing2	71	6.54 (1.67)	58	6.48 (1.54)	18	6.77 (2.24)	
Pre-test	89	0.46 (0.11)	71	0.45 (0.12)	18	0.47 (0.08)	
Recog_ptst	89	0.47 (0.14)	71	0.46 (0.14)	18	0.53 (0.14)	*
Apply_ptst	89	0.48 (0.15)	71	0.48 (0.15)	18	0.47 (0.11)	
Complex_ptst	89	0.42 (0.16)	71	0.42 (0.17)	18	0.41 (0.13)	
GPA	91	2.94 (0.63)	73	2.94 (0.66)	18	2.93 (0.50)	
Previous	91	0.14 (0.35)	73	0.12 (0.33)	18	0.22 (0.43)	
Survey	89	8.78 (2.43)	71	8.80 (2.33)	18	8.67 (2.87)	
News_high	91	0.25 (0.44)	73	0.21 (0.41)	18	0.44 (0.51)	**
Attitudes	84	3.38 (0.75)	66	3.30 (0.76)	18	3.70 (0.61)	**
Pre_interest	84	3.73 (0.77)	66	3.67 (0.79)	18	3.94 (0.64)	
Pre-like	84	3.62 (0.83)	66	3.58 (0.80)	18	3.78 (0.94)	
Pre_take_more	84	2.81 (1.24)	66	2.65 (1.17)	18	3.39 (1.33)	**
Engmajor	91	0.47 (0.50)	73	0.45 (0.50)	18	0.56 (0.51)	
Undecmajor	91	0.45 (0.50)	73	0.51 (0.50)	18	0.22 (0.43)	**
Othermajor	91	0.08 (0.27)	73	0.04 (0.20)	18	0.22 (0.43)	*
Freshman	91	0.48 (0.50)	73	0.53 (0.50)	18	0.28 (0.46)	*
Credits	91	39.95 (40.15)	73	34.25 (36.55)	18	63.06 (46.57)	***
Fem	91	0.21 (0.41)	73	0.12 (0.33)	18	0.56 (0.51)	***
Black	91	0.05 (0.23)	73	0.04 (0.20)	18	0.11 (0.32)	
Age	91	20.68 (3.66)	73	20.37 (3.74)	18	21.94 (3.11)	
Online	91	0.20 (0.40)					

Standard deviations are in parenthesis. Results of tests of significance difference in the means marked for the following significance levels: * .10, ** .05, *** .01.

Table 3: Regression Results: Dependent Variable is Examscore or Writing2

Variable	Model 1 Examscore		Model 2 Examscore		Model 3 Writing2		Model 4 Writing2	
Intercept	46.317	***	45.681	***	1.437		-2.915	
	(4.34)		(4.45)		(0.65)		(-1.08)	
Examscore							0.052	**
							(1.70)	
Writing1							0.328	*
							(1.66)	
Pre-test	40.972	***						
	(4.51)							
Recog_ptst			-3.788		-2.811		-3.065	
			(-0.55)		(-1.74)		(-1.99)	
Apply_ptst			21.725	***	-1.091		-2.147	
			(3.00)		(-0.67)		(-1.33)	
Complex_ptst			22.285	***	4.358	***	4.333	***
			(3.22)		(2.61)		(2.60)	
GPA	3.980	**	4.678	***	0.604	*	0.196	
	(2.08)		(2.51)		(1.43)		(0.46)	
Previous	-8.522	**	-9.632	***	-0.645		-0.929	
	(-2.63)		(-3.06)		(-0.73)		(-1.06)	
Survey	0.905	**	0.694	*	0.254	**	0.229	**
	(1.92)		(1.50)		(2.15)		(2.01)	
News_high	0.340		0.985		-0.522		-0.232	
	(0.14)		(0.42)		(-0.97)		(-0.45)	
Attitudes	2.441	**	2.735	**	0.681	**	0.551	*
	(1.75)		(1.99)		(1.97)		(1.63)	
Undecmajor	-7.122	***	-7.147	***	-0.330		0.153	
	(-2.93)		(-3.04)		(-0.64)		(0.29)	
Othermajor	-0.070		0.245		-1.739	*	-1.681	*
	(-0.02)		(0.06)		(-1.88)		(-1.91)	
Freshman	-2.745	*	-1.888		-0.474		-0.274	
	(-1.30)		(-0.90)		(-1.02)		(-0.61)	
Fem	-1.740		-2.035		1.071	*	1.345	**
	(-0.62)		(-0.74)		(1.71)		(2.16)	
Black	-6.847		-6.878		-3.696	**	-2.183	
	(-1.43)		(-1.49)		(-2.11)		-1.22	
Age	-0.485	*	-0.510	*	-0.041		-0.056	
	(-1.77)		(-1.94)		(-0.70)		(-0.93)	
Online	10.301	***	11.867	***	0.187		-0.419	
	(3.75)		(4.38		(0.30)		(-0.61)	
N	81		81		66		65	
F	9.85	***	9.71	***	1.78	*	2.25	**
$\bar{R}^2$	0.59		0.62		0.15		0.25	

Student t-statistics in parenthesis.
Significance levels: * .10, ** .05, *** .01.

Table 4: Regression Results: Dependent Variable is Final Exam Score

Variable		Model 5 Final Exam		Model 6 FE_Recog		Model 7 FE_Apply		Model 8 FE_Complex	
Dep. Var Mean		*.69*		*.72*		*.68*		*.68*	
Face-to-face mean	*N=63*	*.68*		*.70*		*.67*		*.70*	
Online mean	*N=14*	*.72*		*.82*		*.70*		*.62*	
Sig. difference?		*NO*		*YES*		*NO*		*YES*	
Intercept		0.437	***	0.501	***	0.420	***	.353	**
		(3.74)		(3.16)		(2.68)		(2.16)	
Pre-test		0.118							
		(1.04)							
Recog_ptst				0.202	**				
				(1.69)					
Apply_ptst						0.221	**		
						(1.81)			
Complex_ptst								0.097	
								(0.79)	
GPA		0.003		-0.020		-0.010		0.038	**
		(0.19)		(-0.94)		(-0.44)		(1.69)	
Previous		0.042		0.084		0.082		-0.011	
		(1.04)		(1.44)		(1.44)		(-0.18)	
Survey		-0.001		-0.007		-0.004		0.005	
		(-0.24)		(-0.84)		(-0.52)		(0.60)	
Attitudes		0.004		0.025		-0.003		-0.013	
		(0.22)		(1.00)		(-0.12)		(-0.49)	
Undecmajor		-0.113	***	-0.155	***	-0.080	**	-0.102	***
		(-4.14)		(-4.06)		(-2.10)		(-2.62)	
Othermajor		-0.048		-0.043		-0.024		-0.067	
		(-0.91)		(-0.58)		(-0.33)		(-0.89)	
Fem		-0.052		-0.023		-0.073		-0.083	
		(-1.47)		(-0.48)		(-1.43)		(-1.65)	
Black		0.031		0.043		-0.010		0.062	
		(0.37)		(0.37)		(-0.09)		(0.56)	
Age		0.012	***	0.011	**	0.013	***	0.012	***
		(3.54)		(2.35)		(2.78)		(2.57)	
Online		0.002		0.008		0.011		-0.048	
		(0.04)		(0.14)		(0.19)		(-0.82)	
N		71		71		71		71	
F		3.52	***	3.30	***	2.11	**	2.70	***
$\bar{R}^2$		0.28		0.27		.15		.21	

Student t-statistics in parenthesis.
Significance levels: * .10, ** .05, *** .01.

Final Exam = percentage score on final exam
FE_Recog = percentage score on the recall and recognition questions on the final exam
FE_Apply = percentage score on the simple application questions on the final exam
FE_Complex = percentage score on the complex application and analysis questions on the final exam

Appendix
Grading Rubric Used in the Writing Assignment

Level of Achievement	General Presentation	Reasoning, Argumentation
Exemplary (10 pts)	• Provides a clear and thorough introduction and background • Addresses the question • Presents arguments in a logical order using appropriate tools from class • Uses acceptable style and grammar (no errors)	• Demonstrates an accurate and complete understanding of the question • Uses several arguments and backs arguments with examples, data that support the conclusion
Quality (8 pts)	• Combination of above traits, but less consistently represented (1-2 errors) • Same as above but less thorough, still accurate	• Uses only one argument and example that supports conclusion
Adequate (6 pts)	• Does not address the question explicitly, though does so tangentially • States a somewhat relevant argument • Presents some arguments in a logical order • Uses adequate style and grammar (more than 2 errors)	• Demonstrates minimal understanding of question, still accurate • Uses a small subset of possible ideas for support of the argument
Needs improvement (4 pts)	• Does not address the question • States no relevant arguments • Is not clearly or logically organized • Fails to use acceptable style and grammar	• Does not demonstrate understanding of the question, inaccurate • Does not provide evidence to support response to the question
No Answer (0 pts)		

[1] In Fall 2001, Spring 2002, and Fall 2002 85 percent of students earned As or Bs with most being As. There were 13 percent withdrawals or failures in the MBA version of this course. Fall 2002 is the first full semester for this online course at the undergraduate level, which is the subject of this study.

[2] Some examples of student distress in online courses can be seen in Hara and Kling (2001).

[3] WebCT offers a selective release mechanism that will open future modules as modules are completed, however, much of the navigation relies on the manual opening of modules and module quizzes since WebCT can not handle multiple selective release criteria, nor count the number of times that a student has completed a quiz as part of the selective release mechanism. Additional desirable features of WebCT could include the ability to lock out test questions from ever being repeated to a student once asked and to automatically email warnings and messages to individual students based on certain criteria, e.g., achieving too low of a score or having not logged on in too many days.

[4] The questions are: i. What comments do you have on this module and your experience in completing it? ii. What main point have you learned that you did not fully understand before? iii. What questions do you have at this time? Include any points that still remain muddy or unclear. Do consider posing the muddy points to your fellow students in the discussions. iv. What recommendations do you have for us as we continue to change and enhance the course?

[5] Additionally they find that the improvement to the student's economic knowledge is not significantly related to the instructor or the students' ability level. If Maki and Maki (2002) that distance learning benefits the strongest, then the use of the CATs may be a proportionally more valuable addition for the weaker students.

[6] Chizmar and Walbert (1999) discuss the minute paper as encouraging contacts between students and faculty.

[7] What we include as initial endowments, Chizmar and Ostrosky (1998) calls aptitude in economics (for the pre-test score) and aptitude in all other courses (for GPA). Our variable measuring previous attempts of the course would have to come under their aptitude in economics, but they did not include such a variable.

[8] Pre and post testing have been used in much of the literature to assess the value added to students by taking a certain course and in comparison studies. One example is from Chizmar and Ostrosky (1998) who used the TUCE (Test of Understanding of College Economics). The TUCE has come under criticism for a variety of reasons and we decided that we wanted to measure learning on a set of content standards with which we were comfortable. This can be seen as only a weak response to Walstead's call for "new standardized tests in economics to measure outcomes from economic courses and for evaluations of teaching innovations in economics." (Walstead (2001)).

[9] The actual rubric is at http://www.flaguide.org/cat/rubrics/rubrics3.htm. The homepage www.flaguide.org is the Field-tested Learning Assessment Guide for science, math, engineering and technology instructors. The guide is based at the University of Wisconsin-Madison.