Pretesting Students to Improve Teaching and Learning

By: Scott Simkins and Stuart Allen

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Abstract:

The focus of this paper is on developing ways to evaluate teaching performance on a regular basis as a means of improving teaching effectiveness and increasing student learning in the classroom. In particular, this paper shows how an instructor-developed pretest, when given at the start of an introductory economics course as part of a pre- and post-test strategy, can be used as a diagnostic and developmental tool for instructors to assess and improve teaching effectiveness. Evidence of students' deficiencies in basic economic and math or graphing skills has led to making changes in content and delivery to increase students' chances of success in the economics course. In addition, pre- and post-test results can be used to determine which economic concepts are being taught effectively and which areas need improvement. (JEL A2)

Article:

Introduction

Teaching assessment is a contentious issue in college education. Yet, like it or not, as universities have faced increased pressure in recent years to refocus their efforts on teaching effectiveness, the assessment of teaching and student learning has become more important for both universities and professors. In most cases, teaching assessment is carried out as a means of evaluating teaching at the end of a process (for example, tenure or promotion) rather than as a means of improving it throughout that process. The focus of this paper is on developing ways to evaluate teaching performance on a regular basis as a means of continually improving teaching effectiveness and increasing student learning in the classroom.[1] In particular, this paper shows how an instructor-developed pretest, when given at the start of an introductory economics course as part of a pre- and post-test strategy, can be used as a diagnostic and developmental tool for instructors to assess and improve teaching effectiveness.

Background Information

This study is based on pre- and post-tests given to 179 students enrolled in the Principles of Macroeconomics course during the 1995 spring semester at the University of North Carolina at Greensboro, a medium-sized state university.[2] Table 1 provides the selected attributes of students included in this data. The typical student is a single, white, 20-year-old sophomore, taking 12 to 15 semester credit hours of courses, with a Scholastic Assessment Test (SAT) score (verbal plus quantitative) of about 940 (prior to recentering) and a cumulative grade-point average (GPA) of about 2.8. The student is likely to live off campus and works about 16 hours per week in addition to going to school. This student generally completed the prerequisite Principles of Microeconomics course in the previous semester and has taken at least one semester of college algebra and most likely a semester of calculus as well.

The pretest covers basic economic concepts and mathematical skills and includes nine multiple-choice questions, four short mathematical problems, and a graphing exercise.[3] There are other (standardized) pretests that could have been employed in this study, such as the widely used Test of Understanding in College Economics (TUCE).[4] However, the TUCE requires the utilization of two class periods to conduct

pre- and post-tests, focuses only on economic concepts, and reflects more Keynesian-oriented content than is typically included in these courses. The reason for developing this pretest is to determine the link between mathematical and graphing ability, previous economic knowledge, and course performance. The ability to develop course-specific content is a significant advantage in using an instructor-developed pre- and post-test rather than a standardized test.

TABLE 1
Selected Attributes of Students in the Study

Student Attribute	Percent of Students	Student Attribute	Percent of Students
Age		**Hours Worked per Week**	
18-21	73.6	0 hours	34.9
22-26	16.0	0 < hours < 10	5.7
27-30	2.9	10 < hours < 20	24.5
Over 30	7.5	20 < hours < 30	20.7
		30 < hours < 40	8.5
		Hours > 40	5.7
Sex		**Living Arrangements**	
Male	55.7	Home	28.3
Female	44.3	On campus	34.9
		Off campus, other than home	36.8
Race*		**Principles of Microeconomics Taken**	
White	81.1	During prior semester	84.0
Black	8.5	During prior summer session	1.0
Asian	7.5	Two semesters ago	7.5
Hispanic	1.9	More than one year ago	7.5

TABLE 1 (CONT.)

Student Attribute	Percent of Students	Student Attribute	Percent of Students
GPA Coming into Course		**Math Level Coming into Course****	
GPA < 1.5	1.9	High school algebra	5.8
1.5 < GPA < 2.5	28.3	College algebra	24.0
2.5 < GPA < 3.5	44.3	Calculus (one semester)	61.5
GPA > 3.5	25.5	More than one semester of calculus	8.7
Class		**Statistics Level Coming into Course****	
Freshmen	13.2	None taken yet	64.4
Sophomores	54.7	Currently enrolled in business statistics	28.8
Juniors	23.6	One semester of business statistics completed	3.8
Seniors	6.6	Transferred credit for business statistics	2.9
Other	1.9		
Entering SAT, Total Score**			
SAT < 800	7.1		
800 < SAT < 900	22.9		
900 < SAT < 1000	32.9		
1000 < SAT < 1100	18.6		
1100 < SAT < 1200	7.1		
1200 < SAT < 1300	11.4		

Notes: *There is one missing value for this variable. **There are only 70 observations for SAT scores because entering SAT scores were not available for the 36 transfer students in this sample. Reported SAT scores are prior to the recentering process. ***There are two missing values for this variable. The student attributes are based on a 106-student subsample of the 179 students in this study who gave permission to use information provided in a student questionnaire and to obtain information from their student files. Despite the smaller number of students in this subsample, it is felt that the distribution of attributes within this group is representative of the entire sample of students.

Pretesting as a Diagnostic Tool

Overall, the pretest results provide useful information about the knowledge that students bring into the course. To the extent that this preexisting knowledge is correlated with course performance, the pretest results can be used to give students and instructors early feedback on the need for assistance while there is time to take corrective action through tutoring, extra homework assignments, improved note-taking skills, and other remedial help. In addition, the pretest results provide a benchmark for assessing teaching effectiveness at the end of the course.[5]

Pretest Results for Individual Questions

Pretest results are given in Table 2. The second column lists the percentage of students correctly answering each of the pretest questions. Among the questions pertaining to economic concepts (Section A), most of the percentages are in the .25-.50 range (random guessing would lead to a score of .25), although more than half the students correctly answered two of the macroeconomic questions prior to the start of the course. Surprisingly, despite having taken the prerequisite Principles of Microeconomics course, fewer than half the students could answer the two microeconomic questions (1-2) correctly.[6]

TABLE 2
Percentage of Students Answering Correctly and Correlation with Final Exam Scores

Question Numbers and Topics	Percent of Students	Correlation with Final Exam Scores
Section A: Economic Concepts		
1. Supply and Demand Shifts	.39	.22
2. Supply and Demand Equilibrium	.46	.28
3. International: Exchange Rates	.35	.01
4. Aggregate Demand and Supply	.53	.17
5. Business Cycle Fact	.59	.23
6. Aggregate Demand and Supply	.27	-.01
7. Economic Growth	.34	.12
8. International: Fact	.22	.21
9. Economic Growth and Productivity	.22	.17
Section B: Graphing and Algebraic Concepts		
1. Percentage Change	.60	.30
2. Fraction as Decimal	.75	.10
3. Algebraic Function	.31	.15
4. Compound Interest	.47	.07
5. Graphing	.69	.30

Notes: Questions in both sections were multiple-choice. The number of students in the sample was 179.

The results in Section B of Table 2 summarize students' incoming mathematical and graphing abilities. Nearly all of the students had completed college algebra prior to their enrollment in this course, and over 60 percent had completed one semester of calculus. Despite this background:

1) 40 percent of the students could not calculate a percentage change (no limitations were placed on using a calculator, though most students did not);
2) 25 percent of the students could not convert 1/8 to a decimal equivalent;
3) 69 percent of the students could not identify the incremental change in a dependent variable due to a change in the independent variable, given an algebraic expression (a Keynesian consumption function); and
4) fewer than 50 percent of the students could draw a line illustrating a positive relationship between two variables (although nearly all could label the axes correctly, given explicit instructions).[7]

What can be made of these results? The pretest results suggest a serious lack of retention of basic economic, mathematical, and graphing skills among the Principles students. However, it is critical that students gain a firm grasp of these concepts if they are to succeed in the typical introductory macroeconomics course. Hafer and Hafer [1998] also make this point, emphasizing the positive correlation between graphing and math skills and student performance in the course. Studies by Evensky et al. [1997], Brasfield et al. [1992], and Lopus and Maxwell [1995] have reached similar conclusions. Based on these studies and the pretest results here, greater care is now taken to build student skills in these areas early in the introductory macroeconomics

course by assigning a variety of homework exercises and short quizzes, emphasizing basic microeconomic concepts, graphing, and data computation.

Correlation of Pretest Scores with Final Exam Scores

In addition to measuring students' incoming knowledge of basic economic, mathematical, and graphing concepts, students' pretest scores help predict student performance on the cumulative final exam, which includes multiple-choice, short-answer, problem-type (analytical or graphing), and essay questions. Overall, the correlation between the total pretest score and the final exam score is 0.42 for the sample of students, suggesting that pretest scores are a useful indicator of student success in the course. Given this result, instructors could use the pretest as a diagnostic tool to determine which students might need additional help to improve their performance in the course.

Simple correlations of individual pretest question performance with final exam scores are listed in the third column of Table 2.[8] Note that four of the five questions exhibiting the highest correlations with final exam scores represent prerequisite skills and knowledge: two mathematical questions testing graphing and percentage-change concepts and two microeconomic questions covering the concepts of supply and demand. This evidence reinforces the importance of prior microeconomic and mathematical skills as a basis for success in this macroeconomics course.

Regression Results

Are the pretest results really useful for predicting student success in the course or are they simply serving as a proxy for other student attributes, such as prior GPA or incoming SAT scores, that would better predict student success in this course? To answer this question, examine the relationship between the students' final exam performance and a variety of student attributes. The analysis was based on 70 observations (106 students gave permission to use student attribute data but SAT scores were unavailable for 36 transfer students included in the sample), using ordinary least squares regressions.[9] The results of this analysis are summarized in Table 3.

This paper employs the traditional framework of the knowledge production function, used in most economic education research on pre- and post-tests of knowledge. In this framework, a student's postknowledge at the end of a course is modeled as a function of his preknowledge coming into the course, along with student, instructor, and class attributes that affect learning during the course (for example, work effort by students, class size, enthusiasm of instructor). The focus of this paper examines the degree to which a student's preknowledge can be used to predict overall performance in the Principles of Macroeconomics course, so nearly all of the student attributes that were examined deal with information known at the beginning of the course.

First, a regression model was analyzed that included only variables summarizing students' intellectual abilities and past academic performance coming into the course (SAT scores and cumulative GPA). The results for this model (Model 1 in Table 3) indicate that a student's GPA coming into the course is the dominant predictor of success in the course, even when SAT scores are included in the regression. The coefficient on the GPA variable has the expected sign and is significant at well below the 1 percent level. When pretest scores are added to the regression model (Model 2 in Table 3) the GPA variable remains highly significant along with the pretest score. This simple model explains about 40 percent of the observed variation in final exam scores.

Also estimated were regression equations that included a variety of additional student attributes, including student age, level of previous math experience, credit hours earned, and grade in the prerequisite Principles of Microeconomics course. In addition, a time commitment variable was included that was intended to measure the time constraints faced by students while enrolled in this course. This variable was constructed by multiplying each student's current semester-hour course load by 3.0 (based on the rule of thumb that each

student should be spending three hours outside of class for every hour in class during the week) and adding weekly work hours. Model 3 is representative of the types of models that included the wider set of student attributes.[10]

TABLE 3
Regression Results: Pretest as Predictor of Student Course Performance

Independent Variable	Parameter Estimate					
	Model 1		Model 2		Model 3	
Constant	16.559	(.1360)	16.513	(.1200)	29.085	(.1930)
SAT Score, Verbal	0.028	(.0980)	0.017	(.3170)	0.007	(.6900)
SAT Score, Quantitative	0.022	(.3120)	0.003	(.1450)	-0.011	(.6170)
GPA at Start of Course	10.558*	(.0001)	11.565*	(.0001)	8.395*	(.0050)
Score on Pretest			1.285*	(.0100)	1.417*	(.0030)
Student Age					-0.237	(.8040)
Level of Math** Coming into Course					-0.001	(.5760)
Out-of-Class Time Commitment***					-0.165	(.1330)
Semester Hours Earned at Start of Course					0.141	(.0520)
Grade for Principles of Microeconomics†					4.565	(.0060)
F-statistic	13.570	(.0001)	12.893	(.0001)	7.820	(.0001)
Number of Observations	70		70		70	
Adjusted R^2	.35		.41		.47	

Notes: *denotes significance at the 5 percent level. **denotes high school algebra = 1, college algebra = 2, one semester of calculus = 3, more than one semester of calculus = 4. ***denotes out-of-class time commitment = [(3 x current semester credit hours)+(current semester employment hours)]. † denotes A = 4, B = 3, C = 2, D = 1, and F = 0. Dependent variable is score (percent correct) on final exam. p-values are in parentheses.

For present purposes, the most important result from Model 3 is that the pretest score remains highly significant (with the expected sign) even after controlling for a wide variety of student background attributes. Another variable that is statistically significant at the 5 percent level is the student's grade in the Principles of Microeconomics course. According to the data, students who performed well in the introductory microeconomics course are more likely to do well in macroeconomics, even after taking into account the GPA and pretest scores. This result is consistent with the simple correlation findings reported earlier: knowledge of basic microeconomic skills is positively correlated with achievement in the Principles of Macroeconomics course. In addition, a student's level of college experience, measured by earned semester hours of academic credit prior to the course, is nearly significant at the 5 percent level. This may reflect the notion that either many lower achieving students leave the university before they graduate (leaving a smaller

pool of relatively higher achieving students as each cohort of students advances) or students develop better learning skills and analytical ability as they acquire more college experience.

Overall, the regression results support those reached earlier based on simple correlations: knowledge of basic skills (such as microeconomic and mathematical concepts) increases students' chances of performing well in macroeconomics, regardless of their GPA level. The regression results also strongly suggest that the pretest can be used to identify students who are likely to perform poorly in the Principles of Macroeconomics course. For these students, increased attention to the development of basic microeconomic concepts and mathematical skills are critical to success in the introductory macroeconomics course.

Pretesting as a Developmental Tool

To measure student learning, the 179-student sample was used to calculate pre- and post-test response patterns for a six-question subset of the nine micro and macro questions that appeared on the pretest. Particular interest is paid to what percentage of the students answered these questions correctly on the comprehensive fmal exam compared with the pretest. While a simple set of multiple-choice questions cannot hope to fully measure student learning, the pre- and post-testing strategy employed in this study provides valuable insight to the degree that students are learning specific course concepts. In particular, information gained from this testing procedure can be used to suggest areas of improvement to increase student learning in the course. In addition, to the extent that the pretest questions are related to course objectives and goals, this information can also be used to measure success in achieving those goals.[11]

The pre- and post-testing results are listed in Table 4. Columns Al and A2 indicate the percentages of students answering each question correctly on the pretest and final exam, respectively. The fact that the mean on the final exam is higher for each question than the mean on the pretest represents one measure of student learning, or value added during the course.

To obtain a more comprehensive view of student learning, students' pretest and final exam responses (correct and incorrect) were examined for the six questions. The percentage of students who fall into the four possible pretest and final exam response combinations are listed in columns B 1, Cl, D1, and El of Table 4.[12] In assessing student learning, the focus is on column El which lists the percentage of students who were able to answer a question correctly on the final exam after incorrectly answering the question on the pretest. This column represents value added, the percentage of students who gained knowledge during the course. Based on this methodology, the higher this number, the more value added in terms of student learning.

The remaining columns provide additional information about teaching effectiveness and student learning. Column Bl indicates the percentage of students who have lost knowledge. These students likely guessed the correct answer on the pretest but answered incorrectly on the final exam. Columns C 1 and D1 indicate the percentage of students who appear to have neither gained nor lost knowledge during the semester. Of the two groups, those in column C 1 , those who failed to answer the question correctly on both the pretest and the final exam, are more troubling. These are the students whose knowledge has not been increased during the semester and represent a missed opportunity for increasing their learning in the classes.

Conditional Expected Frequencies

Two factors could affect the conclusions about student learning drawn from the results reported in Table 4. First, the ease of the pretest question affects the amount of measured additional learning, or value added, that is possible during the semester. Second, random guessing by students distorts the true amount of observed learning. To adjust for these two factors, compute expected frequencies for each of the categories listed in Table 4 (see the Appendix for a description of their derivation). The expected frequencies are based on conditional probabilities that take into account the ease of the question by using the distribution of pretest responses to determine the overall frequencies for the four possible categories. These frequencies reflect the results expected on the final exam, based on chance, given the observed pretest results.

To determine the extent to which value added has occurred, compare the expected conditional frequencies with those actually observed for each of the four categories, in particular, those in columns El and E2 of Table 4. Large differences between actual percentages and expected frequencies indicate that the result is unlikely to be due simply to chance.

TABLE 4
Measuring Student Learning Comparison of Pre and Post Responses

			Percentage of Students' Pretest and Final Exam Responses							
	Percent of Students Answering Correctly		Pretest: Correct Final: Incorrect		Pretest: Incorrect Final: Incorrect		Pretest: Correct Final: Correct		Pretest: Incorrect Final: Correct	
Question Number and Subject Area Example	Pretest (A1)	Final Exam (A2)	Actual (B1)	Expected Frequency (B2)	Actual (C1)	Expected Frequency (C2)	Actual (D1)	Expected Frequency (D2)	Actual (E1)	Expected Frequency (E2)
1. Microeconomics: Shift of supply and demand	.39	.53	16.80	18.75	30.70	45.75	21.80	20.25	30.70	15.25
2. Microeconomics: Actual price < equilibrium price	.46	.60	12.80	18.75	27.40	40.50	33.50	27.25	26.30	13.50
3. International: Exchange rate and trade	.35	.68	7.80	18.75	24.60	48.75	27.40	16.25	40.20	16.25
4. Macroeconomic policy	.53	.82	10.10	18.75	8.40	35.25	42.50	34.25	39.10	11.75
5. Macroeconomics: Business-cycle fact	.59	.75	11.20	18.75	13.40	30.75	48.00	40.25	27.40	10.25
6. Long-run growth standard of living	.34	.67	9.50	18.75	23.50	49.50	24.60	15.25	42.50	16.50

Interpreting the Results

The results in Table 4 indicate evidence of considerable value added in the introductory macroeconomics course, especially regarding the macroeconomic questions (3-6). The percentage of students improving their performance on the final exam relative to the pretest (column El) is 2.5 to 3.3 times greater than the expected frequencies (column E2) for these questions. In addition, the percentage of students who correctly answered the macroeconomic pretest questions but answered these questions incorrectly on the final exam (column B1) is small relative to the expected frequency (column B2). Recall that this expected frequency reflects the percentage of students expected if students guessed on both the pretest and final exam questions.

While the results for the macroeconomic questions were encouraging, students showed less value added for the two microeconomic questions (1-2). The value added is only about two times greater than the expected frequencies for these questions. In addition, a comparison of columns B1 and B2 show that the actual and expected frequencies are similar, a result consistent with random guessing. These results suggest a lack of retention of basic microeconomic skills and again lead to conclude that at the margin, teaching resources should be shifted to basic microeconomic concepts such as supply and demand. The correlation and regression results discussed earlier indicate that an improvement in students' skills in this area will have a positive effect on course performance.

Conclusions

The pretest described here provides an example of a simple tool that can be developed and used by instructors to assess fundamental student skills at the beginning of the course and measure teaching effectiveness, as defined by value added during the course. The advantage of this type of tool is that it is quite flexible and can be used by individual instructors in a wide variety of courses. Using the pretest at the

beginning of the semester to measure students' incoming knowledge of course-related concepts and then post-testing students at the end of the course using the same questions provides valuable information that can measure student learning, suggest areas for teaching improvement, and improve course delivery.

In the introductory macroeconomics course, the pre- and post-test results have led to a change in teaching strategies in a number of ways. Overall, the exercise reinforced the importance of understanding basic microeconomic and mathematical concepts for student success in the macroeconomics course. Reinforcement of basic microeconomic concepts is essential for increased learning during the course. Instructors can now assume less knowledge of basic microeconomic concepts, such as market equilibrium and interpretation of demand and supply shifts, and focus more attention on these basic concepts early in the course. Basic math and graphing skills are also reinforced by including additional homework assignments and incorporating in-class group exercises and other active learning activities throughout the course. Because these courses rely heavily on basic graphical analysis and continual use of fundamental microeconomic concepts, additional practice in these areas will help improve student learning and performance.

The level of teaching is improved by carrying out the type of instructor-developed pre- and post-testing procedure illustrated here because it encourages instructors to critically evaluate course objectives and goals, and to assess the quality of their teaching. When used as a developmental tool, the pre- and post-testing strategy provides a useful means of continually improving teaching effectiveness and student learning.

Appendix

The following example illustrates how the expected conditional frequencies in Table 4 are computed. Consider a pretest question where 80 percent of the students answered correctly. For the 20 percent of the students who answered incorrectly, assume that their probability of correctly (incorrectly) answering the question on the final exam is 25 percent (75 percent), the expected value if all four answers had equal probability of being chosen. The expected conditional frequency of an incorrect answer on the final exam, given the incorrect answer on the pretest, is therefore (.20)(.75) = 0.15. The expected conditional frequency of a correct answer on the fmal, given an incorrect answer on the pretest, is consequently (.20)(.25) = 0.05. The latter (0.05) would be the number reported in column E2 for this question, while the former (0.15) would be the number reported in column C2. Note that these expected frequencies depend on the actual distribution of incorrect and correct answers on the pretest and, hence, will vary from question to question. For example, questions with a larger percentage of students answering the pretest question incorrectly will increase both expected frequencies.

For those students who answered the pretest question correctly but answered the same final exam question incorrectly, there are two possibilities. The student either lost knowledge or guessed in both cases. The latter is assumed. Thus, the conditional expected frequency of answering the final exam question incorrectly, given that the pretest question was answered correctly by guessing is (.25)(.75) = 0.1875. This is the expected frequency shown in column B2. Note that this number does not depend on the actual distribution of pretest results. It simply reflects the expected frequency of students in this category due to chance.

For those students who answered the question correctly on both the pretest and the final exam, there are also two possibilities. The student either knew the answer on the pretest and the final exam or guessed correctly in both cases. Both possibilities are added together to obtain the expected frequency for this outcome. With four equally likely answers, random guessing would lead 25 percent of the students to correctly answer the question. Therefore, assume that the remainder, 0.80 (those who answered correctly) - 0.25 (those who guessed) = 0.55, knew the correct answer on both the pretest and final exam with a probability of 1. The resulting conditional probability for this group is 0.55. Those students who guessed correctly on both the pretest and the fmal exam have a conditional probability of (0.25)(0.25) = 0.0625. Thus, the conditional expected frequency of observing a correct answer on the final, given a correct answer on the pretest, is the fraction of students who knew the material at the start of the course (.55) plus the probability of guessing the

correct answer on both the pretest and fmal exam (.0625), which equals 0.6125. This is the expected frequency illustrated in column D2 of Table 4, and this also depends on the distribution of actual pretest results. This procedure is repeated for each of the questions analyzed, using the actual distributions of pretest results to compute the expected conditional frequency for that question.

Footnotes:

1. The issues of teaching quality and effectiveness are particularly important for economics departments. Over the last decade, enrollment in economics courses has dropped significantly, along with the number of majors. It is believed that continual improvement in teaching leads to increased student learning, and success in principles of economics courses increases the likelihood that students will enroll in additional economics courses.
2. The study includes 179 of 202 students, in three sections, who took the pretest on the first day of class and the final exam at the end of the course. Becker et al. [1996] point out that failure to consider missing data problems caused by students who left the course during the semester may bias test score results. However, the focus is on the value added during the semester for those students who completed the course. Of the 179 students in the sample, six failed the course in a previous semester.
3. The pretest is available from the authors upon request.
4. See Saunders [1991] for a summary of the TUCE (third edition) content and methodology.
5. The pretest counts as a quiz grade in the course, increasing the incentive for students to perform their best and providing a credible measure of students' economic, math, and graphing knowledge at the beginning of the course.
6. This figure is even more surprising given that over 80 percent of the students in this sample took the Principles of Microeconomics course in the preceding semester, and over 90 percent of the students took this course within the previous year.
7. On question 5 of section B, students were awarded l/2 point for correctly labeling the axes and l/2 point for correctly drawing a positively sloped line.
8. Multiple-choice and true-or-false questions accounted for less than 25 percent of the final exam score. Final exam scores were measured as a percentage of total points possible.
9. The distribution of student characteristics for this subsample of students is very similar to that of the 106-student sample reported in Table 1.
10. Models were studied using various combinations of the variables listed in Table 3, but, in each case, the results were qualitatively the same: the coefficient on the GPA and pretest score variables were always significant, while the coefficients on the remaining variables were not significantly different from 0 (at the 5 percent level).
11. Using the pre- and post-testing framework as a means of assessing student learning or teaching effectiveness in the classroom also raises some questions. First, can a set of multiple-choice questions fully reflect learning during a course? The best hoped for is that the pretest questions help to measure cognitive dimensions of learning, while fully realizing that learning can be measured across many dimensions. Second, will instructors "teach to the exam" and thereby affect the measured level of value added during the course? All standardized tests, including the TUCE, are prone to this criticism, not just instructor-developed tests such as the one illustrated in this paper. When used as a developmental tool to improve teaching (rather than as an evaluative tool), there is little incentive to teach to the exam.
12. This analysis is similar to the pre- and post-test analysis carried out by Saunders and Powers [1995] using the TUCE III data. They use the value-added approach to make suggestions on reallocating content coverage to increase student learning in the Principles of Microeconomics course. The one important difference between their analysis and this is that this analysis develops an expected conditional frequency measure to compare results against a randomly observed result.

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