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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

Appealing to Good Students in Introductory Economics

Elizabeth J. Jensen and Ann L. Owen

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Abstract: The authors examine the effectiveness of different teaching techniques using a unique data set that allows them to match student and instructor characteristics to assess their impact on students' interest in economics. They find that devoting less class time to lecture and more to discussion is effective for all types of students. However, the magnitude of the effects of these two techniques varies considerably by type of student, as does the impact of several other teaching techniques. They conclude that using a variety of teaching techniques is the most successful strategy to appeal to the broad range of learning styles adopted by "good" students.

Key words: economics majors, good students, pedagogy
JEL codes: A2, A22

Do the choices that instructors make about how to teach introductory economics classes and how to evaluate students affect students' decisions about continuing in economics? Are different types of students influenced by different factors? Authors of recent articles on teaching economics to undergraduates consistently advise instructors to use teaching methods that actively engage students in class.[1] For example, Gremmen and Potters (1997) argued that students who participate in experimental games learn more; Marks and Rukstad (1996) advocated the use of the case method in teaching macroeconomics; Johnston, James, Lye, and McDonald (2000) found positive effects of collaborative learn-

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ing techniques that involve group problem solving; and Frank (1998) suggested that economics can become more interesting when in-class debate is used. After conducting an overall review of the undergraduate economics major, Siegfried et al. (1991) also strongly supported pedagogy that requires active learning.[2]

In spite of this overwhelming advocacy of more interactive teaching techniques, economics instructors have been slow to abandon the lecture/exam format. Becker and Watts (2001) found that the median principles instructor spends 83 percent of class time lecturing and uses multiple-choice exams about half of the time. Siegfried et al. (1996) corroborated this finding using a different sample, and Benzing and Christ (1997) reached a similar conclusion, with 86 percent of their respondents reporting that they lectured all the time or very often.[3] Goldin (1991) suggested that a heavy emphasis on publications in tenure and promotion decisions is one of the reasons why economics instructors have been unwilling to abandon the less-engaging lecture format. However, our data show that teaching methods do not vary substantially from these norms even at liberal arts colleges where teaching quality is often an important determinant of tenure and promotion.[4] Researchers on educational practices in general suggest that a passive classroom experience is likely to discourage good students, leaving economics classrooms populated with disinterested, poor-performing students.

In this article, we offer a comprehensive look at the effectiveness of different teaching techniques. We used a unique data set from 34 different liberal arts colleges that allowed us to match student and instructor characteristics to assess their impact on students' interest in economics. In particular, we evaluated specific teaching methods by determining how they affected the probability that students would change their minds about economics during the course of the semester. *Successful techniques* were those that encouraged students who initially did not think they would take more economics courses to change their minds, and *unsuccessful* ones were associated with a higher probability of discouraged students who initially thought they would take more economics courses but decided not to after the course. Recognizing that students learn in many different ways, we evaluated these techniques for several different types of students, all of whom might be considered by some criteria to be "good students," as well as for all students. Overall, we were interested in answering two basic questions. First, were the teaching methods commonly employed by introductory economics instructors discouraging students, particularly good students, from continuing to study economics? Second, which teaching methods were successful in encouraging students to continue in economics, particularly those students who might already be motivated to learn?

We found that less lecture and more discussion were effective for all types of students. The magnitude of the effects of these techniques, however, varied across types of students, even among various types of good students. Although our results convincingly supported the argument that introductory economics instructors should lecture less often, they did not identify a set of techniques that are an optimal replacement. In fact, our results indicated that different types of students responded differently to many pedagogical techniques. Using a variety of techniques is likely to give an instructor the best chance of reaching the broadest range of students. Finally, we present evidence that one type of good student—those with

high GPAs—finds economics more relevant, is more confident in his or her ability to understand economics, and receives higher grades when enrolled in lecture-based courses. We conjecture that the reluctance of economics instructors to adopt active-learning techniques may be in part the result of their own experience as students who found lectures to be an efficient way of learning.

In the following sections, we discuss what we mean by good students and how we identify them in our sample. We then present our main estimation results.

WHAT IS A GOOD STUDENT?

A preliminary step in our analysis was to define what we meant by "good student." Because different students might have different strengths, each of which might enhance their ability to learn, choosing only one or two criteria for identifying students' strengths might not capture all strengths.[5] For this reason, we used a variety of alternative means of identifying good students and compared and contrasted the results we obtained. Although in many cases this prevented us from making an overarching claim about the effectiveness of various pedagogical techniques, we believed this approach was valuable because it allowed us to assess the techniques' impact on several different kinds of students.

We used a unique data set that contains information about students' characteristics, attitudes, and opinions, as well as those of their instructor and their instructor's methods. We used our data to create five different measures of good student.[6] The first was a gauge of a student's past success in college, relative to his or her classmates. We calculated the ratio of each student's self-reported GPA to the average GPA of all students in the class. We then classified any student for whom this ratio was greater than 1 as a good student and set the dummy variable, HIGHGPA, equal to 1. This measure therefore identified students who had performed above average in a variety of classes. Because even the first-year students in our sample would have had several classes during their first semester, this measure of success reflected input from different instructors and different disciplines. A drawback to this measure, however, was that these students had succeeded under current teaching practices. If students have not been exposed to a variety of teaching methods, using this measure of good student would not shed light on the effectiveness of less-popular measures. In particular, our findings might tell us only that students who have done well in the past will continue to do well if we perpetuate current practice.

Our second means of identifying good students also relied on past success—student performance on a standardized test. For this measure, we calculated the ratio of each student's self-reported total SAT score to the average total SAT score of all the students in the class. We set the dummy variable HIGHSAT equal to 1 for students for whom this ratio was greater than 1. As with our first measure, a disadvantage of focusing on this group of students was that they had demonstrated their ability to do well under current teaching practices and a very specific evaluation method: timed, multiple-choice exams.

Our last three measures of a good student relied more on self-reported student characteristics than on past academic performance. In addition to examining

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influences on students who had done well in classes and on SATs, we were interested in influences that affected students who liked to think about problems and students who enjoyed expressing their ideas and opinions. For students who agreed strongly (responded with the maximum rating of 5) with the statement, "I like to think about problems that don't have clear-cut solutions," we set the dummy variable, SOLVER, equal to 1. We also examined a subset of these students: those who had higher than average GPAs compared to others in their class. Thus, SOLVERGPA equal to 1 corresponds to those students for whom both SOLVER equals 1 and HIGHGPA equals 1.

Finally, the last dimension of student quality that we considered was the desire to participate in class discussions. For students with above average GPAs (HIGHGPA = 1) who responded with the maximum rating of 5 to the statement, "I like classes in which there is an opportunity to express my ideas and opinions," we set the dummy variable EXPRESSGPA equal to 1. Therefore, these students liked to contribute to the class and had also performed well in previous classes.[7]

We should point out that four out of the five ways we identified good students in our sample compared them with other students at their college. We did this even though, in absolute terms, by some measures, the students at the bottom of the distribution at the most selective college would compare favorably to the students at the top of the distribution at the least selective college.[8] Implicitly, we assumed that the best students at the most selective college have something in common with the best students at less selective schools. If our assumption is incorrect, and we have identified good students in a way that is not meaningful, then we would expect statistically insignificant and inconsistent results.

In thinking about the appropriate way to identify good students, it is also important to recognize that three out of our five measures used student GPA in some way. Because grade inflation varies across colleges, it is difficult to pool students from all colleges with these measures. Furthermore, because the C student at a more-selective college might earn an A at a less-selective college, even using an absolute measure of GPA (rather than a relative measure that compares students' GPA with the average at their college) would still implicitly judge students relative to the other students at their own school. Explicitly making the comparison relative provided us a measure that was easier to interpret.

A final issue with our data and method is the use of self-reported data on performance. Because our sample was taken in several different classes across many institutions, we necessarily relied on self-reported data on grades and test scores for many of our measures of good student. Maxwell and Lopus (1994) found that self-reported data often overstates student achievement because either poorly performing students do not report their grades or test scores, or students inflate their grades and test scores. This could be problematic for our study; however, the fact that our data contained very few missing values (for example, only 2.7 percent of the sample did not report a GPA) mitigates the first concern, and the second concern is somewhat alleviated by our use of relative measures of performance. In particular, we identified good students as above average. To the extent that the overstating did not affect student's relative position in the performance distribution, our method is still valid. Later, when we looked at a student's

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performance in the economics class in particular, we divided by the student's self-reported GPA to examine relative performance, thus minimizing any effect of grade inflation resulting from student exaggeration.[9]

The simple correlation coefficients of our five different measures of good students as well as three different measures of success in appealing to these students are presented in Table 1. Possible measures of success included whether students taking their first economics class wanted to continue in economics (CONTINUE = 1), whether they become encouraged (ENCOURAGED = 1) during the semester, or whether they become discouraged (DISCOURAGED = 1) during the semester. *Encouraged students* were those who did not intend to take more economics when they signed up for their first class but later decided they would, and *discouraged students* were those who did intend to take more economics classes initially but no longer thought they would.[10] Because results using CONTINUE as a measure of success are obfuscated by the fact that some students take a second economics course primarily to satisfy major requirements rather than out of interest, we focused our analysis on those students who actually changed their minds during the course of the semester, becoming either encouraged or discouraged.[11]

The raw correlations in Table 1 suggest that the five indicators of good students are related but that they measure distinctive traits. The lowest correlations were between students who had above-average GPAs or above-average SAT scores and those who liked to solve open-ended problems, suggesting that the desire to tackle complex problems may not be an important trait of students who earn good grades or high test scores under current teaching methods. The results in Table 1 also indicate that, on average, good students were not more or less likely to continue in economics or to become encouraged or discouraged during the semester. In the next section, we examine the determinants of ENCOURAGED and DISCOURAGED more thoroughly and investigate teaching practices that affect these student outcomes.

METHOD AND RESULTS

Method

To gauge the impact of various teaching techniques, we focused on those techniques that increased the probability that students would change their minds during the course of the semester about their desire to study economics further. Specifically, in our initial investigation, we estimated binary probit models using ENCOURAGED and DISCOURAGED as the dependent variables and student, instructor, and class characteristics as the independent variables. Because some of the independent variables in the probit estimations might also be influenced by events in the classroom, we later investigated further the impact of teaching techniques on some of the student characteristics.

We could argue on a theoretical basis that many of the variables in our data set could help to explain why students become encouraged or discouraged during introductory economics classes. First of all, the characteristics of the students may matter. Students take introductory economics classes for many different rea-

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TABLE 1. Correlation Matrix

	Mean	S.D.	Encouraged	Discouraged	Continue	HIGHGPA	HIGHSAT	SOLVER	EXPRESSGPA
Encouraged	.423	.494							
Discouraged	.205	.404	−.433**						
Continue	.515	.499	.754**	−.669**					
HIGHGPA	.521	.500	−.026	.025	−.034				
HIGHSAT	.512	.500	.027	−.042	.013	.250**			
SOLVER	.226	.418	.013	−.018	.023	.061**	.064**		
EXPRESSGPA	.222	.416	.030	.032	.003	.511**	.170**	.290**	
SOLVERGPA	.130	.337	.030	−.039	.037	.371**	.147**	.717**	.511**

**Indicates correlation is significant at the .05 Type I error level.

sons, which may influence their propensity to become encouraged or discouraged. For example, students who are forced to take a course because it is required may be less likely to become encouraged than those who take the class because they are interested in public policy or finance. Furthermore, student attitudes and opinions about their ability to do economics or the usefulness of economics may influence their willingness to take more economics classes. General characteristics such as class year may also affect the probability that students become encouraged or discouraged.

Second, instructor characteristics may matter as well. In fact, our objective in this study was to examine the effect of pedagogical choices on students' decisions about economics. We also included in our list of independent variables several different measures of assessment and teaching methods used in the student's class. Finally, college or class characteristics may influence students' decisions. For example, it is possible that having a one-semester combined microeconomics/macroeconomics course may make a student less likely to feel the need to take more economics. Or perhaps the ability of students to count business courses (e.g., marketing, organizational behavior, accounting) toward the economics major may be associated with more students continuing in economics.

Because there are many different student, instructor, and class/college characteristics that may influence the decision to continue, we initially estimated our model including a rather large list of independent variables. We interacted each of these variables with the good student measure to determine whether the effects of these variables differed for the group we identified as good students. A list of the variables in the initial specification, grouped by the reason they were included in the original estimation, is presented in Table 2. We summarize in Table 2 extensively used assessment and teaching methods and omit a catch-all "none-of-the-above" category. For assessment methods, the omitted category included writing assignments, quizzes, problem sets, presentations, and computer labs. For teaching methods, the omitted category included experiments, computer labs, demonstrations, and student presentations.

As expected, many of these variables were insignificant in this initial estimation. To present a more parsimonious specification, we removed insignificant variables from our estimation.[12] We discuss the results next.

Initial Results

The results from the ENCOURAGED and DISCOURAGED estimations show that both student and instructor characteristics influenced student choice. (Tables 3 and 4 focus on a subset of the coefficients. The full set of results is available from the authors upon request.) Students who were more confident in their ability to understand economics (CONFIDENCE), who entered the course with a strong predisposition to major in economics (POSMAJOR), who thought that economics studies the ideas and issues that interest them (RELEVANT), and who expected to do well in the course relative to their other classes (RELGRADE) were more likely to be encouraged and less likely to be discouraged.[13] In general, the results reported in columns 2 through 6 of Tables 3 and 4 do not support the

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TABLE 2. Independent Variables Used in Initial Specifications

Characteristics	Mean	*SD*	Min	Max	Definition
Student Characteristics					
Reasons for taking class					
ADVICE‡	2.82	1.32	1	5	advice of family or friends
CAREER‡	3.54	1.26	1	5	importance to career
CUREVENT‡	3.37	1.16	1	5	interest in current events
FINANCE‡	3.65	1.12	1	5	interest in finance
POSMAJOR‡	2.58	1.53	1	5	considering econ as a major
PUBPOL‡	3.27	1.15	1	5	interest in public policy
REQD‡	2.72	1.58	1	5	required
Student attitudes and opinion					
CONFIDENCE‡	3.68	1.01	1	5	I understand the material as well as most of the other people in the class
FREEZEUP‡	2.81	1.30	1	5	often afraid will freeze-up on exams
GRADSCHOOL‡	2.95	1.07	1	5	economics helps get into grad school
RELEVANT‡	3.48	1.01	1	5	economics helps me understand issues in which I am interested
Other student characteristics					
GRAPHS	2.332	0.80	1	4	discomfort with graphs
JUNIOR	0.090	0.29	0	1	1 if junior
RELGRADE	1.00	0.064	0.67	1.24	expected grade/GPA
SOPHOMORE	0.25	0.44	0	1	1 if sophomore

Instructor Characteristics					
Assessment methods					
COLLAB	10.66	12.29	0	60	percentage of grade for which collaborative work accepted
CURVE	0.68	0.47	0	1	1 if grade on a curve
EXAM	71.97	13.39	30	100	exams—percentage of grade
PARTICIPATION	2.89	4.42	0	15	participation—percentage of grade
Teaching methods					
DISCUSSION	13.50	11.52	0	60	percentage of class time spent in discussion
GRPPROB	4.50	7.04	0	30	percentage of class time spent in group problem solving
LECTURE	65.05	21.57	15	95	percentage of class time spent lecturing
WARMUP	0.35	0.48	0	1	1 if do warm-up
Other instructor characteristics					
TCHEXP	13.76	10.73	1	40	years teaching experience
$TCHEXP^2$	304.30	397.40	1	1600	years teaching experience squared
Class/College Characteristics					
BUSINESS	0.12	0.33	0	1	1 if college has business major
CALCULUS	0.44	0.50	0	1	1 if major requires calculus
CLASSIZE	34.91	17.52	5	93	class size
COMBINED	0.47	0.50	0	1	1 if course covers both micro and macro topics
ECONBUS	0.14	0.35	0	0	1 if econ major can count 3 or more "business" courses toward major
MACRO	0.21	0.41	0	1	1 if intro macro

Note. Total number of observations is 1,776 (excludes seniors and those not taking first college level economics course). Characteristics of smaller classes receive less weight in the calculation of average instructor and class characteristics because the averages are weighted by student respondents. ‡indicates variables measured on a scale of 1 to 5, with 5 being *strongly agree* or *very important*.

TABLE 3. Selected Probit Results; Dependent Variable: Encouraged

	Good student measures					
	(1)	(2) HIGHGPA	(3) HIGHSAT	(4) SOLVER	(5) EXPRESSGPA	(6) SOLVERGPA
Confidence	0.1470	0.2411	0.1719	0.1237	0.1628	0.1479
	(2.15)**	(2.32)**	(1.53)	(1.54)	(2.10)**	(1.97)**
Goodstudent*		–0.1422	0.0392	0.0271	–0.1275	–0.2897
Confidence		(1.00)	(0.26)	(0.18)	(0.74)	(1.37)
Posmajor	0.2605	0.2434	0.1999	0.2350	0.2758	0.2574
	(6.67)**	(4.23)**	(3.20)**	(5.34)**	(6.21)**	(6.15)**
Goodstudent*		0.0538	0.1110	0.3522	–0.0103	0.4380
Posmajor		(0.69)	(1.32)	(2.97)**	(0.10)	(2.20)**
Relevant	0.2101	0.1792	0.0500	0.2319	0.2205	0.2358
	(3.61)**	(2.03)**	(0.55)	(3.55)**	(3.33)**	(3.80)**
Goodstudent*		0.0751	0.2601	0.3624	0.0898	0.3752
Relevant		(0.66)	(2.20)**	(2.10)**	(0.62)	(1.63)
Relgrade	3.8121	3.9802	5.4479	4.3508	3.4962	3.7913
	(3.85)**	(2.79)**	(3.56)**	(3.65)**	(3.08)**	(3.48)**
Goodstudent*		–0.2695	–1.3640	–2.2917	4.3572	4.1519
Relgrade		(0.12)	(0.63)	(0.99)	(1.52)	(1.11)
Curve	0.1137	0.2481	0.2014	0.0459	0.2386	0.1363
	(0.91)	(1.37)	(1.03)	(0.33)	(1.71)*	(1.04)

Goodstudent* Curve		–0.2142 (0.84)	–0.2524 (0.92)	0.2372 (0.61)	–0.7992 (2.17)**	–0.9349 (1.40)
Exam	0.0007 (0.15)	–0.0054 (0.78)	0.0104 (1.34)	–0.0010 (0.18)	–0.0010 (0.19)	–0.0023 (0.45)
Goodstudent* Exam		0.0098 (1.04)	–0.0115 (1.15)	0.0161 (1.29)	0.0105 (0.91)	0.0424 (2.61)**
Grpprob	–0.0128 (1.21)	–0.0085 (0.58)	–0.0246 (1.54)	–0.0178 (1.55)	–0.0052 (0.45)	–0.0137 (1.22)
Goodstudent* Grpprob		–0.0083 (0.39)	0.0108 (0.45)	0.0396 (1.29)	–0.0544 (1.55)	0.0689 (1.72)*
Lecture	–0.0065 (2.08)**	0.0006 (0.14)	–0.0129 (2.45)**	–0.0055 (1.55)	–0.0032 (0.91)	–0.0041 (1.20)
Goodstudent* Lecture		–0.0123 (1.91)*	0.0047 (0.68)	–0.0156 (1.82)*	–0.0191 (2.39)**	–0.0226 1.76)*
Participation	0.0022 (0.15)	–0.0030 (0.15)	–0.0270 (1.20)	0.0062 (0.37)	0.0083 (0.53)	0.0100 (0.65)
Goodstudent* Participation		0.0140 (0.49)	0.0500 (1.65)*	–0.0941 (2.23)**	–0.0055 (0.14)	–0.1151 (2.32)**
Warmup	–0.4205 (3.23)**	–0.2836 (1.50)	–0.0969 (0.45)	–0.5012 (3.40)**	–0.4285 (2.89)**	–0.4391 (3.15)**
Goodstudent* Warmup		–0.3315 (1.22)	–0.6000 (2.04)**	0.4702 (1.21)	0.0130 (0.04)	0.6287 (0.94)
Observations	821	821	740	821	821	821

Note. Robust *z* statistics are in parentheses. A full set of coefficients is available from the authors upon request.
**Significant at the .05 Type I error level; *significant at the .10 Type I error level.

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TABLE 4. Selected Probit Results; Dependent Variable: Discouraged

	Good student measures					
	(1)	(2) HIGHGPA	(3) HIGHSAT	(4) SOLVER	(5) EXPRESSGPA	(6) SOLVERGPA
Confidence	–0.2571	–0.3382	–0.3029	–0.2795	–0.2121	–0.2679
	(4.28)**	(3.48)**	(3.20)**	(4.06)**	(3.02)**	(4.17)**
Goodstudent*		0.0833	0.1673	–0.0163	–0.3030	0.1739
Confidence		(0.65)	(1.23)	(0.09)	(2.05)**	(0.63)
Posmajor	0.0404	0.0777	–0.0156	0.0277	0.0307	0.0491
	(1.13)	(1.40)	(0.28)	(0.69)	(0.74)	(1.29)
Goodstudent*		–0.0705	0.1085	0.0009	0.0589	–0.1317
Posmajor		(0.98)	(1.41)	(0.01)	(0.68)	(0.86)
Relevant	–0.4014	–0.5530	–0.2658	–0.3630	–0.4894	–0.4263
	(6.65)**	(5.69)**	(2.82)**	(5.31)**	(6.64)**	(6.54)**
Goodstudent*		0.2296	–0.3020	–0.2753	0.2100	–0.0327
Relevant		(1.96)**	(2.51)**	(1.80)*	(1.65)*	(0.15)
Relgrade	–4.4856	–4.2931	–6.0190	–4.5451	–4.4434	–4.3858
	(5.10)**	(3.14)**	(4.45)**	(4.44)**	(4.24)**	(4.66)**
Goodstudent*		0.4879	0.6774	–2.7753	–0.1315	–16.0282
Relgrade		(0.24)	(0.36)	(1.07)	(0.05)	(1.99)**
Curve	–0.0454	0.1408	–0.0614	–0.1054	0.0266	–0.0687
	(0.36)	(0.74)	(0.30)	(0.76)	(0.19)	(0.52)
Goodstudent*		–0.2862	0.0298	0.8743	–0.3366	–0.0564
Curve		(1.11)	(0.11)	(2.21)**	(0.97)	(0.08)

Exam	–0.0035	–0.0058	–0.0142	–0.0009	–0.0021	–0.0017
	(0.80)	(0.82)	(2.00)**	(0.18)	(0.42)	(0.35)
Goodstudent*		0.0046	0.0127	–0.0224	–0.0089	–0.0447
Exam		(0.51)	(1.30)	(2.02)**	(0.76)	(2.52)**
Grpprob	–0.0172	–0.0322	–0.0406	–0.0186	–0.0136	–0.0153
	(1.69)*	(2.32)**	(2.83)**	(1.70)*	(1.22)	(1.49)
Goodstudent*		0.0300	0.0459	–0.0105	–0.0336	–0.1845
Grpprob		(1.48)	(2.20)**	(0.30)	(1.14)	(2.06)**
Lecture	0.0019	–0.0029	0.0038	0.0001	–0.0003	0.0004
	(0.62)	(0.62)	(0.85)	(0.02)	(0.08)	(0.13)
Goodstudent*		0.0106	–0.0031	0.0110	0.0065	–0.0043
Lecture		(1.71)*	(0.46)	(1.41)	(0.84)	(0.30)
Participation	0.0037	–0.0269	0.0296	–0.0063	–0.0052	–0.0010
	(0.28)	(1.26)	(1.52)	(0.41)	(0.33)	(0.07)
Goodstudent*		0.0464	–0.0581	0.0468	0.0181	0.0912
Participation		(1.65)*	(1.93)*	(1.20)	(0.56)	(1.36)
Warmup	0.3984	0.2516	0.0311	0.5630	0.3588	0.4365
	(3.21)**	(1.39)	(0.15)	(4.04)**	(2.53)**	(3.36)**
Goodstudent*		0.2982	0.6383	–1.0705	0.2844	–0.4635
Warmup		(1.19)	(2.25)**	(2.98)**	(0.85)	(0.76)
Observations	1116	1116	998	1116	1115	1116

Note. Robust z statistics are in parentheses. A full set of coefficients is available from the authors upon request.
**Significant at the .05 Type I error level; *significant at the .10 Type I error level.

hypotheses that CONFIDENCE, POSMAJOR, and RELGRADE have differential effects for good students compared with all students, but they do indicate that the relevance of economics can be particularly important for good students. Its effect, however, depends on our definition of good student. The positive sign on the interaction term of good student and relevant in column 2 of Table 4 suggests that the relevance of economics is less important for students with high GPAs, but the coefficients in columns 3 and 4 suggest that it is more important for students with high SAT scores or those who like to solve problems. This latter result is also reinforced by the coefficients in columns 3 and 4 in Table 3.

The results in Tables 3 and 4 also suggest that pedagogical choices have an impact on students and that they may have differential effects on different kinds of students. We examined two types of choices made by the instructor: the allocation of class time to different teaching methods and the choice of assessment methods. For example, column 1 of Table 3 indicates that spending a greater percentage of class time lecturing (LECTURE) is associated with a lower probability of encouraged students, and the results in columns 2, 4, 5, and 6 suggest that it is the better students who are less likely to become encouraged when classes are taught with more lecture. The marginal effects of increasing the amount of lecture that are associated with the coefficients in Table 3 are noteworthy. For example, if we focus on the statistically significant results reported in Table 3, increasing the amount of time spent lecturing by one standard deviation (21.57), holding all other variables constant, is associated with a 10 to 16 percentage point decrease in the probability of a good student's becoming encouraged. Interestingly, however, LECTURE has less effect on the probability of becoming discouraged, although column 2 of Table 4 shows weak evidence that students with high GPAs are more likely to become discouraged when classes contain more lecture.

In contrast, spending a larger percentage of class time in group problem solving (GRPPROB) does not seem systematically to affect the probability of becoming encouraged but is associated with a lower overall probability of most students' becoming discouraged. The results in column 6 of Table 4 suggest that students with high GPAs who like to solve problems may be particularly affected by this technique. The marginal effects of the coefficients in Table 4 indicate that a one standard deviation increase in the amount of class time spent in group problem solving (7.04) is associated with a 24 percentage point decrease in the probability of these high GPA problem solvers' becoming discouraged.

In these initial estimations, we found limited evidence that assessment methods systematically affect good students. For example, in Tables 3 and 4, we show that counting exams as a larger percentage of the grade (EXAM) was associated with a higher probability of becoming encouraged and a lower probability of becoming discouraged for problem solvers with high GPAs, but that effect did not hold for other types of good students. Similarly, the results in Table 3 suggest that problem solvers and problem solvers with high GPAs dislike having participation count as a large part of the grade (PARTICIPATION); however, these effects were not evident in Table 4. Thus, overall, the results in Tables 3 and 4 indicate that teaching and assessment methods do encourage and discourage students in their study of economics, although the effects vary by type of student.[14]

Further Results

Although the results presented in Tables 3 and 4 support the hypothesis that teaching techniques influence student choice about studying economics, they are incomplete. Some of the student characteristics that we used as explanatory variables in the probit estimations can themselves be influenced by events in the classroom. In this section, we explore the determinants of the three student characteristics, RELEVANT, RELGRADE, and CONFIDENCE, that were consistently found to be important in our ENCOURAGED and DISCOURAGED estimations, focusing the discussion on the impact of teaching and assessment methods.[15]

Before looking at the regression results, however, it is helpful to compare good students with the other students. Differences in means for CONFIDENCE, RELEVANT, and RELGRADE reveal that those classified as good students by our various measures were generally more confident in their ability to understand economics and find economics more relevant but obtained slightly lower grades in economics classes relative to their GPAs than did students in general. These differences were usually statistically significant but small in magnitude.

We present selected results from estimating the determinants of RELEVANT in Table 5.[16] Two teaching techniques that had a particularly noteworthy effect were the amounts of class time devoted to lecture and to discussion. Whereas devoting more time to discussions in class did not generally affect students' judgment that economics studies the ideas and issues in which they were interested, it was an effective technique for several subgroups of students. Students with high GPAs, students with high SAT scores, students with high GPAs who like to express their ideas and opinions in class, and problem solvers with high GPAs all were more likely to think that economics was relevant when the class incorporated more discussion. This does not necessarily imply, however, that less lecture time would also lead these same groups of students to think economics is more relevant. Although the negative coefficients on the lecture variable in columns 2 through 6 of Table 5 indicate that devoting more class time to lecture leads students to conclude that economics is less relevant, adding back the interaction term for high GPA students, high SAT students, and problem solvers with high GPAs suggests that, for these students, more time spent lecturing does not have this effect. Perhaps, for these students, learning through lecture is a practiced and comfortable way of learning. It is noteworthy that high GPA students who like to express themselves in class did not have this positive interaction. Because methods of evaluation did not significantly and consistently affect students' perception of relevance, we do not report these coefficients in Table 5.

In Table 6, we examine the determinants of students' relative grades. Looking at the effects of various pedagogical choices made by the instructor revealed several interesting results. Spending a larger percentage of class time in group problem-solving activities improved the relative grades for students of all types and devoting more class time to lecture also tended to increase students' relative grade.[17] Our results suggest that high GPA students, in particular, do well in classes in which the instructor spends more time lecturing. This is consistent with

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TABLE 5. Selected OLS Results; Dependent Variable: Relevant

	Good student measures					
	(1)	(2) HIGHGPA	(3) HIGHSAT	(4) SOLVER	(5) EXPRESSGPA	(6) SOLVERGPA
Career	0.1021	0.1054	0.1071	0.0982	0.1001	0.0997
	(4.32)**	(4.47)**	(4.25)**	(4.12)**	(4.26)**	(4.22)**
Curevent	0.1613	0.1650	0.1543	0.1635	0.1678	0.1715
	(6.61)**	(6.69)**	(5.96)**	(6.67)**	(6.85)**	(6.94)**
Finance	0.1211	0.1147	0.1121	0.1190	0.1128	0.1165
	(4.71)**	(4.48)**	(4.04)**	(4.64)**	(4.43)**	(4.52)**
Graphs	–0.1502	–0.1324	–0.1456	–0.0984	–0.1116	–0.1335
	(5.10)**	(3.19)**	(3.41)**	(2.97)**	(3.40)**	(4.26)**
Goodstudent*		–0.0632	–0.0472	–0.1900	–0.1841	–0.1910
Graphs		(1.06)	(0.75)	(2.76)**	(2.56)**	(2.11)**
Posmajor	0.0422	0.0406	0.0244	0.0461	0.0415	0.0449
	(2.34)**	(2.26)**	(1.24)	(2.55)**	(2.30)**	(2.50)**
Pubpol	0.1423	0.1430	0.1558	0.1310	0.1432	0.1367
	(5.97)**	(5.86)**	(6.07)**	(5.45)**	(5.94)**	(5.65)**

Collab	–0.0032	–0.0044	–0.0093	–0.0017	–0.0032	–0.0027
	(1.59)	(1.53)	(2.85)**	(0.75)	(1.42)	(1.27)
Goodstudent*		0.0031	0.0097	–0.0065	–0.0005	–0.0018
Collab		(0.76)	(2.17)**	(1.24)	(0.08)	(0.27)
Disc	0.0018	–0.0073	–0.0105	0.0002	–0.0027	–0.0004
	(0.52)	(1.55)	(2.14)**	(0.06)	(0.72)	(0.10)
Goodstudent*		0.0181	0.0211	0.0135	0.0210	0.0300
Disc		(2.72)**	(2.99)**	(1.40)	(2.47)**	(2.42)**
Lecture	–0.0025	–0.0067	–0.0081	–0.0030	–0.0037	–0.0034
	(1.49)	(2.97)**	(3.27)**	(1.67)*	(2.06)**	(2.00)**
Goodstudent*		0.0088	0.0096	0.0048	0.0053	0.0120
Lecture		(2.77)**	(2.78)**	(1.06)	(1.28)	(2.07)**
Tchexp	0.0233	0.0233	0.0237	0.0251	0.0225	0.0219
	(2.62)**	(2.60)**	(2.50)**	(2.84)**	(2.52)**	(2.47)**
Tchexp2	–0.0006	–0.0006	–0.0007	–0.0007	–0.0006	–0.0006
	(2.50)**	(2.42)**	(2.56)**	(2.68)**	(2.31)**	(2.28)**
Observations	1535	1494	1357	1535	1493	1494
Adjusted R^2	0.29	0.31	0.29	0.30	0.32	0.32

Note. Robust z statistics are in parentheses. A full set of coefficients is available from the authors upon request.
**Significant at the .05 Type I error level; *significant at the .10 Type I error level.

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TABLE 6. Selected Probit Results; Dependent Variable: Relgrade

	Good student measures					
	(1)	(2) HIGHGPA	(3) HIGHSAT	(4) SOLVER	(5) EXPRESSGPA	(6) SOLVERGPA
Curevent	–0.0007	–0.0064	0.0003	–0.0007	–0.0019	–0.0013
	(0.49)	(2.86)**	(0.13)	(0.42)	(1.10)	(0.81)
Goodstudent*		0.0108	–0.0022	0.0006	0.0057	0.0061
Curevent		(3.80)**	(0.69)	(0.16)	(1.78)*	(1.44)
Finance	0.0054	0.0061	0.0048	0.0057	0.0038	0.0052
	(3.54)**	(2.72)**	(1.88)*	(3.18)**	(2.19)**	(3.04)**
Goodstudent*		–0.0022	0.0008	–0.0028	0.0063	–0.008
Finance		(0.76)	(0.25)	(0.89)	(1.92)*	(0.52)
Graphs	–0.0228	–0.0242	–0.0229	–0.0233	–0.0229	–0.0235
	(11.36)**	(12.42)**	(10.56)**	(11.62)**	(11.53)**	(11.71)**
Posmajor	0.0073	0.0058	0.0071	0.0074	0.0068	0.0072
	(6.29)**	(5.14)**	(5.67)**	(6.33)**	(5.88)**	(6.14)**
Pubpol	–0.0018	0.0012	0.0017	–0.0022	–0.0004	–0.0005
	(1.18)	(0.51)	(0.74)	(1.27)	(0.25)	(0.32)

Goodstudent*		–0.0052	–0.0062	0.0030	–0.0031	–0.0025
Pubpol		(1.75)*	(1.94)*	(0.77)	(0.93)	(0.58)
Exam	–0.0003	–0.0005	–0.0002	–0.0004	–0.0003	–0.0003
	(2.32)**	(2.36)**	(1.17)	(2.88)**	(2.23)**	(2.04)**
Goodstudent*		0.0002	–0.0001	0.0005	0.0002	0.0001
Exam		(0.88)	(0.38)	(1.67)*	(0.78)	(0.45)
Grpprob	0.0008	0.0007	0.0010	0.0008	0.0007	0.0008
	(2.78)**	(2.56)**	(3.16)**	(2.61)**	(2.41)**	(2.55)**
Lecture	0.0002	0.0000	0.0003	0.0002	0.0001	0.0002
	(2.37)**	(0.41)	(2.27)**	(2.24)**	(1.23)	(2.01)**
Goodstudent*		0.0004	–0.0001	–0.0001	0.0001	–0.0001
Lecture		(2.96)**	(0.58)	(0.50)	(0.82)	(0.65)
Part	–0.0004	0.0000	–0.0011	–0.0007	–0.0005	–0.0005
	(1.19)	(0.00)	(2.10)**	(1.86)*	(1.20)	(1.19)
Goodstudent*		–0.0006	0.0015	0.0015	0.0006	0.0006
Part		(0.85)	(1.98)**	(1.71)*	(0.86)	(0.67)
Warmup	0.0100	0.0033	0.0155	0.0117	0.0073	0.0080
	(2.98)**	(0.66)	(2.91)**	(3.13)**	(1.90)*	(2.21)**
Goodstudent*		0.0115	–0.0093	–0.0087	0.0081	0.0107
Warmup		(1.88)*	(1.34)	(1.07)	(1.22)	(1.23)
Observations	1562	1562	1399	1562	1561	1562
Adjusted R^2	0.20	0.26	0.20	0.20	0.22	0.21

Note. Robust z statistics are in parentheses. A full set of coefficients is available from the authors upon request.
**Significant at the .05 Type I error level; *significant at the .10 Type I error level.

our earlier suggestion that learning through lecture is a skill that these students have perfected. Another teaching technique associated with higher relative grades for most students was doing a warm-up activity at the beginning of the semester. This effect was particularly strong for high GPA students.

We obtained mixed results for the effects of different assessment techniques on RELGRADE. Counting participation as a larger share of the grade was associated with lower relative grades in two out of the six specifications in Table 6 but slightly higher relative grades for high SAT students and problem solvers. Counting exams as a larger percentage of the grade was also associated with lower relative grades, except for students who had identified themselves as problem solvers.

In Table 7, we show the determinants of CONFIDENCE. Group problem solving was associated with greater overall student confidence in their ability to understand economics, and, for some groups of students (high GPA and high SAT students), more lecturing also gave them greater confidence. High GPA students are also more likely to be confident when the instructor devotes more class time to discussion.

Assessment methods also affect student confidence, problem solvers, high GPA students who like to express themselves in class, and high GPA students who like to solve problems are more confident when a larger percentage of the grade is determined by exams. We present some weaker evidence in Table 7, however, that suggests that counting participation as a larger percentage of the grade tends to decrease the confidence of many different types of students.

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The Net Effect

The results presented in the previous two sections about the effectiveness of various teaching techniques often suggest opposite conclusions when viewed in isolation. For example, the results in Table 3 indicate that students with high GPA are less likely to become encouraged when more class time is devoted to lecture; however, subsequent results indicate that these students have higher relative grades (Table 6) and higher confidence (Table 7) when more class time is devoted to lecture. Furthermore, the sheer number of these results makes it difficult to identify important factors. In this section, therefore, we focus on a few variables under the instructor's control and calculate their net effect on student interest in economics.

The effects of increasing the value of specific variables by one standard deviation from the average on the probabilities of students' becoming encouraged and discouraged are shown in Table 8.[18] In general, we found that teaching techniques had a greater impact on encouraging students than on discouraging them. Possibly, students were evaluating economics relative to other classes. If other introductory classes were not particularly interactive, then having a noninteractive economics class might not be discouraging. If the economics class was interactive, however, it might be more likely to gain student interest because it was different from other introductory classes. The calculations in Table 8 show that more lecturing reduced the probability of becoming encouraged across all groups

of students, with the largest effect on students who reported that they like to solve problems, particularly high GPA problem solvers, and students with high GPAs who like to express themselves in class.

Although allotting more time to discussion resulted in moderate increases in the probability of becoming encouraged for all groups of students, the effects of other pedagogical techniques varied across the groups. For example, problem solvers (both SOLVERS and SOLVERGPA) responded positively to group problem solving, but this technique lowers the probability of being encouraged for other students, particularly for high GPA students who like to express their ideas and opinions in class. Similarly, some groups of students responded positively to having participation count for a larger percentage of their grade, although this was associated with lower levels of interest among other students. It is interesting that problem-solving students who had the strongest positive response to devoting more class time to discussion also had the strongest negative reaction to counting participation as a larger share of the grade; perhaps these students benefit from active discussion in the classroom even when they do not contribute to it themselves. The large increase in the probability of high GPA students' becoming discouraged when participation was counted as part of the grade was also noteworthy, suggesting that some of these high performers had a strong dislike for participation that was encouraged by grades.[19] Finally, counting exams as a larger percentage of the grade also affected students differentially, with problem solvers, particularly high GPA problem solvers, and high GPA students who like to express their ideas in class responding positively.

The success of a particular teaching technique measured by its ability to affect student interest in taking additional economics courses is shown in Table 8. Arguably, one might want to evaluate teaching techniques by other standards, such as measures of how much material students absorbed or to what degree their analytical abilities were sharpened as a result of the teaching methods used. Although our study did not include direct objective measures of the knowledge that students gained, the estimations of RELEVANT, CONFIDENCE, and RELGRADE reported in Tables 5 through 7 allowed us to comment on this aspect of success. CONFIDENCE and RELGRADE are noisy measures of student performance: CONFIDENCE is a student's assessment of the amount learned, and RELGRADE is the instructor's assessment. Finally, the relevant estimation may also provide some indirect evidence as to what techniques allow students to learn more if students who perceive the material to be relevant are more likely to gain a deeper understanding of the material and to retain it.

Focusing only on these supplementary estimations yielded an interesting result. High GPA students found the introductory economics courses more relevant, earned higher relative grades, and were more confident in their ability to learn economics when teachers lectured for a larger portion of class time. Although this same result was not evident for the other subgroups of good students, it suggests an interesting answer to the puzzle we posed at the beginning of this article: In the face of all the evidence in support of techniques that promote active learning, why do economics instructors rely so much on lecture? Perhaps, as former high GPA students themselves, economics instructors found lec-

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TABLE 7. Selected OLS Results; Dependent Variable: Confidence

	Good student measures					
	(1)	(2) HIGHGPA	(3) HIGHSAT	(4) SOLVER	(5) EXPRESSGPA	(6) SOLVERGPA
Finance	.088	.077	.082	.079	.075	.079
	(3.99)**	(3.43)**	(3.46)**	(.352)**	(3.30)**	(3.46)**
Freezeup	−.170	−.113	−.129	−.167	−.156	−.166
	(9.96)**	(4.34)**	(4.85)**	(8.59)**	(7.69)**	(8.60)**
Goodstudent*		−.095	−.042	−.015	−.063	−.035
Freezeup		(2.79)**	(1.13)	(0.38)	(1.61)	(0.74)
Graphs	−.504	−.499	−.483	−.500	−.502	−.501
	(17.94)**	(17.12)**	(15.71)**	(17.49)**	(17.01)**	(17.06)**
Pubpol	.037	.034	.050	.032	.036	.031
	(1.77)*	(1.58)	(2.16)**	(1.47)	(1.65)*	(1.41)
Disc	.003	−.004	.001	.002	.002	.003
	(1.08)	(0.90)	(0.20)	(0.73)	(0.72)	(0.89)

Goodstudent* Discussion		.014 (2.73)**	.005 (0.93)	.009 (1.34)	.005 (0.83)	.010 (1.62)
Exam	−.002 (1.18)	.003 (1.14)	−.002 (0.64)	−.004 (2.18)**	−.003 (1.65)*	−.003 (1.47)
Goodstudent* Exam		.003 (0.79)	.001 (0.26)	.009 (2.22)**	.007 (1.69)*	.009 (1.93)*
Grpprob	.007 (2.01)**	.007 (1.74)*	.010 (2.28)**	.006 (1.45)	.006 (1.64)	.007 (1.79)*
Lecture	.002 (1.40)	−.003 (1.42)	−.003 (1.14)	.002 (0.92)	.000 (0.24)	.001 (0.65)
Goodstudent* Lecture		.008 (3.01)**	.009 (2.90)**	.001 (0.30)	.004 (1.44)	.005 (1.26)
Part	−.009 (1.56)	−.010 (1.75)*	−.008 (1.28)	−.008 (1.50)	−.010 (1.83)*	−.010 (1.73)*
Observations	1677	1563	1419	1604	1562	1563
Adjusted R^2	0.33	0.36	0.35	0.35	0.35	0.35

Note. Robust z statistics are in parentheses. A full set of coefficients is available from the authors upon request.
**Significant at the .05 Type I error level; *significant at the .10 Type I error level.

TABLE 8. The Net Effect

Method	All students	HIGHGPA	HIGHSAT	SOLVER	EXPRESSGPA	SOLVERGPA
			Impact on probability of becoming encouraged			
Lecture	–5.16	–7.78	–4.78	–16.68	–16.92	–17.12
Grpprob	–2.46	–3.80	–2.23	6.58	–14.91	12.10
Disc	0.35	1.68	1.96	4.14	2.70	5.99
Exam	–0.41	1.69	–1.43	8.10	4.71	13.92
Participation	0.11	1.38	4.08	–15.53	0.58	–16.74
			Impact on probability of becoming discouraged			
Lecture	0.79	2.34	–0.91	2.96	1.14	–0.26
Grpprob	–3.50	–1.20	–0.19	–3.02	–7.97	–0.54
Disc	–0.38	–1.71	–1.56	–1.63	–2.39	–0.21
Exam	–0.53	0.08	0.11	–3.70	–3.84	–0.45
Participation	0.59	35.61	–2.57	2.77	2.05	1.02

Note. Changes are in percentage points. Changes are the difference between predicted probabilities associated with a one standard deviation increase from the average in the selected variable and a baseline specification in which all variables are held at their mean.

ture to be an efficient way of learning. Thus, reducing reliance on this technique would be inconsistent with their own personal experience.

CONCLUSION

We examined factors that influence students who change their minds about continuing in economics sometime during their first semester of economics. These students are of particular interest to teachers of economics because something that happened during the semester mattered to these students. We were particularly interested in examining whether pedagogical choices made by instructors affected students' decisions about continuing in economics.

We find that pedagogical choices do matter, although we also find that our results differed across different types of students. Interestingly, things that happen in the classroom tend to be more effective in encouraging students than discouraging them. Overall, our results suggest that students prefer classes that contain less lecture and more discussion. However, our results also suggest that students—even various subsamples of good students—respond differently to techniques such as group problem solving, participation, and the use of exams as a means of evaluation. Using a variety of teaching techniques may be the most successful way of appealing to the broad range of learning styles adopted by good students.

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NOTES

1. Our work is broadly related to a body of literature that examines the connection between student personality traits and success in economics. See, for example, Ziegert (2000) and the references cited therein.
2. Salemi et al. (2001) also advocated active learning in economics classes and outlined research initiatives aimed at encouraging economics instructors to adopt such practices. Interested readers should also see Becker (1997; 2000) and Becker and Watts (1995) for a more general review of current trends and research on teaching economics to undergraduates.
3. Although 56 percent of the Benzing and Christ (1997) respondents indicated that they had changed their teaching methods within the past 5 years to include more participatory activities, these survey averages suggest that the changes were not substantial.
4. In our sample of instructors at liberal arts colleges, the average instructor in the introductory class lectured the majority of class time and relied heavily on exams for determining final grades. In Table 2, we present some summary statistics from our sample.
5. Almost all of the students in our data set attended fairly selective liberal arts colleges and might be considered good students for this reason alone. This fact makes it less likely that we would find differences between the group that we identify as good students and the remainder of the sample.
6. The data set we used contained 1,776 observations from students surveyed while taking their first college-level economics class at one of 34 different liberal arts colleges in the spring of 1999. We obtained the data by soliciting instructors to give out the surveys to students in class. The response rate among instructors was quite high for this kind of survey at 72 percent, but it is possible that our sample contained instructors who may have a special interest in pedagogy. However, because our analysis focused on student and not on instructor behavior, this sampling bias should not affect the interpretation of our results. See Jensen and Owen (2001) for a more detailed description of the survey method and an overview of the data. The data are available at http://academics.hamilton.edu/economics /aowen/annowen.html.
7. We also asked students to rate the extent to which they agreed or disagreed with the statement, "I do not like to speak in class." Although it is possible that some students may like classes in which there is an opportunity to express ideas and opinions but like to do so in written assignments rather than through class participation, the strong negative correlation between the responses to

the two statements suggests that many of the students who like to express their ideas and opinions like to do so in class.

8. For example, students with the lowest SAT scores at the most selective college might have higher SAT scores than those with the best SAT scores at less selective institutions.
9. To the extent that overstating does affect students' relative position slightly, then some students who pass the threshold for being categorized as a good student are in this group inappropriately. However, when we moved the threshold and considered only the top quartile to be good students, our results were similar, thus providing some evidence that overstating is not qualitatively affecting our major conclusions.
10. Students were able to respond Yes, No, or Not sure to the questions, "Did you intend to take more economics when you initially signed up for the class?", and "Do you intend to take more economics?" Any change in those responses would classify a student as either discouraged or encouraged. (For example, a student who responded No to the first question but Not sure to the second question would have been considered an encouraged student.)

    Students who intended to take more economics when they signed up for the class were not eligible to be counted as encouraged and were not used in any of the ENCOURAGED estimations. Likewise, students who initially did not intend to take more economics could not be considered even more discouraged and were omitted from the DISCOURAGED estimation.
11. Because we considered success to be only the intention of taking more economics classes, we did not include another type of teaching success—students who became more interested in economics during the course of the semester but who did not intend to take additional classes because they were more interested in other subjects.
12. *P* values for the χ^2 statistics associated with the test of the null hypothesis that the coefficients on all the removed variables are 0 ranged from .11 to .62 for all 12 estimations in Tables 3 and 4.
13. The results reported in Tables 3 and 4 are the coefficients from the probit estimations and not the marginal effects of the individual variable. The marginal effects of these four factors, however, indicate that they were important determinants of student decisions. For example, the results in column 6 of Table 4 indicate that a one standard deviation increase in CONFIDENCE was associated with a 5 percentage point decrease in becoming discouraged. Similar calculations for RELEVANT suggest a decrease in the probability of being discouraged by 8 percentage points. The effect of a one standard deviation increase in RELGRADE was particularly strong for high GPA problem solvers; a one standard deviation increase in RELGRADE was associated with a decrease in the probability of being discouraged of 25 percentage points.
14. Although including a warm-up activity had a statistically significant effect in several of the specifications reported in Tables 3 and 4, in earlier work (Jensen and Owen 2000; 2001), we did not find the direct effect of including a warm-up activity on the probability of students becoming encouraged or discouraged to be statistically significant. Therefore, this finding was not robust. However, our later results regarding the effect of warm-up activities on students' relative grades were consistent with our previous findings. (A *warm-up* is an activity, such as a game or group assignment, at the beginning of the semester designed to encourage students to get to know each other.)
15. Because RELEVANT, CONFIDENCE, and RELGRADE were not predetermined, the probit results reported in Tables 3 and 4 might be affected by endogeneity. However, when we used the test for exogeneity in a simultaneous probit model described in Rivers and Vuong (1988), we did not reject exogeneity in any of the probit estimations reported.
16. As before, we initially included a larger set of independent variables in these equations but removed variables with insignificant coefficients to present a parsimonious specification. *P* values for the *F* statistic associated with the test of the hypothesis that all of the coefficients on the removed variables were 0 ranged from .45 to .83 for the six estimations for RELEVANT (Table 5) and from .35 to .88 for the six estimations for RELGRADE (Table 6). For the CONFIDENCE specifications (Table 7), the specification in column 4 had an *F* statistic with a *p* value of .09, whereas the remaining five specifications in Table 7 had *F* statistics with *p* values ranging from .52 to .58.

    The results reported for RELEVANT and CONFIDENCE were from OLS regressions. However, because these variables were student responses measured on a scale of 1 to 5, they can also be estimated as ordered probits. Doing so did not change any of our qualitative conclusions.
17. Recall that relative grade is the student's expected grade in the course divided by his or her own GPA, and it is not a measure relative to the other students in the class. Therefore, it is possible for all students in the class to improve their relative grades.
18. For some variables, a one standard deviation increase represented a considerably larger percentage increase than for others. For example, *lecture* is increased by 21.5 percent whereas *group problem solving* is increased by only 7.04 percent.

19. This could occur because (1) the students themselves do not like to participate; (2) they like to participate but want their performance to be evaluated in other ways; or (3) these students do not like the classroom environment when many students in the class participate for the purpose of getting a better grade. There was a modest negative correlation between being a good student and the response to the statement, "I do not like to speak in class," suggesting that the first explanation, a dislike of participating, is not the primary reason for this result.

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