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IS TEACHING THE BEST WAY TO LEARN? AN EVALUATION OF BENEFITS AND COSTS TO UNDERGRADUATE STUDENT PROCTORS IN ELEMENTARY ECONOMICS*

I. INTRODUCTION

The Joint Council on Economic Education (JCEE) has recently sponsored several projects to explore alternative approaches to teaching college introductory economics. The experimental course at Vanderbilt, under the supervision of Rendigs Fels,[1] combines the case method of instruction[2] with the self-paced personalized system of instruction (PSI) developed by Fred S. Keller [5].

The course consists of twenty lessons. Each lesson includes a short examination on basic concepts (seven exams), analytical skills (seven exams), or policy cases (six exams). The course has no lectures. Students are given assignments, study them with the help of a proctor, and take the examinations when they think they are prepared. The criterion for passing is mastery—one hundred percent. Students who do not meet the criterion are recycled, and, after additional study may retake tests on lessons they fail to master. This process continues until each lesson is passed or the semester ends. Grades depend partly on how many lessons are completed during the semester and partly on a final examination. The case method is integrated into the PSI method in the final six lessons. In these lessons students analyze realistic policy issues in a systematic way.

There has been a substantial amount of research on PSI courses summarized in [6]. Most of this research has been conducted in psychology classes. Elizabeth Allison has recently reviewed the application of PSI principles to college level economic instruction [1]. Scott McCuskey has evaluated an adaptation of the Vanderbilt-JCEE course in his Ph.D. thesis [7].

The results of evaluations of student learning in PSI courses are inconclusive, although PSI students seem to do at least as well as conventionally instructed students on standardized multiple-choice examinations. In general students report that they enjoy PSI courses more than traditional courses and usually think that they have learned more than they would have in a conventional course (but the objective data do not always support this hypothesis). Instructors commonly report that it is exciting to teach a PSI course and there is some scattered evidence that PSI courses produce a higher percentage of students concentrating in the field of the course.

The economics of PSI courses has not been examined as carefully as their educational value. PSI courses require significant start-up costs plus substantial instructional resources during their operation. The common organization of PSI courses has one instructor supervising a group of proctors, who in turn each tutor up to ten students. Thus for a course of one hundred students there would be at least eleven teachers. This is generally beyond the cost capabilities of most colleges and universities. For this reason, and because many faculty believe that

* This evaluation is part of a larger project evaluating the personalized self-paced case-method of instruction of elementary economics being conducted experimentally by Vanderbilt University and the Joint Council for Economic Education. Financial support was received from the JCEE, the Ford Foundation, and Vanderbilt. Lee Wehby, Mike Cook, Tom Overstreet, and Martin Rini provided clerical assistance. Rendigs Fels and Stephen Strand contributed to the project from its inception to final reporting of the results.

[1] An extensive description of the course, including all materials necessary to replicate it, is contained in [3].

[2] The essence of the case method is requiring students to systematically think through real-world problems for themselves. A discussion of the case method is included in [2]. Many of the cases used in the course are reported in [4].

one learns best when one is instructing a course, most PSI courses have utilized undergraduate students as proctors. Only in this way can the course be made cost-effective.

Allison says that after the course has been developed it requires less time from the instructor than a conventional lecture course [1, 8]. Fels contends that the supervision of the PSI course plus the supervision of the proctors means that such courses place a heavier burden on the instructor than comparable conventionally taught courses [3, 10]. He argues that only if the instructor is given teaching credit for the proctors as well as for the students enrolled in the PSI course do the benefits exceed the costs to the instructor. Some schools reward the undergraduate students with course credit; others compensate the proctors financially. Whether the instructor is given teaching credit for the proctors is intimately connected with the form of compensation received by the proctors.

If teaching credit for supervising the proctors and compensating proctors with course credit rather than cash are necessary to make the course cost-effective to both the school and the instructor, it is critical that the educational content of the proctoring experience be evaluated. While PSI courses commonly use students as proctors, and many assertions are made that the student-proctor learns more from this activity than available alternatives, there have been no systematic empirical efforts to validate these claims.

This study is an attempt to evaluate the costs and benefits that accrue to proctors in the Vanderbilt-JCEE PSI case-method course.[3] Twenty-one proctors were employed during the 1974–1975 academic year. They answered students' questions, administered tests, and gave provisional grades to tests and papers. Each proctor was responsible for about four to five students. The proctors were all undergraduate students, primarily juniors and seniors with good grade records. Most of them had previously taken intermediate microeconomics and intermediate macroeconomics. The proctors took each of the examinations themselves from Fels prior to administering them to enrolled students. They were compensated for their services with three semester hours of credit.

Each proctor was interviewed immediately after completing the proctoring experience. In addition, examination scores for the spring proctors and a control group are analyzed. Multiple linear regression analysis is used to examine the hypothesis that students develop a more complete understanding of material by instructing others. The evidence supports that hypothesis.

II. INTERVIEW RESULTS

All twenty-one proctors thought that they learned more economics by proctoring than they would have learned in an upper level economics course. Seventeen of the twenty-one thought that academic credit was the appropriate form of compensation for proctoring. The strongest argument against awarding academic credit for proctoring is that the economic principles learned while proctoring should have been learned when the proctors took the elementary course themselves. The counter-argument is that it is not necessary to master anything close to one hundred percent of the material presented to students in conventional elementary economics classes in order to earn an A−. An A− level of understanding is far below that necessary to teach the principles to other students. The academic credit for proctoring is for learning "new material" with which the proctors were previously familiar, but which they did not completely understand. The academic credit is for changing "familiarity" into "understanding" of much of the material in the elementary course.

The student-proctors suggested many benefits from the experience that extend beyond their improved understanding of economic

[3] A complete evaluation of the Vanderbilt-JCEE course on additional criteria is contained in [8].

principles. They commonly cited an improvement in the clarity of their verbal expression, insight into the teaching process and how people learn things, experience they obtained in motivating people, and the interesting (and sometimes trying) experience of recycling people.

Fourteen of the twenty-one proctors identified time as the predominant cost to them of proctoring. Many of the proctors claimed that proctoring took about twice as much time as studying for an alternative upper level economics course. Several proctors complained about the distribution of time required. They apparently were frustrated by their lack of control over their personal time. They had to take the examinations themselves at least as rapidly as their most enthusiastic student and be available to students when they needed help, which sometimes interfered with the proctors' study plans for their other courses.

There were very few costs identified by proctors other than time. A few mentioned inevitable personality conflicts. The responsibility for other people's progress eliminates proctors' options to "just go for a C." Some proctors indicated that recycling students caused them some emotional strain. Only one proctor thought that proctoring hurt his grades in other courses that he was taking simultaneously. Most of the proctors recognized a trade-off between time and pressure. They perceived less pressure on them as proctors than there would have been in an upper level economics course. There were fewer crises (i.e., exams). One proctor put it bluntly: "more time, but less sweat."

III. CONTROLLED EXPERIMENT

An empirical evaluation of the impact of proctoring on understanding economic principles was conducted in spring 1975. To control for initial understanding a test of economic principles was administered to ten proctors and twenty matched students prior to the semester. All of these students took the same examination at the end of the semester, after all classes had been completed, but prior to final examinations.

The test instrument was the new (1975) introductory economics test (micro and macro) in the College Level Examination Program (CLEP) of the Educational Testing Service. This is a 100 item 90 minute multiple-choice test of economic principles. It stresses understanding of abstract economic theory. It is a difficult examination of superior quality and thus was particularly suitable for our purpose, since we wished to discriminate among different levels of understanding at relatively high levels of competence. However, the CLEP examination does not test skill in applications, which constitutes about one-fourth of the experimental course. All students were paid a flat fee of ten dollars to take the two exams. Students were motivated to perform well on the CLEP examination by offering cash prizes of up to ten dollars to the top fifteen scorers on each exam, the size of the prize being related to performance.

The ten proctors were selected by Fels prior to the spring semester. The twenty control group students were matched two to a proctor on the criteria of cumulative grade point average, year in school, background in intermediate microeconomics and intermediate macroeconomics, major, and number of previous economics courses taken. To test the similarity of the control and experimental groups we compared their performance on the CLEP examination before the semester. The proctors averaged 72.4, while the control group averaged 72.6. There is no statistically significant difference between these means. On the basis of this evidence, and considering our matching procedure, we concluded that the experimental and control groups originated from the same population and thus could be used in pooled regression analysis.

The index of performance measuring improved understanding of economics principles during the semester is the difference between the CLEP score after the semester and the CLEP score before the semester.

This is a value added measure; it controls for students' initial understanding of economics principles. Since the goal is to relate improvement in understanding of economics principles *during the semester of proctoring* to the proctoring activity, a value added measure is most appropriate. However, because students who perform particularly well on the pre-test cannot score very well on a value added measure we used an alternative measure of improvement in understanding of economics principles, value added divided by the number of points that were available to be added during the semester.[4] Symbolically the measures of performance are:

$$P_1 = T_2 - T_1, \qquad \text{and} \qquad P_2 = \frac{T_2 - T_1}{100 - T_1};$$

where T_i is the score on the ith test and P_j is the jth performance index.

A simple comparison of mean performance between the two groups reveals that the proctors did appreciably better than the control group. These results are reported in Table I. The proctors' mean is significantly higher than the conventional students' mean at the 0.05 significance level. The pre-test scores are essentially identical. On the average the proctors gained 9.4 points during the semester while the control group gained 3.5 points.

There may have been significant differences in the learning experience, environment, or background of students that are not controlled in a simple comparison of mean scores. In particular, different students take different numbers of courses. In addition, it may be important to see if there are systematic differences in the other standard factors that might explain the difference in performance between proctors and control students. We expect most of the control variables like grade point average, previous intermediate theory courses, cumulative number of economics courses, and year in school to show little impact on differential performance because we initially matched the proctor and control samples on the basis of these criteria. Other control variables include SAT scores, sex, mathematics background, other workload during the semester, and number of other economics courses during the semester. These variables have all been examined in much detail in the literature of economics education and most of the hypotheses relating them to learning are self-evident. Therefore the results of the multiple linear regressions are reported in Table II without further elaboration.

The regression results indicate that only proctoring and the number of economics courses that a student took during the experimental semester had a significant effect on P_2. Not one of the remaining control variables was statistically significant at the .05 level. This provides support for the contention that proctoring in the PSI elementary course provides substantial improvement in the understanding of economic principles by the proctors. In addition, it indicates that alternative economic courses are of value for achieving the same goal. It is somewhat comforting to discover that the major device universities employ to improve student understanding demonstrates a statistically significant impact in the expected direction and that other environmental and socio-demographic variables do not, by themselves, explain much of the difference in improved understanding among students.

Because we expected proctoring and alternative economics courses to improve performance scores, these variables are subjected to one-tail statistical significance tests. Age, sex, SAT scores, semester hours, and total economics courses are subjected to a two-tail statistical significance test because there are competing hypotheses with respect to the predicted sign of the coefficient of each of these variables. In additional regression models a dummy variable for whether a student had taken calculus, students' grade point average, and a series of dummy variables for whether students had taken intermediate micro-economic theory, intermediate macroeconomic theory, and the

[4] This measure was, to my knowledge, first proposed by Whitney [9].

TABLE I
MEAN PERFORMANCE OF PROCTORS AND CONTROL STUDENTS ON CLEP EXAMINATION

Performance	Proctors	Control Students	t-ratio for difference between means
T_1	72.4	72.6	0.4
P_1	+9.4	+3.5	2.82**
P_2	+0.333	+0.155	2.20**
n	10	20	

** = statistically significant at .01 level.

grades they obtained in the intermediate theory courses proved to be statistically nonsignificant. This result was expected since students were matched in the two samples on the basis of grade point average and intermediate economic theory experience. Since the presence of the other control variables did not affect the behavior of the coefficients or standard errors of the variables included in regression (2), the details of these other regressions are not reported.

Because the number of current semester courses in economics is not significant in regression (1), the coefficient should be interpreted as zero. Thus a comparison between proctoring and taking advanced economics courses will obviously favor proctoring in regression (1), since there is no impact of advanced economics courses. However, it is appropriate to control for those factors that were not considered in the matching procedure. Therefore, regression (2) should be examined.

The results of regression (2) indicate that an additional economics course during the semester is associated with a 7.8 percent increase in percent of potential value added to the CLEP score. Proctoring is associated with a 20.8 percent increase in percent of potential value added achieved. According to these figures, proctoring is associated with 2.7 times the increase in CLEP performance during the semester than would result from taking one advanced economics course. If the relative cost to the students of these two alternatives is two to one (many proctors stated that the time demand of proctoring was twice that of an advanced course), then in terms of the test criterion proctoring seems more favorable than an advanced economics course by a ratio of about three to two.

The analysis indicates that course instruction and proctoring were the only significant determinants of how much economic theory was learned by upper-class students. However, several caveats are in order. First, these conclusions come from a relatively small sample of students in one discipline at one university. Whether they can be applied to other educational environments is problematical. On the other hand, these empirical data are, to our knowledge, the first systematic attempt to test the thesis that the most effective way to learn economics is to instruct it. In an area with an abundance of ad hoc theorizing and self-appointed experts, bringing systematic empirical data to bear on the question must be considered progress. Second, only linear models were tested. For example, we did not consider whether the impact of an advanced economics course on

TABLE II
MULTIPLE REGRESSION RESULTS: DEPENDENT VARIABLE IS (POSTTEST-PRETEST)/(100-PRETEST)

Variable	(1)	(2)	Measure, [Mean]
Proctor	.158* (1.95)	.208* (2.40)	proctor = 1, otherwise = 0, [.333]
Concurrent Economics Courses	.038 (0.99)	.078* (1.81)	number of spring 1975 economics courses, [2.87]
Age		-.012 (-1.05)	years (proxy for year in school), [19.67]
Sex		.073 (0.70)	male = 1, female = 0, [.70]
SAT verbal		.0016 (1.69)	numerical score, [669]
SAT quantitative		.0004 (0.51)	numerical score, [579]
Semester hours		-.021 (-1.24)	semester credit hours in spring 1975, [14.1]
Cumulative Economics Courses		.006 (0.48)	cumulative economics courses as of June 1975, [10.5]
R^2 (coefficient of determination)	.183	.497	
F (Fisher's F-ratio)	3.0*	2.5*	

n = 30
* = statistically significant at 0.05 level.

improving the understanding of economic theory depends on whether it is the first, second, third, or fourth economics course taken during the semester. Some people would argue that there is a threshold effect, that is, a minimum number of courses necessary to have any impact at all. Others would argue that there are diminishing marginal returns to improving one's understanding of economic theory with respect to additional courses. A non-linear impact might also be expected from several of the other variables in our regressions. Alternative functional forms have not been examined empirically because of the limited size of the sample. Third, the empirical test explored the relative effect of proctoring and advanced courses only on improving students' understanding of economic theory. There are other worthwhile goals of advanced economics courses—providing familiarity with institutions, generating enthusiasm for economic inquiry, exposing students to research methods, etc. None of these objectives are measured effectively by the test instrument. On the other hand, there are also many benefits of proctoring that go beyond the improved understanding of economic theory. Proctors presumably improve their skills in analyzing realistic policy cases; they learn to

deal with other people in conflict situations; they are forced into self discipline and develop patience. These factors may easily be as important to students' future life experience as learning about economic institutions or research methodology. We have evaluated only one dimension of the multi-dimensional output of university instruction. This comparison can be useful if it permits an objective evaluation of alternative instructional techniques on this single dimension. Then more effort can be directed toward comparative evaluation of the other dimensions of instruction and the all important problems of how these different dimensions should be weighted in instructional decisions.

IV. CONCLUSION

Based on interviews of proctors and on empirical analysis, it is concluded that proctoring is an effective means for students to improve their understanding of economic principles. The twenty-one proctors during 1974–1975 unanimously voiced the view that they learned more economics by proctoring than by taking an alternative advanced economics course. An empirical study of ten proctors and twenty control students indicates that the proctors would improve their scores on an economics exam 2.7 times the improvement by students who elected to take an advanced economics course instead. On the basis of this evidence an argument can be made for compensating proctors for their services with academic credit.

Studies which conclude that students in PSI courses perform no differently from students in conventional lecture-discussion courses have failed to enumerate an important set of benefits that accrue to the student-proctors. This supports a case for employing students (rather than professional instructors) as proctors for PSI courses. If student-proctors are compensated with course credit and the instructor is given teaching credit for the proctors, PSI courses stand a good chance of being cost effective. The evidence uncovered in this analysis suggests that there is more learning of economic theory taking place during proctoring than during alternative economics courses, which provides a logical foundation for compensating undergraduate student-proctors in PSI courses with academic credit.

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