Use of a Student-Authored Study Guide to Teach Undergraduate Applied Econometrics

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Abstract

This paper represents an analysis of how the incorporation of a student-authored study guide project influences learning and student perceptions in an undergraduate applied econometrics course. Results show that the project does help students perform higher on questions directly related to the creation of the study guide. While students taking part in this project appear to outperform those in classes without the project on problem-solving examinations, these gains do not appear to be statistically significant. Nevertheless, the study guide project is viewed favorably by students and they tend to believe it helps them prepare for examinations. Incorporation of this project as a learning tool seems to provide a marginal improvement in important student evaluation measures.

Key Words: applied econometrics; learning assessment; study guide development; student perceptions

JEL Codes: A22; C01

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1. Introduction

The literature in economic education over the past decade is rich with information on various techniques and materials useful in making introductory economics courses more interesting to students. The common thesis in this area of research is that, presumably, a more interesting method of imparting course material beyond the standard lecture format will motivate students to learn more effectively. While it has not been empirically proven that any of the various approaches enhance student learning of the basic subject material in economics, the proliferation of alternative learning vehicles in the literature and in the textbooks available to instructors suggests that there is a growing belief that these methods are effective.

The general claim that a combination of lecture and another alternative information delivery device, especially one that involves the active participation of students, is not new to the literature in the education discipline (Rich, 1988). A series of more detailed discussions on teaching techniques that extend beyond the traditional “chalk and talk” approach that are specific to introductory economics were presented in two papers by Becker and Watts (1995, 1998). An extension of this line of analysis by Cameron (1998) showed that students typically learn in different ways and that the use of varied learning tools can improve effective thinking in an introductory economics classroom. Strategies used to teach basic concepts in economics range from the use of simulation games (Raehsler, Haggerty, and Caropreso, 1996) and the incorporation of experimental bargaining games (Raehsler, 1999) to a more abstract use of Shakespeare to teach monetary economics (Kish-Goodling, 1998). Bekar and Grant (2010) provide a more detailed discussion of how literary novels can be used to teach economics. They find that the use of a novel along with movies and magazine articles helped in a freshman seminar course. Unfortunately, the authors do not provide any empirical evidence to substantiate the effectiveness of this teaching strategy aside from observational information. As a consequence, the article is more of an explanation of how to incorporate a literary novel into various types of economics courses rather than an assessment of the technique.

Applied statistics and econometrics courses provide an added pedagogical challenge when compared to introductory economics courses in that the material taught is typically linked to a student’s academic performance in a wide range of mathematics courses. Every instructor teaching undergraduate statistics or econometrics will teach students with some variance in overall mathematical ability that is often influenced by many previous instructors. Any perceived lack of mathematical preparation or student trepidation concerning quantitative analysis can greatly inhibit learning in these type of courses. Becker (1987) is the first to provide an alternative view on how to teach statistical methods to undergraduate students. Rather than focusing on a more traditional lecture centered on describing econometrics from a theoretical perspective, the development of more innovative microcomputer labs with more sophisticated software created an environment for improved teaching of statistical methods. Becker and Greene (2001) significantly expanded this perspective by outlining key concepts and skills where teaching needed to be improved in undergraduate econometrics and statistics. They noted that most lectures and textbooks in the field tend to downplay the practical aspects of applying econometric theory despite the wealth of data available with relatively simple software. They advocated the use of real data in teaching econometrics and discussed some areas where data would be available. The authors pointed out that the reticence of instructors to use realistic examples was often based on the perceived effort required; a claim that does not garner support when considering the level of technology currently available. Hendry and Nielsen (2009) expand on this work by providing real data and displaying how this information can be used to cover a wide range of topics in an advanced econometrics course. Mixon and Smith (2006) had previously identified a particular statistical software that can be used to teach an undergraduate econometrics course. Interestingly, no research involving alternative methods in teaching econometrics looks at measuring the empirical
impact of the teaching technique on student performance. As a consequence, this is an important avenue of research given the critical nature of econometrics in the discipline.

The analysis in this study takes a slightly different approach in looking at the impact of a much different type of student activity meant to improve student involvement and learning. Specifically, this study focuses on measuring the impact on academic performance that the inclusion of a student-authored study guide has on learning in an undergraduate applied econometrics course. The rationale behind the belief that an active project like this can aid in student learning is that it forces students to read more deeply into the material presented in the course. In addition, the process of developing study guide questions might actually be a way students can study for examinations. Furthermore, the prospect of a student seeing his or her name as an author of a study guide to be used by other students in subsequent classes could lead students to put greater effort in the project.

2. Study Guide Project and Course Sections
The analysis in this paper is limited to using information derived from sections of an undergraduate applied econometrics course taught in three separate semesters: spring of 2013, the fall of 2013, and the spring of 2014. Students enrolled in the undergraduate applied econometrics class are typically business majors, however, a good number of students enrolled boast a variety of academic majors in liberal arts and science. In the spring 2013 semester a total of 54 students completed the course and the study guide project was included in the final grade. During the fall semester 2013 course, 61 students completed the semester and the group project was not utilized. As a final comparison, 57 students taking the course during the fall semester of 2014 were not assigned the project but were supplied with the study guide developed the previous year. For a consistent comparison of academic performance results, the same quiz and examination questions were given each semester and courses were taught by the same instructor.

The study guide project itself was fairly simple. Students were assigned to one of five groups and each group was required to develop study guide questions for various chapter topics in the course. The five general areas were sampling distributions and estimation, analysis of variance, regression analysis, residual analysis, and forecasting. For each topic, three groups were assigned in order to maximize the exposure students had to the material. For example, assignments were as follows:

Sampling Distributions and Estimation: Groups 1, 2, and 3
Analysis of Variance: Groups 4, 5, and 1
Regression Analysis: Groups 2, 3, and 4
Residual Analysis and Corrections: Groups 5, 1, and 2
Forecasting and Time Series Analysis: Groups 3, 4, and 5

Each group was required to submit fifteen multiple choice questions as well as three essay questions (or problems to solve) to the instructor prior to the beginning of class discussion on the material. Therefore, if the sampling distribution and estimation discussion was scheduled to begin on a Monday, the groups responsible for that part of the study guide (Groups 1, 2, and 3) would need to turn in their questions the previous Friday. The instructor served as the initial editor and all problems were
handed out to each student in the next class. Weekly quizzes were distributed consisting of three questions from each group (nine questions from the study guide) and one question developed by the instructor. Each topic would be covered by two quizzes prior to examinations. At the end of the semester, all questions along with answers are published in a study guide with students listed as authors (a copy of the study guide is currently in a display case in the college). This study guide was used in the spring 2014 class.

During the course of a semester, each group needed to develop 45 multiple choice questions and nine essay questions by the time the lecture for the material began. This required group members to study the material prior to classroom presentation and to find a way to coordinate group work on the problems. Each group elected a representative to serve on the editorial board for the final version of the study guide to make sure problems were solved correctly even after instructor revisions. Students were told that the guide would be published with their names included as authors and that it would be used by subsequent classes. Assessment of work done on the project would be based on an overall group grade, a grade from others in the class using the study guide questions, and a score from each colleague within each group.

Analysis on the impact of this project is based on performance on quiz questions coming directly from the study guide questions, additional quiz questions related to the material each group studied, and remaining questions not directly linked to each group’s work along with examination performance in the class. A survey was provided at the final examination and responses are studied in addition to taking a look at how student evaluations compare for two different sections of the course (one with the study guide project and another excluding the project).

3. Empirical Results

The bottom line when introducing any class assignment involves considering how student learning is influenced. This is best measured by looking at class performance on examinations and quizzes. This section will begin by looking at performance on quiz and examination material in the class that utilized the study guide from a separate group-level to an overall course performance. Results will then concentrate on how academic performance compares across classes when the primary difference relates to the inclusion of the study guide project. While not as closely linked to learning outcomes, the analysis will conclude by looking at the results of a student survey on the project and student evaluations across two different semesters.

3.1 Academic Performance in the Spring 2013 Sections (with the study guide project)

As stated above, the Spring 2013 section of undergraduate applied econometrics included the study guide project. Table 1 below outlines important statistics related to academic performance on quizzes and the group project. The primary information provided in Table 1 focuses on quiz performance relevant to the study guide project for each group and the class as a whole. During each unit, two quizzes comprised of ten multiple choice questions were given. As explained above, three groups are responsible for creating fifteen multiple choice questions and three essay questions each meaning that 45 multiple choice questions are available for the two quizzes in each unit. For each quiz three multiple choice questions are selected from each group with one developed by the instructor added (making ten multiple choice questions for each quiz). This means that during the course of a semester consisting of ten multiple choice questions, each group will see 18 of questions in the study guide they specifically created, 36 questions from the study guide on questions created by other groups assigned to the same unit (recall that three groups are assigned to each unit), 36 questions from the study guide developed by groups in other units, and 10 questions inserted by the instructor and not available in the study guide. These questions are termed “Group-Developed Questions”, “Related Material Questions”, “Unrelated
Material Questions”, and “Instructor-Created Questions” respectively in the tables below. Each midterm examination utilized one essay question from each group assigned to each particular material unit.

Results looking at quiz scores show some interesting patterns when compared across question type as presented in Table 1 below. As expected, there are differences across groups with regard to average performance on quizzes. These differences are fairly significant in that the average score (in percentage of total points) ranges from 84.67 percent for the top group to 68.30 percent for the bottom group with respect to performance on the multiple choice quizzes. Quiz results across the categories of multiple choice questions defined above follow expected patterns. For each group, performance is much higher on questions directly developed by the group and significantly lower for questions developed by the instructor. It is important to note that performance on quiz questions in the study guide developed by other groups, regardless of whether the material matched a group’s assignment, were higher than instructor-developed questions. This shows that the study guide was utilized by most students in the course but that working directly on material did not provide a group with any comparative advantage over groups not working in the same unit. This seems to indicate that the study guide provided some direct benefits but that actively working on material early did not. Interestingly, the largest variation in scores existed for instructor-developed questions. This implies the possibility that active participation of students in the project translates to a somewhat improved performance on questions not in the study guide relative to those already seen by students. The difference for instructor-developed questions across groups seems to support this claim.

The table also presents the standard deviation of scores assigned to each student in the group by colleagues. In order to provide differential points and, hopefully, provide all students in each group to fully participate in the project, students were asked to assign points for fellow group members to identify the value of their contributions.

**Table 1: Summary Performance Data by Group**

<table>
<thead>
<tr>
<th>Category</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Quiz Score</td>
<td>84.67</td>
<td>83.42</td>
<td>81.40</td>
<td>70.60</td>
<td>68.30</td>
<td>78.15</td>
</tr>
<tr>
<td>Group-Developed Questions</td>
<td>92.13</td>
<td>91.20</td>
<td>87.78</td>
<td>78.89</td>
<td>82.78</td>
<td>86.93</td>
</tr>
<tr>
<td>Related Material Questions (Developed by Other Groups)</td>
<td>84.03</td>
<td>83.56</td>
<td>80.56</td>
<td>71.11</td>
<td>70.00</td>
<td>78.29</td>
</tr>
<tr>
<td>Unrelated Material Questions (Other Group Material)</td>
<td>83.80</td>
<td>82.87</td>
<td>81.94</td>
<td>68.33</td>
<td>63.61</td>
<td>76.65</td>
</tr>
<tr>
<td>Instructor-Created Questions</td>
<td>76.67</td>
<td>70.83</td>
<td>71.00</td>
<td>62.00</td>
<td>53.00</td>
<td>67.22</td>
</tr>
<tr>
<td>Standard Deviation of Colleague Scores (Cohesion Measure)</td>
<td>2.97</td>
<td>3.39</td>
<td>3.26</td>
<td>6.71</td>
<td>3.20</td>
<td></td>
</tr>
</tbody>
</table>

Groups where work is equally shared will have a lower standard deviation of how points are assigned to colleagues in each group.
Students were told that their ratings would not be revealed (they were collected at the final examination). This quantitative information is used to loosely identify the level of cohesion or shared work load by group members. The idea is that if every group member contributed equally to the final group product, each student would receive the same score and the standard deviation of scores would be zero. The higher this standard deviation becomes, the less equal are work shares among students in the group and this is regarded as being a less cohesive group (a few leaders and a good number of free riders). It was initially believed that this might explain how well groups do and how well students learn. While the top group in terms of quiz performance does appear to display the greatest level of cohesion (smallest standard deviation) and one of the lower-performing groups shows the opposite (a higher standard deviation), there does not seem to be a clear and consistent pattern when observing results for the remaining three groups. This indicates that a lack of cohesion or the existence of “free-riders” in groups does not appear to adversely impact quiz scores. It should be noted, however, that with the exception of Group 4, the standard deviation values are relatively similar. This implies that there are very few students not participating adequately in the project outside the one group. Favorable statistics involving survey results discussed in a later section support this notion. As a consequence, the relatively poor performance of Group 4, especially on questions developed by the group, indicates there is some possibility that poor group dynamics can adversely affect academic performance. Further investigation, however, on this needs to be accomplished before making any definitive conclusion.

### 3.2 Academic Performance Across Classes

Table 2 below presents data on academic performance across classes for three different semesters of the same course. The study guide project was first used in the spring semester of 2013. In order to determine the possible impact of the study guide project, during the fall 2013 class the same questions on quizzes and examinations were given but the project was not used and the study guide was not made available to students. Of course, an important question is whether academic performance is affected by work on he study guide (or the actual project) or simply by the availability of the study guide remains. To try and test this, the study guide was made available to students in the class during the spring 2014 semester but the project was not assigned (therefore, this is the study guide created by students the prior year). Overall quiz score, scores on study guide questions developed by students, scores on instructor-developed questions, scores on the midterm essay questions (also available in the study guide), and final examination scores (entirely problem-solving essay questions) are displayed in Table 2 below.

Results show that there are statistically significant differences in average quiz scores in both spring 2013 and spring 2014 semesters when the study guide was utilized. As a consequence, it is clear that the use of the study guide helps with average performance on quizzes. This difference, however, is primarily due to the performance on questions seen in the study guide. Table 2 shows a significant difference on study guide questions when comparing classes not using to those using the study guide. This difference becomes statistically insignificant, however, when instructor-developed questions are analyzed. This indicates that when the study guide is provided to students, they tend to utilize it in preparing for quizzes.

Table 2 also shows the possible impact that the development of the study guide has compared to simply utilizing the study guide. Overall quiz scores and scores on study guide questions are significantly higher in the class that created the study guide as a project (spring 2013) compared to the class that simply used the study guide (spring 2014). Since results on instructor-created multiple choice questions were essentially identical, it appears the activity involved in creating the study guide helped on quiz performance for multiple choice questions in the study guide. This would seem to make sense as creating and solving problems is a way to learn material. Unfortunately, this did not translate to statistically significant improved performance on questions provided by the instructor.
Table 2: Summary Data of Performance Across Classes

<table>
<thead>
<tr>
<th>Category</th>
<th>Spring 2013 Data (With Project)</th>
<th>Fall 2013 Data (Without Project)</th>
<th>Spring 2014 (Without Project)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Quiz Scores</td>
<td>78.15*</td>
<td>64.97</td>
<td>72.75**</td>
</tr>
<tr>
<td>Study Guide Questions</td>
<td>79.36*</td>
<td>64.81</td>
<td>73.35**</td>
</tr>
<tr>
<td>Instructor-Created Questions</td>
<td>67.22</td>
<td>66.39</td>
<td>67.37</td>
</tr>
<tr>
<td>Midterm Essay Examination Scores</td>
<td>74.24*</td>
<td>65.93</td>
<td>73.79*</td>
</tr>
<tr>
<td>Final Examination Scores</td>
<td>69.22</td>
<td>66.51</td>
<td>69.41</td>
</tr>
<tr>
<td>Sample Size</td>
<td>54</td>
<td>61</td>
<td>57</td>
</tr>
</tbody>
</table>

* Average score significantly different from Fall 2013 average score.
** Average score significantly different from Spring 2013 average score (Fall 2013 not included).

Examinations in the course consisted of problem-solving or essay questions. Table 2 shows that the incorporation of the study guide as done in the spring 2013 and 2014 semesters resulted in significantly higher scores than during the semester without the study guide (fall semester of 2013). The project of creating the study guide, however, did not appear to provide a significantly higher average score than during the semester where just the study guide was utilized. The final examination each semester consisted of essay problems students did not see in the study guide and, consistent with the multiple choice question analysis, while the average was lower for the fall semester class, it was not statistically significant. This seems to indicate that the incorporation of the study guide helps students solve essay problems they see in the study guide but does not significantly impact questions not observed in the study guide. Overall, it does appear that scores on quizzes and examinations do improve using this project, but they are not significantly altered by just the inclusion of this semester exercise. It may be that gains are seen in factors that cannot be measured through examination of course material.

3.3 Student Survey

At the conclusion of the final examination, students were asked to fill out a survey on the study guide project. The following eight questions were asked of each student:

Question 1: This was an enjoyable project to work on during the semester.
Question 2: I thought the study guides helped me prepare for the exams.
Question 3: I would have preferred having quizzes and homework in place of the study guide project.
Question 4: This was a difficult project to work on.
Question 5: This project helped us form a study group to prepare for examinations.
Question 6: Our group worked well together.
Question 7: This project should be continued in future sections of this course.
Question 8: Do you believe it is important that the study guide will be published with your name included.

Answers provided were on a five point scale with 5 as strongly agree and 1 as strongly disagree. Results of the survey are displayed in Table 3 below that include average responses, the standard deviation of responses, and the t-statistic when testing to see whether the sample average is equal to 3 (the neutral answer). The statistics show that in questions 2, 4, 6, 7, and 8 the averages are significantly favorable or unfavorable. In question 2, for example, students appear to believe that the study guide helped them prepare for examinations. Question 4 shows students did not view the project as being too difficult while questions 6 and 7 showed that students believed groups worked well together and that the project should be continued in the future. This supports the earlier contention that only one group seemed to experience a free-rider problem. Question 8 results clearly indicate that it was important for students to see their names on the finished product.

Table 3: Student Survey Results

<table>
<thead>
<tr>
<th>Measure</th>
<th>Average</th>
<th>Standard Deviation</th>
<th>t-statistic for significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>3.357</td>
<td>0.951</td>
<td>1.679</td>
</tr>
<tr>
<td>Question 2</td>
<td>4.036</td>
<td>0.962</td>
<td>4.817</td>
</tr>
<tr>
<td>Question 3</td>
<td>2.893</td>
<td>1.257</td>
<td>-0.381</td>
</tr>
<tr>
<td>Question 4</td>
<td>2.429</td>
<td>0.879</td>
<td>-2.907</td>
</tr>
<tr>
<td>Question 5</td>
<td>2.893</td>
<td>1.100</td>
<td>-0.435</td>
</tr>
<tr>
<td>Question 6</td>
<td>3.857</td>
<td>0.971</td>
<td>3.950</td>
</tr>
<tr>
<td>Question 7</td>
<td>3.714</td>
<td>0.937</td>
<td>3.409</td>
</tr>
<tr>
<td>Question 8</td>
<td>3.607</td>
<td>0.737</td>
<td>3.682</td>
</tr>
</tbody>
</table>

3.4 Student Evaluations

Student evaluation results for the spring semester and fall semester sections in 2013 are included. The relevant questions on the student evaluations are as follows:

Question 1: The quality of instruction was
Question 2: The amount of effort in this course compared to others is
Question 3: Materials used helped achieve course objectives.
Question 4: Found course content to be
Question 5: The instructor effectively used examples/applications/illustrations in this course.

Survey responses range from 1 to 5. In questions 1 and 4 a value of 5 is associated with excellent while a value of 1 is poor. For question 2 a value of 1 means less effort while a value of 5 means more effort. For the remaining questions, 1 is assigned to highly disagree while 5 corresponds to a highly agree. For each question, a larger average is better than a smaller average. Table 5 below shows average responses for each question. It appears that overall instructor performance, student opinion about course content and the use of applied examples to teach the course are all higher in the section that utilized the study guide project. Students did report that, on average, more effort was required in this section. While it is unclear whether the use of the study guide project alone can take credit for this increase, it certainly did not negatively impact ratings; an important feature when applying for tenure and promotion. Interestingly, students in the section utilizing the study guide project reported a lower average on the question that measured how course materials helped meet course objectives. This runs counter to the perception that the study guide project assisted students in preparing for examinations. One explanation is that student evaluations and the student survey were given at two different times in the course (student evaluations are given approximately one month before final examinations). In addition, students are likely including other homework and examinations among materials meant to meet course objectives.

Table 5: Student Evaluations for Undergraduate Applied Econometrics with and Without Study Guide Project

<table>
<thead>
<tr>
<th>Student Evaluation Question</th>
<th>Spring 2013 (With Study Guide Project)</th>
<th>Fall 2013 (No Study Guide Project)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quality of Instruction</td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td>2. Effort Compared to Other Courses</td>
<td>4.2</td>
<td>4.0</td>
</tr>
<tr>
<td>3. Material Helped Achieve Course Objectives</td>
<td>3.7</td>
<td>3.9</td>
</tr>
<tr>
<td>4. Found Course Content to Be</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td>5. Used Example/Applications/ Illustrations Effectively</td>
<td>4.8</td>
<td>4.5</td>
</tr>
</tbody>
</table>

4. Conclusion

While the student study guide project began as a way to involve students more in actively solving problems in applied econometrics, it really has become a mechanism to break up the standard lecture format of the course. Results in this analysis are somewhat encouraging in that it is clear that students took the project seriously and used the study guide to prepare for quizzes and examinations. This resulted in significantly higher quiz scores and marginally higher scores on examinations. It would
not be realistic to anticipate that a single project would significantly improve overall examination scores, so results in this study are encouraging. This does represent a specific example of a way to incorporate a new teaching methodology without sacrificing content; a major goal of the recent educational literature dealing with statistics and econometrics. While the improvement on the final examination averages in applied econometrics were not statistically significant, student perceptions of the course were positively influenced. Whether this was a result of the project or the greater perception of instructor involvement in the course is uncertain. This does provide a reason to further explore the use of a student-authored study guide in quantitative courses.

Future analysis will need to focus on which students are helped by using this type of project. While not officially recorded, attendance appeared to improve in classes using this project. That implies that the greatest gain might have been experienced by students in the middle to lower half of the typical grade distribution. An analysis including the characteristics of students taking the course may help solve this area of inquiry.
References


