A COLLABORATIVE LEARNING LAB: DOES THE FORM MATTER?

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A recent paper found that adding a collaborative learning lab (CLL) component to a traditional introductory microeconomics class significantly improved students' scores on a standardized final exam. Here, the authors reconsider these results in two fundamental ways. First, this article is able to include student-specific factors, such as standardized test scores and age, to control for a student's desire and ability to perform. These results suggest that they slightly underestimate the gains from CLL classes. The second question addressed concerns the implementation of the CLL component. In the original work, the CLL class contained only 24 students in class (small-CLL). This paper introduces the CLL component into a class with 48 students (large-CLL). The authors found students attending a large in-class CLL failed to perform significantly better on a standardized test than students attending classes without an in-class CLL. They also performed significantly worse than students in a small-CLL environment. This article suggests that a CLL can improve scores if care is taken to both maintain an environment that maximizes student–instructor interaction and monitors student collaboration. (*JEL* A2, D0)

I. INTRODUCTION

In a recent paper, Moore (1998) introduced an out-of-class collaborative learning lab (CLL) in his introductory economics classes and reported on its effectiveness as indicated by answers to a student questionnaire. He concluded that students found the CLL enjoyable, helpful, and a very worthwhile experience. Khandker and Elfessi (2000) extended this by measuring the effectiveness of the course from a questionnaire gauging student perception and the students' actual performance on a standardized test compared to a control group's performance on the same test. The results reinforced Moore's (1998) conclusion that students not only were enthusiastic about the CLL but also gained a greater understanding of the materials, as evidenced by their significantly higher test scores.

Even though both articles introduced a CLL into an introductory economics class, their methods varied in significant ways. Specifically, the differences are:

- *Content coverage.* To save the entire class time for content coverage, Moore (1998) urged his students to take the unit tests outside of class at prearranged times. Because it required 70 hours of additional time per hundred students, specially trained CLL student mentors were hired to conduct the CLL part of the course. Moore (1998) not only had to train the student mentors, he also had to arrange schedule-compatible student work groups. Taking a different approach, Khandker and Elfessi (2000) introduced a CLL component inside of regular class time, thereby eliminating the need for tutors and additional demands on students' time. However, this reduced the total lecture time

ABBREVIATION

CLL: Collaborative Learning Lab

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by about six hours. They compensated for the lost lecture time by combining two regular sections of an introductory microeconomics class containing 48 students each into a large, predominantly lecture class that met for two consecutive hours per week. The six lost hours were recovered by reducing the amount of time needed for recap. This arrangement enabled the instructor to meet with the students one additional hour per week without increasing his or her workload by dividing them into four small collaborative learning labs of 24 students each (this method of teaching will be referred to as small-CLL).

- *Collaboration among students.* Moore's (1998) students had to explain their answers orally to student tutors. However, only one student from each group was called on to explain the group's answer. To eliminate the free rider problem, tutors used a random procedure to determine which student would be called on. This procedure motivated the group members to ensure everyone in the group understood the materials and could communicate the group's answer to the tutor. It was the instructor in Khandker and Elfessi's (2000) CLL class who, by his or her observation and presence, ensured everyone participated in collaborative discussions.
- *Encouragement of continuous improvements.* Moore's (1998) students were allowed to take further iterations of the unit tests until they answered all the questions correctly. In Khandker and Elfessi's (2000) CLL class, the entire class discussed mistakes made by different groups under moderation from the instructor.

Although differences are evident, the implementations are rooted in the same principle of increasing student collaboration. When analyzing the effectiveness of increased collaboration, Moore's (1998) study was limited to an opinion survey instead of a controlled experiment. The most important contribution of Khandker and Elfessi (2000) article was the comparison of students' scores on a standardized final to those of a control group, which did not participate in a CLL component. However, one potential bias stems from the fact that the class size, time of day, and length of each class differed among groups.

To overcome the potential problems mentioned, this article applies yet another method of instruction. In this method, the class time, class duration, and class size were kept the same between the control and experimental groups to eliminate potential biases. The implementation involved adding a CLL component into a traditional Monday–Wednesday–Friday class (herein large-CLL). Even though students were enthusiastic about the CLL component, students attending a large-CLL class failed to perform significantly better on a standardized test than students attending a non-CLL class. Thus, it appears improvements are dependent on the CLL (and hence lecture) class sizes. Furthermore, the effectiveness of a CLL component diminishes as the CLL class sizes increase (and hence lecture class sizes decrease).

Additionally, and unlike Khandker and Elfessi (2000), student specific characteristics were included to control for differences in the ability and desire of students in different groups. After accounting for these differences, the gains on a standardized final from a small-CLL class are larger than was previously estimated.

II. CLASS DESIGN

To eliminate potential instructor bias, all classes were taught by one of the authors. The non-CLL control group was taught in the fall of 1996; the instructor taught two sections of a Monday–Wednesday–Friday introductory microeconomics class with a total of 95 students in a standard lecture format. Out of 42 lecture hours during the semester, 8 hours were spent on first-day introduction, pretest, three midterm exams, and three review sessions. The remaining 34 hours were used to cover the standard materials, which were divided into nine units. A 20-question, multiple-choice homework assignment was given after the completion of each unit.

The small-CLL class used in Khandker and Elfessi's (2000) was taught in the fall of 1998. It consisted of 92 students enrolled in a two-hour lecture class and one of the four one-hour classes. The one-hour classes were limited to 24 students. Nine of the 14 one-hour classes were converted to CLLs where students gathered in groups of four to solve and discuss exercises for nine different units. The remaining five one-hour classes were devoted to the same introduction, pretest, and midterm exams given to the non-CLL group.

The two-hour lecture classes in the small-CLL format allowed Khandker and Elfessi (2000) to cover the entire material in lecture (making up for the six hours of lost lecture time). It reduced the recap time, and the instructor efficiently utilized the ten-minute break in between two lectures (giving breaks at a convenient time when a chapter or section was completed).

The large-CLL format was taught in the fall of 1999, and the same instructor converted 9 of the 14 Friday classes into CLL classes. Three of his nine CLL classes were available through the reduction of the review classes from the non-CLL class. Again, six fewer hours of lecture were available; they were partially recouped through less in-lecture student–teacher interaction, fewer real-world examples, and less in-class content coverage. Instructor's lecture classes were smaller with 46 students in each, as opposed to 95 students in the small-CLL lecture classes, whereas the CLL classes were larger with 48 students (as opposed to 24 students in the small-CLL classes). Another major difference between the two methods of instruction was the form of the lectures. The large-CLL lectures were on Mondays and Wednesdays, one hour each during the same time (morning hours) as the non-CLL classes, as opposed to two consecutive hours of afternoon lectures for the small-CLL classes.

Each method of instruction adhered to the same procedures where appropriate. A departmentally designed pretest (herein *APTPRE*), similar to the Test of Understanding of College Economics, consisting of 20 multiple-choice questions was given the first day of class. The primary objectives of the test designed by the department's assessment committee were to serve as a measuring instrument for controlled experiments in teaching introductory economics and to enable instructors to compare the performance of their students before and after the completion of the particular introductory course.[1] The final exam, consisting of 40 multiple-choice questions, was administered at the end of the semester. In the CLL classes, assignments were given at the end of each unit, and students had time to develop answers before attending CLL class. Students discussed answers with their group members for the first 25 minutes, and the instructor made sure each student was participating in the group discussion. The instructor also gave extra attention to those groups with relatively lower group scores identified from the previous unit. Each group submitted one answer sheet, which the instructor graded and returned immediately. During the second half of the class, the instructor acted as moderator as answer sheets were discussed between groups.[2] The non-CLL classes were given the same assignments but did not have the opportunity for intergroup discussions.

1. A copy of the instrument is available from the authors on request.

III. RESULTS

The data for the non-CLL and small-CLL classes were taken from the Khandker and Elfessi (2000) article. In their paper, they were only able to control for student differences by their performances on the standardized pretest (*APTPRE*). The *APTPRE* results failed to demonstrate a significant difference between the non-CLL and the small-CLL classes. However, this only controlled for a student's knowledge of microeconomics when he or she entered the class and failed to account for potential differences in the student's desire and ability to learn. Becker (1997) suggests that there are additional individual characteristics that influence a student's ability to perform on a standardized final in an economics principles class, such as ACT scores. In light of this potential shortcoming, we were able to append to Khandker and Elfessi's (2000) data with information obtained from institutional resources on individual student characteristics.

In Table 1, we augment Khandker and Elfessi's (2000) empirical evidence by including student-specific factors, such as age, ACT scores, and year in school.[3] The inclusion of student-specific variables does not suggest there are any systematic differences between the control group and the small-CLL group, as is evidenced by the insignificance of the coefficient on the dummy variable *EXPERIM*, given in column (3) of Table 1. The one interesting note in this regression is the dummy

2. A comparative analysis of the three teaching methods is provided in the appendix.

3. For a complete list of variables, refer to the appendix.

TABLE 1
Small-CLL Class versus Non-CLL

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent	*APTPRE*	*APTPRE*	*APTPRE*	*SCORE*	*SCORE*	*SCORE*
EXPERIM	−0.292	−0.515	−0.658	1.786	2.068	2.628
	(0.468)	(0.235)	(0.152)	(0.050)*	(0.015)*	(0.006)**
APTPRE				0.474	0.401	0.416
				(0.015)*	(0.028)*	(0.027)*
GENDUM1		0.191	0.164		0.678	0.341
		(0.645)	(0.690)		(0.424)	(0.686)
AGE		−0.002	−0.109		1.220	0.801
		(0.990)	(0.629)		(0.000)**	(0.035)*
REPEAT		1.811	1.624		−2.151	−2.460
		(0.000)**	(0.002)**		(0.034)*	(0.026)*
ACTMTH		0.023	0.024		0.665	0.634
		(0.686)	(0.671)		(0.000)**	(0.000)**
COLL2			−0.894			0.525
			(0.061)			(0.583)
YRNSCH1			0.043			−2.154
			(0.945)			(0.073)
Constant	6.475	6.048	8.678	18.070	−20.781	−11.096
	(0.000)**	(0.111)	(0.091)	(0.000)**	(0.003)**	(0.244)
Observations	141	124	124	140	123	123
R^2	0.004	0.019	0.052	0.065	0.269	0.289

Note: Robust *P* values in parentheses.
*significant at 5%; **significant at 1%.

variable, *REPEAT*, which takes the value of one if the student was previously enrolled in this class and zero otherwise. It suggests that the students retained something from the previous class, if only a small amount, because it only improves their *APTPRE* score by 8.2% over the average.

Further confirmation of Khandker and Elfessi's (2000) results can be found in the second half of Table 1. These results are slightly more robust then their original findings, and, in fact, it appears as though they slightly underestimate the improvement on the standardized 40-question final (*SCORE*). They reported students in the small-CLL class performed roughly 4.7% better than they would have in the non-CLL class; our results suggest the improvement was on the order of 6.6%. Incorporating the individual student characteristics allows us to confirm the findings of other authors, such as Becker (1997), who have suggested that age and ACT quantitative scores significantly improve the students' scores on standardized multiple-choice finals in principles class. Interestingly, we fail to find support for the hypothesis that women do significantly worse than men on multiple-choice exams, as has been found in research by Robb and Robb (1999).

Moving to the large-CLL format, the first three columns of Table 2 present the results when the pretest (*APTPRE*) is the dependent variable. This article fails to find any significant correlation between the class format and the students' performances on the pretest. When comparing the large-CLL and non-CLL outcomes on the final exam, it appears there is no significant difference between them. This should not be taken to mean that a CLL component is ineffective; rather, there are several possibilities that can include (but are not limited to) the reduction in content coverage. In fact, it is a bit surprising that although there were nearly six fewer hours available for content coverage in the large-CLL format, students performed just as well as students in the control group.

Turning to the two methods of teaching CLL, the small-CLL and large-CLL formats necessitate a direct comparison as they entail different advantages and disadvantages

TABLE 2
Large-CLL versus Non-CLL

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent	*APTPRE*	*APTPRE*	*APTPRE*	*SCORE*	*SCORE*	*SCORE*
EXPERIM2	0.859 (0.047)*	0.802 (0.116)	0.718 (0.162)	−0.242 (0.800)	−0.615 (0.554)	−0.672 (0.515)
APTPRE				0.530 (0.012)*	0.362 (0.107)	0.350 (0.136)
GENDUM1		0.136 (0.782)	0.209 (0.685)		0.943 (0.307)	0.591 (0.544)
AGE		−0.257 (0.278)	−0.302 (0.346)		0.679 (0.079)	0.305 (0.576)
REPEAT		−0.868 (0.299)	−0.847 (0.366)		2.147 (0.118)	1.908 (0.153)
ACTMTH		0.068 (0.365)	0.069 (0.334)		0.665 (0.000)**	0.662 (0.000)**
COLL2			−1.072 (0.056)			−0.346 (0.753)
YRNSCH1			0.360 (0.603)			−1.233 (0.306)
Constant	6.475 (0.000)**	10.061 (0.057)	11.401 (0.113)	17.704 (0.000)**	−10.065 (0.284)	−1.575 (0.906)
Observations	125	107	107	125	107	107
R^2	0.032	0.071	0.110	0.056	0.253	0.262

Note: Robust *P* values in parentheses.
*significant at 5%; **significant at 1%.

as outlined. From Table 3, we find students in the small-CLL class, captured by the dummy variable (*EXPERIM1*), performed roughly 7.2% worse than students in the large-CLL classes on the pretest. This difference may stem from the fact that some students take economics in high school. However, even students repeating the class seemed to do no better than the average. When comparing the results of their final exams (*SCORE*), students in the small-CLL did significantly better than the large-CLL students. In fact, their final exams were on average 6.5% better than those of non-CLL students. As before, the ACT quantitative score positively and significantly affected their final scores.

It is clear from the results presented that a CLL component does not guarantee that all students will improve their performance on a multiple choice test. In fact, it is well established in the literature different students learn differently.[4] As a result, any teaching method may be biased in that it simultaneously is favorable to one style of learning and unfavorable to another (Terregrossa and Englander, 2000). Given the same number of students in the control and experimental groups, Khandker and Elfessi's (2000) efforts to reduce the size of the CLL classes to accommodate collaborative learners (students who learn better in a collaborative learning environment) translated into a large lecture class, which may have been biased against lecture learners (who learn better in traditional small lecture class). Therefore, a change in teaching style may have redistributed the benefits among students, helping one group of learners at the expense of another. Khandker and Elfessi's (2000) method, in fact, may have shown that small-CLL helped collaborative learners more than it hindered the lecture learners.

There are two possible further explanations for the failure of the large-CLL class

4. E.g., Dunn and Dunn learning-style model (1999) suggested that people process information either analytically, globally, or a combination of these two. The model indicated that analytic learners use inductive reasoning to process information from specific facts to a general conclusion, whereas global learners use deductive reasoning to process information from a general conclusion to specific facts.

TABLE 3
Small-CLL versus Large-CLL

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent	*APTPRE*	*APTPRE*	*APTPRE*	*SCORE*	*SCORE*	*SCORE*
EXPERIM1	−1.150 (0.002)**	−1.263 (0.003)**	−1.443 (0.002)**	2.003 (0.025)*	2.190 (0.025)*	2.608 (0.019)*
APTPRE				0.494 (0.009)**	0.398 (0.051)	0.435 (0.034)*
GENDUM1		0.161 (0.695)	0.290 (0.496)		−0.741 (0.415)	−1.040 (0.269)
AGE		−0.065 (0.698)	0.144 (0.501)		0.425 (0.266)	−0.126 (0.814)
REPEAT		−0.195 (0.820)	−0.075 (0.931)		1.456 (0.182)	1.166 (0.271)
ACTMTH		0.125 (0.080)	0.132 (0.053)		0.455 (0.003)**	0.435 (0.005)**
COLL2			−0.006 (0.988)			−0.451 (0.642)
YRNSCH1			0.775 (0.193)			−1.765 (0.170)
Constant	7.333 (0.000)**	5.685 (0.201)	1.005 (0.847)	17.725 (0.000)**	−0.008 (0.999)	12.180 (0.339)
Observations	148	129	129	147	128	128
R^2	0.065	0.120	0.133	0.063	0.170	0.187

Note: Robust *P* values in parentheses.
*significant at 5%; **significant at 1%.

to produce improved final exam scores relative to the control group. First, the reduced content coverage, due to a six-hour reduction in lecture time, probably negatively impacted students' performances on the standardized final exam. The small-CLL class was able to mitigate the reduction in lecture time by more efficient use of the two-hour lecture, a strategy that did not result in a loss of content. Unfortunately, this strategy was not available for the large-CLL format. Second, the decreased ability of the instructor to monitor the groups to guarantee that students were actively engaged in the material. This does not necessarily mean students in the small-CLL received more instructor assistance than the large-CLL; rather, their probability of being monitored was double the probability in the large-CLL and, therefore, more likely to guarantee improved continuous collaboration.

IV. CONCLUSIONS

This article endeavored to compare three different teaching methods. The findings suggest that incorporating a collaborative learning lab component into an introductory microeconomics class can significantly improve a student's performance on a multiple-choice final. The authors further suggest the method of CLL best suited to students requires a smaller class setting, where the instructor can better moderate and monitor the collaborations.

Khandker and Elfessi (2000) claimed the small-CLL was conducive for better learning. However, as pointed out earlier, its advantage might be partially offset by the presence of a large and longer lecture class. Being constrained by time for content coverage, large classes consisted of primarily lecture, with minimal student–teacher interaction. Because lecture learners learn better with student–teacher interaction during lecture, Khandker and Elfessi (2000) felt that the two-hour lectures might put them at a disadvantage. This may be the case, but this article found that the advantages of the small-CLL format outweigh any potential disadvantages.

Additionally, this article found that the inclusion of student-specific characteristics allows one to revise upward estimates of the benefits of adding a small-CLL component

to class. Students' final scores were as much as 6.5% higher then those of the non-CLL control group. Khandker and Elfessi (2000) estimates put the gains at 4.7%.

Finally, it should be noted that this article is not implying that this method will work for all instructors. In fact, just as students have different learning styles, instructors have different teaching styles. Given that our instructor prefers the CLL method, the positive results could be driven entirely by his or her enthusiasm for this method. That is not a shortcoming of this research but a note of caution. Future research could compare student outcomes in a CLL environment across different instructors, and it should attempt to identify which students prefer which environment.

APPENDIX

TABLE A1

Variable Descriptions

Variable Name	Description
SCORE	The number of correct answers on a multiple-choice final exam. The exam contained the same 40 questions every semester.
APTPRE	A 20-question comprehensive micro-pretest given the first day of class.
ACTMTH	The student's score on the quantitative portion of the ACT.
AGE	The student's age on the tenth day of class.
GENDUM1	Dummy variable for gender, where Female = 1 and Male = 0.
REPEAT	A dummy variable where 1 = previous enrollment in the class and 0 = first time in the class.
COLL2	A dummy variable where 1 = college of business major, 0 = major outside the college of business.
YRNSCH1	A dummy variable that takes the value of 1 for freshman and 0 otherwise.
EXPERIM	A dummy variable that takes the value of 1 for the experimental group (1 = small-CLL, and 0 for no CLL) as in Khandker and Elfessi (2000).
EXPERIM1	A dummy variable that takes the value of 1 for the small-CLL and 0 for the large-format CLL.
EXPERIM2	A dummy variable that takes the value 1 for the large-CLL and 0 for non-CLL.

TABLE A2

Comparison of Different Teaching Methods Used

Teaching Methods	When Offered	CLL Offered	Time Available	Advantages	Concerns
Non-CLL Taught in the traditional way with six lecture classes (two sections) per week. Both small-CLL and large-CLL methods used this class as their control group.	Fall 1996; Monday–Wednesday–Friday morning classes.	No CLL.	42 hours total; 34 lecture hours; 8 hours of introduction (1 hour), pretest (1 hour); and three exams (1 hour each); 3 hours reviews	Whole semester was available for content coverage. Lectured during morning hours (students' preferred time slot).	48 students in each of the two classes.
Small-CLL Taught with a very large two-hour lecture class (combining two sections) and four small-CLL classes per week. Khandker and Elfessi (2000) used this class as their experimental group.	Fall 1998; Monday–Wednesday morning classes for introduction, exams, and CLL; Wednesday two-hour afternoon class for lecture.	Inside class with 24 students (6 groups of 4 students). Some previous studies require CLL out of class.	42 hours total; 14 2-hour lecture; 9 1-hour CLL; 5 hours of introduction (1 hour), pretest (1 hour) and three exams (1 hour each).	Small-CLL class conducive for better collaborative learning. Instructor could give special attention to the groups with lower previous group scores. Instructor conducted CLL without increasing workload. Does not require additional meetings outside of class (some previous studies require students' meeting additional hours outside of class).	Large lecture classes (92 students). Students who learn better in lecture are at a disadvantage. Longer lecture classes with minimal student-teacher interaction in lecture classes and taxing students' ability to concentrate. Lecturing at a time preferred by only 1.2% of the students.
Large-CLL Taught with four large one-hour lecture classes and two large-CLL classes (two sections) per week. This study used this class as the experimental group.	Fall 1999; Friday morning class for introduction, exams, and CLL; Monday–Wednesday morning classes for lecture.	Inside class with 48 students (12 groups of 4 students). Some previous studies require CLL out of class.	42 hours total; 28 1-hour lecture; 9 1-hour CLL; 5 hours of introduction (1 hour), pretest (1 hour) and three exams (1 hour each).	Lectured during morning hours (students' preferred time slot) so that time difference bias, class size bias, and length of class lecture bias that are present in Small-CLL method of teaching are eliminated. Does not require additional meetings outside of class (some previous studies require students' meeting additional hours outside of class).	More student groups to moderate. Less content coverage. Less student–teacher interaction in lecture classes.

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