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The impact of classroom demonstrations and online discussions on student achievement

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ABSTRACT

While researchers have documented many benefits of various active learning activities, the *relative* effectiveness of such techniques is still up for debate in the literature. This paper analyses the results of a two-year study involving ten sections of microeconomics principles classes in which face-to-face lectures are supplemented with in-class pen-and-paper practice problems (the control group), in-class demonstrations, or online discussions. The Test of Understanding in College Economics (TUCE) is used to measure learning outcomes. The main conclusions are as follows: (1) in-class demonstrations have a positive effect on student learning, with the exception of African–American students; (2) female students perform better having participated in online discussions; and (3) traditional pen-and-paper recitation questions "teach to the test" but do not impart as much economic intuition as the two alternative pedagogical methods.

1. Introduction

In a provocative finding, Walstad and Allgood (1999) and Walstad and Rebeck (2002) report that the traditional pedagogical methods of teaching economics courses do a disappointingly inadequate job of educating students about economic topics. In fact, the authors find that many economics students possess merely a cursory understanding of the discipline's basic concepts and perform only marginally better than non-economics students on tests of fundamental economic knowledge. This perception has become so widespread that Ferraro and Taylor (2005), in a tongue-in-cheek comment, claim that "advanced study [in economics] is necessary to rectify the damage done to economic intuition by an introductory economics class." This evidence notwithstanding, Watts and Schaur (2011), through a series of surveys conducted in 1995, 2000, 2005, and 2010, document that the vast majority of face-to-face economics courses are still taught with traditional chalk-and-talk methods. Even though many economics instructors seem to continue along a path shown to be ineffective, the authors also note a gradual increase in the use of active in-class learning techniques.[1]

During the 1960s, Vernon Smith developed the double auction game to study economic theory through classroom experiments.[2] Since that time, the use of demonstrations and experiments in economics classes has gained some ground, their dual purpose being to both answer economic research questions about consumer, firm, and market behavior and to educate economics students. Several studies have since found that in-class demonstrations consistently improve student

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[1] I define active learning as any pedagogical method which requires all students to verifiably participate in class. The most common form of active learning involves students working on problem sets in class, a practice traditionally used in recitation sessions.

[2] See Smith (1991) for a compilation of these studies.

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learning when compared to traditional lecture formats.[3] Three decades later, the increased availability of computers and more convenient internet access have allowed for more classes to be taught using online components; indeed, many courses forgo the classroom completely. Discussion forums, a staple of online classes, constitute a new form of active learning; encouragingly, Koohang et al. (2012) report improved student perception of courses which include online discussions.

Given the evidence, it seems surprising that there has been such a slow growth in the implementation of alternative teaching methods. The fault perhaps lies in the lack of consensus about the relative merits of the various techniques. Although there are many different options available for instructors interested in adding an active learning component to their courses,[4] the comparative effectiveness of these options is still being debated in the economic pedagogy literature. The purpose of this paper is to compare the effectiveness of three fairly common active learning techniques: traditional recitation sessions, in-class demonstrations, and online discussions using the results of a semester-long experiment conducted in ten principles of microeconomics classes.

In-class demonstrations offer students an interactive involvement with economic theories; rather than passively hearing about, say, the impact of a tax on the market for cigarettes, students actively participate in a simulated market and experience the price adjustment mechanisms first hand. Studies of the effectiveness of in-class demonstrations were initially performed by conducting only one or two experiments in treatment classes; Cardell et al. (1996), however, question the appropriateness of this approach since students receive only limited exposure to the treatment. Instead, the authors engage in a large-scale study of 1800 students, half of whom are taught with the continuous use of in-class demonstrations, which replace Discussion Sections, throughout the semester. The subsequent analysis shows no effect of this innovation on the students' level of learning as measured by the Test of Understanding in College Economics (TUCE).

Follow-up studies by Emerson and Taylor (2004), Ball et al. (2006), Dickie (2006), and Durham et al. (2007), however, report a positive impact of in-class demonstrations on students' learning. Emerson and Taylor (2004) employ the Bergstrom and Miller (2000) textbook to supplement traditional lectures with eleven in-class experiments, and find that the treatment group's performance on the TUCE increases by about 2.5 points. Ball et al. (2006) instead utilize an electronic clicker system called WITS; students in the control class study the analyses of in-class demonstrations rather than actually participating in them. Instead of using the TUCE as the measure of interest, the authors use the final exam score, on which students from the treatment group score an average of 3.2 points higher than those in the control group. Dickie (2006) also shows that students in the treatment group improve their TUCE scores vis-à-vis a control group; however, he finds that placing grade incentives in the experiments dampens the positive effect. Finally, Durham et al. (2007) report that in-class demonstrations have a positive impact on learning as measured by exam outcomes, but find this impact is limited to students who are multimodal or kinesthetic learners.

Less encouragingly, Green (2014) shows that the impact of a prolonged in-class experiment has a negative average impact on the treatment group. Green's approach is unique in that a single semester-long macroeconomic experiment is run throughout the length of his course. Using final exam questions as a metric, he finds that students who participate in the experiment perform worse on average than those in the control group. This result suggests that the specific structure of the experiment is just as critical to student learning as the addition of in-class demonstrations to a traditional curriculum.

Unlike studies of in-class demonstration effectiveness, analyses of online and hybrid courses typically suffer from a selection bias problem since students have prior information that lets them sign up for either the control or the treatment classes.[5] To address this issue, Coates et al. (2004) proxy for students' decisions to attend an online class and thus control for the selection bias using Heckman two-stage least squares and endogenous switching models. Their results show that online students tend to perform worse than traditional face-to-face students. Additionally, online students do better in online classes than they would do in a traditional course; thus, the bias direction indicates that the difference in TUCE scores may be larger than reported in other studies. These findings are confirmed by Green (2014) who finds that students in hybrid classes do worse than those in both traditional lecture and in-class demonstration courses.[6]

All of these studies can be classified as first-generation comparisons which show that active learning is, generally, a more effective tool than the passive lecture format. This paper takes the next step by considering the relative merits of three different active learning techniques. This approach is similar to the work of Emerson et al. (2014), who compare the use of in-class problem sets to the think–pair–share method that requires students to pair up and discuss problem solutions after they work together on the questions independently. Emerson et al. (2014) only expose their students to the treatment for a total of approximately sixty minutes during the entire semester;[7] in my study, students are exposed to the treatment for approximately 10 h. Although the authors do not show any significant improvement from using think–pair–share over working alone, this line of study takes the crucial next step in pedagogical research: determining the optimal type of active learning methods.

The innovative nature of my study is the way in which the various treatment sections are taught. All classes receive one hour of lecture per lesson; the remaining half an hour is used for the application of the treatment. The control group spends

[3] Emerson and Taylor (2004), Ball et al. (2006), and Dickie (2006) document the improvement in student performance due to in-class demonstrations.
[4] For example, Starting Point (http://serc.carleton.edu/econ/index.html), a website dedicated to expanding the use of innovative pedagogical techniques in economics classes, lists seventeen different teaching methods available for implementation.
[5] Hybrid classes combine traditional in-class lectures with a limited online component; they are thus combinations of face-to-face and online classes.
[6] Green (2014) does not control for selection bias in his study; therefore, these results may be even stronger than his paper suggests.
[7] Each think–pair–share exercise lasts close to five minutes, and there are about twenty of them conducted throughout the semester.