What is a classroom economics experiment?

Relatively recently, economists have begun to employ experimental methods – both in research and teaching. Research experiments help economists test the validity of theories and the efficacy of new market mechanisms. Classroom experiments help instructors illustrate concepts and engage students in the learning process, making economic theory easier for students to understand.

Classroom experiments are one of a variety of active learning techniques intended to promote higher-order thinking. A classroom experiment asks students to make economic decisions in a controlled environment. These decisions create data for analysis and discussion. When well designed and implemented, experiments help students discover important concepts for themselves. That discovery leads students to take greater ownership of their new-found knowledge, generating higher levels of engagement with the subject and potentially longer-term retention of the material.

Experiments covering a wide range of concepts are readily available for classroom use. Some sources include Parker (1995), Bergstrom and Miller (2000), Holt (2006), Holt’s VeconLab

1, Aplia2, EconPort3, indexed experiments in Delemester and Brauer (2000), and economic education journals. Experiments are most frequently employed in principles courses, with many level-appropriate experiments available. More complex experiments and variations of simple ones are available for use in upper level courses. Most experiments can be run by
hand, i.e. using paper and pencil, with face-to-face interactions that students typically enjoy. There are also computerized versions available for many experiments (VeconLab and Aplia are particularly user-friendly sources). Computerized experiments allow for automated data collection and use outside of class time (with either synchronous or asynchronous student interaction). Experiments can often be adapted for a wide range of class sizes. The three experiments described in the next section are illustrative of the variety of experiments and topic coverage available.

**Examples**

*Double oral auction experiment*

The double oral auction experiment demonstrates how prices convey information in a competitive economy. The instructor assigns students the roles of potential sellers and buyers of a hypothetical good. Students begin the experiment knowing only the production cost or consumption value that the instructor has assigned to them. People sometimes refer to this set-up as the pit market experiment because the instructor typically designates a section of the classroom where students mingle to negotiate their trades. In this trading pit, students call out offers to sell or buy at prices they specify. As they trade and observe other trades, students begin to see how a decentralized economy uses prices to signal decisions about production and distribution. The instructor typically runs several trading rounds, allowing students to note that prices converge despite the initial chaos. The instructor records trades, displaying this information for everyone to see during the experiment and distributing it afterwards for the debriefing and analysis.
The workhorse of classroom experiments, the double oral auction provides a concrete example of a competitive market. It demonstrates the concepts of market clearing, convergence to equilibrium and gains from trade. The trading experience and the follow-up analysis bring these abstract concepts into sharp focus. In the analysis, students begin to understand how the competitive model can make reliable predictions about behavior. They start with building supply and demand curves from information the instructor distributes (after the experiment) about every buyer’s willingness to pay and every seller’s cost of production. Using these curves, students find the price and quantity that theory predicts will prevail in equilibrium. They compare these equilibrium predictions to actual prices and quantities in various rounds of the experiment. They similarly calculate consumer and producer surplus predicted by theory and compare those to experimental results.

The economics education literature describes many extensions of this experiment, including price controls, taxes, subsidies, and other shifts in demand or supply. In a 45-minute class the instructor typically runs several rounds, including some of these extensions. One class session early in the term can give students background for concepts they will use throughout the course. The experiment complements lectures, providing experience that makes students the experts in subsequent discussions. For example, the results from a price-ceiling round offer a starting point for a later lecture on rent controls, with the supply and demand curves from the experiment providing the theoretical structure behind the discussion.

The literature describes how to run and debrief many experiments that use the double oral auction market mechanism, covering a wealth of topics. Gillette (1996) presents a demand-shift extension for a health economics course. Here, a third-party offers to pay 80% of the price in a market for health care services. Hazlett (2008) uses a credit market where inflation variability
causes a wealth transfer between borrowers and lenders. The experiment shows how inflation uncertainty can prevent the credit market from efficiently allocating funds. In Hazlett (2003), most students take the roles of banks that lend and borrow in a federal funds market. The other students run a Federal Open Market Committee Trading Desk, using open market operations to change the amount of excess reserves in the banks, thereby changing the federal funds rate. Hazlett and Ganje (1999) develop a market for foreign exchange where students take the roles of importers and exporters. Their government maintains an official foreign exchange market at an overvalued rate, driving the traders to start a parallel foreign exchange market. The effects of unemployment compensation are illustrated in Hazlett (2004), where students take the roles of employers and workers negotiating wage contracts in markets for skilled and unskilled labor. The government offers workers progressively greater amounts of unemployment compensation, which raises the unemployment rate among the unskilled and narrows the distribution of income between skilled and unskilled.

The double oral auction experiment proves robust as well as versatile. Instructors can try variations on the fly, including some suggested by students. For instance, students may be tempted to collude, organizing themselves into a cartel of buyers or sellers. It works to let them, even to allow them to step outside of the classroom to do their colluding. When the collusive agreement breaks down after a round or two, students become more firmly convinced of the usefulness of the competitive model.

The basic experiment works in classes of eight or more students. In a hand-run experiment, i.e. with students trading face-to-face rather than over a computer network, the instructor typically starts class by passing out instructions, record-keeping sheets, and private information slips that establish a person’s production cost or consumption value. During the
experiment, the instructor stands by a blackboard or a computer with projector, ready for students to come and report their trades.\footnote{\textsuperscript{4}} Between rounds part-way through the experiment, some instructors pass out new production costs and consumption values so that the high-cost sellers and low-value buyers who were priced out of the market get new roles enabling them to trade. Passing out the new roles also allows the instructor to shift demand or supply (or both), generating a new equilibrium.

When run online, with students entering their offers via computers, the experiment is called a double auction. Holt’s freely available VeconLab, and Aplia’s commercial teaching resources both offer browser access to a double auction run on their servers.

With some modifications, the hand-run experiment works even in very large classes. The standard set up poses problems in large-enrollment courses due to the lack of room for a trading pit, long queues to report trades, and excessive time spent passing out paperwork reassigning roles. To solve these problems, Vazquez-Cognet (in Vazquez-Cognet et al, 2010) redesigned the double oral auction for his class of 500 students. In his version, students negotiate in the general area of their seats, sometimes standing on those seats. He limits rounds to one minute and prices to increments of 25 cents. He uses a show of hands for reporting trades, rather than having students come to the front of the room. After each round, he asks sellers to raise their hands when he calls out the price range that includes the trade they made. He counts the number of hands in each price range and displays that number for all to see.

Vazquez-Cognet notes that after the chaos of the first trading round, students expect reported prices to range widely. Instead, a mass of hands goes up in a narrow price range. Through this exercise, students see chaos resolved into order more dramatically than if they looked at a list of trades, the way reporting occurs in the standard set up. Vazquez-Cognet finds
fast convergence to equilibrium in very large classes. Because of that fast convergence he has
time to add extensions and an in-class follow-up, all within 45 minutes. He even reassigns roles
with an announcement that speedily converts low-value buyers into low-cost sellers, and high
cost sellers into high-value buyers. He notes that after the excitement of hundreds of people
trading, and ten calmer minutes of students answering debriefing questions in pairs, the last few
minutes of general discussion draw out students who have never before spoken in a large class.

Production experiment

Variations of an experiment illustrating production and cost concepts can be found in Neral and
Ray (1995), Bergstrom and Miller (2000, chapter 10), and Vazquez-Cognet (2008). In the
production experiment, students are presented with the opportunity to produce a simple good (for
instance, widgets\(^5\), paper airplanes, or solutions to mathematical problems). The instructor
assigns all students to small production groups, generally consisting of 1 to 4 students. Each
group is provided with a single unit of some fixed input (typically some type of capital – a
stapler, pen, folder, calculator, etc.). Groups engage in production of the specified output for a
fixed period of time. Then the level of the variable input (labor) and total output (product) of
each group is recorded. After each production round, groups are slowly consolidated so that the
number of students (the labor input) in each group increases while the available capital input
remains at one unit per group.

At the end of the experiment, students have production data. Specifically, students have
output levels for various levels of labor input. In the debriefing following the experiment,
students use this data to study concepts including total, average, and marginal products of labor;
diminishing marginal product; total, average, and marginal cost; and fixed vs. variable inputs. In
reflecting on their production experience and working with the data, students develop a better understanding of production and cost concepts. For example, as bottlenecks arise at the point of the fixed input, students get a clearer idea of the source of diminishing marginal product. This experiment helps students gain a firmer grasp of the distinction between fixed and variable inputs, and between average and marginal products. Further, students are far more engaged and interested in costs associated with their own production than in an abstract cost example concocted by their professor.

The production experiment is relatively simple to implement. It can easily be run and debriefed in a 50-75 minute class period. By way of materials, little more than pens, paper, and a small amount of capital (depending on the variation of the experiment – staplers, folders, etc.) is required. The experiment works with a range of class sizes from relatively small (10 students) to very large classes. An option in larger classes is to have some students participate in production while the others watch (perhaps with some serving as quality control inspectors) and have the entire class participate in the debriefing. Alternatively, Vazquez-Cognet’s (2008) version (in which students produce solutions to mathematical problems using varying amounts of labor and a fixed amount of capital – a calculator) allows participation by all of the students in a very large class. Generally, having all students participate maintains student interest better than having a subset participate while others watch.

As with most experiments, for students to fully appreciate the concepts illustrated in this experiment, it is imperative that all students participate in the debriefing and that follow-up exercises be assigned either in class or as homework. For examples of these exercises, see Bergstrom and Miller (2000) or Vazquez-Cognet (2008).
Hazlett (2007) describes a hand-run experiment that helps students see how uncertainty about future economic performance can cause a recession. Each student represents a firm that makes decisions about whether to invest to expand its operations. Groups of four firms play a repeated game in which each firm privately chooses either a high or low level of investment spending. An aggregate economy consists of a group of four firms, e.g. a class of 40 students would have ten such economies. After each round of decisions, students observe the investment levels of the other firms in their economy and of the firms in the other economies around the classroom.

Before they make any decisions, students see a table showing how their profit depends on the investment decision made by all of the firms in their economy. They can see that when others in their economy invest at a low level, they would be best off also investing at a low level. Choosing instead a high level would be tantamount to expanding productive capacity in a time when low incomes (due to low investment by the other firms) prevent customers from buying their firm’s extra production. Similarly, when others in their economy invest at a high level, they would be best off also investing at a high level. That high investment allows their firm to take advantage of high incomes (due to high investment by the other firms) that create demand for their extra production. An outcome with every firm in the economy investing at a high level generates the greatest possible profits for all. An outcome with every firm investing at a low level generates modest profit for all. The worst outcome for any firm would be to invest at a high level when all the other firms in its economy invest at a low level.

Students see that when firms anticipate an expansion, their confidently high levels of investment cause an expansion. Likewise, when firms fear a recession, their conservatively low levels of investment cause a recession. In the debriefing, an instructor who wants to use the
language of game theory could note that the outcome where all four firms choose a low level of investment is a bad Nash equilibrium for the one-shot game. That is, this outcome is Pareto inferior to the Nash equilibrium of all four choosing a high level.

In initial rounds, firms cannot communicate with each other. They have to guess what other firms in their economy might do. They form their guesses based on what has happened in the past, especially in their own economy, but also in other economies. For instance, in an economy whose firms have mainly chosen low levels in the past, everyone might be on the verge of losing confidence. At this point, seeing another economy where everyone has invested at a high level could inspire these firms. Each might then choose a high level in hopes that the others in its economy feel similarly inspired.

Once a group has experienced a round with everyone investing at a high level, they tend to maintain high levels in future rounds. They can, however, find their confidence shaken by events that introduce new uncertainty. For instance, the instructor can simulate real-world changes by replacing one of their firms with a firm that has a history of choosing low investment.

Between later rounds, the instructor asks some students to explain their past decisions and describe their confidence in the prospects for their economy. Their answers constitute indirect communication between firms, the kind provided by news stories in the real world. The instructor thus serves the role of a journalist reporting on and propagating waves of pessimism or optimism among the business community. Later yet, the instructor allows direct communication between firms, during which almost all firms immediately agree to choose a high level of investment.

In the debriefing, the class considers the self-fulfilling nature of expectations. They discuss what policy makers might do to prevent expectations of a recession from becoming self-
fulfilling. The experiment works in classes of eight or more and takes about 45 minutes to run and debrief.

**How best to implement classroom experiments**

To create a valuable learning experience, the instructor chooses an experiment that promotes deep understanding of an important concept, an understanding that students would not get from an explanation, or would not remember without a hands-on example. Effective experiments engage students in making decisions, holding their attention while not confusing them with unnecessary complexity. Students must be motivated to arrive in time to hear all of the instructions, plus have a chance to ask clarifying questions. To minimize frustration, students must understand the instructions or else they make random decisions that muddy the results. Sometimes, however, it takes a round of experience before the instructions click for all students.

In an experiment like the double oral auction the instructor wants to give students incentive to maximize their gains from trade, encouraging them to behave as they would in a real-life profit-maximizing situation. The instructor could motivate students with course credit, extra credit, money, or even candy awarded in proportion to their gains from trade. Some instructors simply give course credit for on-task participation and count on the joy of participation and the typical competitive nature of students to motivate sellers and buyers to seek out the best price.

Experts often recommend running an experiment before lecturing on the theory the experiment demonstrates (Holt, 1996; Noussair and Walker, 1998; Bergstrom and Miller, 2000). Students seem to become more convinced of the predictive power of theory when they discover it for themselves. For instance, when participating in a double oral auction before hearing a
lecture on price controls, sellers generally greet the announcement of a price floor with enthusiasm. Disillusionment with minimum prices develops rather quickly as producers realize they cannot sell as many units as they would like at the elevated price.

If at all possible, instructors should arrange for every student to participate. Active participation rather than passive observation gives students better insight. Plus, participation offers more fun.

The role of the instructor should be to facilitate the experiment. This role entails watching out for and helping confused students, but not announcing what the instructor expects to happen or telling students what actions to take. If an instructor suggests, for example, that buyers offer higher prices, students might doubt the power of a market to find the equilibrium without this intervention.

Instructors should not lie to participants. For instance, an instructor who tells students they will receive payoffs according to their choices in a prisoner’s dilemma game must distribute the payoffs as promised. Distributing in any other way would cost the instructor credibility. Without that credibility, students might not believe the instructions in future experiments and instead act in a manner that appears random.

Finally, debriefing asks students to put their economic knowledge to use and analyze the results. While an explanation from the instructor might seem like a more efficient way to conduct the analysis, it risks circumventing the learning process. Instead, the instructor should plan follow-up questions that guide students through the analysis in a written assignment, in small groups, or in a general discussion.

**Evidence on the efficacy of classroom experiments as a pedagogical tool**
Several studies have addressed the efficacy of classroom experiments as a pedagogical technique. Gremmen and Potters (1997) and Frank (1997) investigate the effect of a single experiment and find that students’ participation in the experiment improves their understanding of the specific topic illustrated. Other studies take a more comprehensive pedagogical approach to experiments, utilizing multiple experiments throughout a course. Cardell et al. (1996) find no significant effect on student achievement from the four experiments they employ. Emerson and Taylor (2004), Dickie (2006), Ball et al. (2006), and Durham et al. (2007), however, all find that students realize significantly higher levels of achievement (either measured by the Test of Understanding in College Economics or course work performance) when exposed to a curriculum making extensive use of experiments (between seven and eleven experiments). The positive effect of classroom experiments on student achievement is documented in micro (Emerson and Taylor; Dickie; Ball et al.; Durham et al.) and macroeconomic (Durham et al.) principles courses in classes ranging in size from 20 to 120 students and for both hand-run (Emerson and Taylor; Dickie; Durham et al.) and computerized (Ball et al.) experiments.6

Evidence suggests that some students gain more than others from participation in experiments. Emerson and Taylor (2007) use the Myers-Briggs (Personality) Type Indicator (MBTI) to distinguish across student personality types in their sample. They find that the experimental approach appears to benefit students with “intuitive” personality types (as measured on the sensing/intuitive dimension of the MBTI) while it is neutral with respect to most other dimensions. That is, students who tend to be more abstract thinkers (intuitive types) may derive greater benefit from the experimental pedagogy than more concrete and factual thinkers (sensing types). Durham et al. find that the magnitude of the experimental effect varies by learning style. Specifically, multimodal and kinesthetic learners gain significantly more from
the experimental approach than do other types. While evidence suggests that classroom experiments are better suited to some personality types and learning styles, more investigation into the role of personality type and learning styles and their combined effect with classroom experiments is needed.

In addition to higher levels of student achievement, there is also evidence (both formal and anecdotal) that students (and instructors) enjoy experiments. Ball et al. find that student evaluations of instructors are significantly higher in microeconomic principles courses where students participated in experiments than in the same course where students only discussed the results of experiments. Durham et al. find that students exposed to an experimental pedagogy have significant, positive increases in their attitudes towards their principles courses compared to those in courses using chalk-and-talk. Abundant anecdotal evidence suggests that students and professors alike enjoy a pedagogical approach involving classroom experiments. To the extent that experiments positively influence students’ attitudes towards economics and their economics courses, the experiments are likely to lead to a better overall classroom experience for all involved.

While positive achievement and attitudinal effects support the use of classroom experiments as a pedagogical tool, questions remain. As economists well know, incentives matter. The question with classroom experiments is how to incentivize students to behave as they would in real-world situations; otherwise students may make random choices that generate unclear results. To address the motivation issue, some instructors use grade incentives (course grades or extra credit) while others use prizes (money or candy). Dickie finds that grade incentives tied to student performance in experiments do not increase learning beyond that of a control group who received no incentive. Debate remains as to the best approach.
Little is known about longer term, post course, effects of experiments. Durham et al. find evidence that students exposed to experiments perform better on an exam measuring their retention (administered in an upper division business class in a subsequent semester). No other studies have addressed whether differences exist in long-term retention. Further, limited evidence suggests that exposure to classroom experiments does not lead to a difference in the number of majors or upper-division economics classes taken by students in general. However, some students (males and students who took economics in high school) take more upper-division economics courses when exposed to experiments in micro principles (Emerson and Taylor, 2010). The minimal effects on selection of major and subsequent courses are not terribly surprising given the limited influence that the pedagogy in any one course may have. To the extent that some programs adopt classroom experiments (or active learning in general) across the curriculum, it would be interesting to investigate whether there are any significant effects on students’ course and major selection.

References


Murphy, J. (2004), ‘A simple program to conduct a hand-run double auction in the classroom’, *Journal of Economic Education*, Online Section 35 (2), 212.


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4 Murphy (2004) offers a freely available, downloadable program for instructors running the experiment by hand. His program displays trades, stores and plots results, plots the supply and demand curves, and even tracks individual gains from trade.

5 In the Neral and Ray (1995) incarnation of the production experiment, a widget is defined as a piece of paper folded into fourths and then stapled.

6 While not all papers specify which experiments were employed in their studies, the experiments frequently covered topics including demand and supply (often using the double oral auction experiment outlined in example one), price controls, taxes, monopolies and cartels, production and costs, externalities or public goods, comparative advantage, and the prisoners’ dilemma. Emerson and Taylor (2004) and Dickie (2006) identify the topic and the experiment source for all of the experiments administered in their studies. Cardell et al. (1996), Ball et al. (2006), and Durham et al. (2007) identify the topics covered by the experiments implemented in the course of their investigations but not the source of the experiments.