EXPERIMENTAL ECONOMICS
METHODS IN THE LARGE
UNDERGRADUATE CLASSROOM:
PRACTICAL CONSIDERATIONS

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I. INTRODUCTION

Since its emergence around mid-century, laboratory experimental economics has been widely recognized for introducing a new empirical research methodology rooted in the direct observation of human behavior. It is less well known that research in experimental economics has always gone hand in hand with its use as a pedagogical tool. A notable very early example is Harvard University professor E. H. Chamberlin’s classroom experiments with an “imperfect market” (1948). In the mid-1950s, Vernon Smith (1962) began conducting the first double-auction market experiments in his classes at Purdue University. Over the years, it has been increasingly common to find experimental researchers investigating alternative methods for integrating simple decision-making exercises into their classrooms, based on their experience with research experiments. The objective was to create vehicles for “hands on” experiential learning and thus make economic theory more
tangible, meaningful, and interesting to the students. The range of such educational exercises encompasses many economic issues, broadening students understanding of both market efficiency and market failure.

While practitioners of experimental economics have independently recognized that laboratory experiments can play a valuable pedagogical role, this has recently evolved into a well-defined movement to promote the potential of experimental methodology in economic education. There are several explanations for this delay. First, for many years there were very few economists who had significant exposure to experimental research; even fewer had any formal graduate training in the use of experimental methods. This lack-of-human-capital explanation has become somewhat less relevant over time as the methodology has matured and its usage has spread to many institutions around the world. Second, as many of us who have used the methodology of experiments in the classroom can attest, the technology of experimentation has been a stumbling block in the path of more widespread classroom use. Most research experiments, whether run using pencil and paper or computers, utilize from 4 to 12 subjects. With introductory economics classes having enrollments of several hundred students at most large public universities, and intermediate-level classes having several dozen students, it simply was not always practical to try to involve everyone in a hands-on experience. Even in relatively small classes where involving all students is practical, instructors may be reluctant to accept the opportunity cost of reduced classroom time devoted to more traditional activities. Finally, there is the issue of how to motivate the students. Experimental economists have largely abandoned the early protocol of asking subjects to simply imagine that the decisions they are making are generating profits for a fictitious firm. Instead, most research experiments have used cash as a motivating device (see Smith & Walker, 1993). Clearly, the use of significant cash rewards for hundreds (or even dozens) of students is rarely, if ever, financially feasible.

The primary focus of this study is methodological. Computer-based procedures for conducting out-of-class decision-making exercises are presented. This new framework is ideally suited for giving every student in even the largest introductory classes a hands-on learning experience. The methodology has been extensively integrated into the core material of economics classes ranging in size from 10 to 400 at the authors’ respective institutions. The use of non-monetary reward structures to motivate students is discussed. Finally, examples are given of how this methodology can go beyond the simple presentation of results by introducing students to the use of laboratory research methods to study economic behavior.
II. A PORTFOLIO OF SOFTWARE FOR LARGE GROUP DECISION EXERCISES

The authors’ interest in creating computer software specifically designed for implementing decision-making exercises into the teaching of undergraduate economics began in the mid-1980s. The motivation for these decision tasks was the experimental research the authors had been conducting utilizing alternative institutional settings to investigate market and non-market behavior. It was important that the first computerized teaching exercise focus on a topic central to any standard presentation of microeconomic theory and be very easy for instructors to use in either small or very large classes. Programming complexity was an additional consideration, given the desire to keep the software development time to a minimum. Eventually, the portfolio of computerized decision exercises grew to three exercises, which are now used by both faculty and graduate student instructors at Indiana University and the University of Arizona. The exercises consist of a monopoly market, a non-market public goods decision-making problem, and an asset market. These three exercises are discussed in more detail in Williams and Walker (1992). Each of these three lessons is brought to life using software designed for the NovaNET computer system, however, the conceptual basis of the large group decision exercises can be applied to other technologies. The following are summary descriptions.

A. The Monopoly Exercise

Our choice for this first classroom exercise motivated by research in experimental economics was a posted-offer market where students are assigned the role of a monopolist facing a stable demand curve in a series of decision-making rounds. The students’ objective is to maximize profit under a performance-based reward structure rooted in earning extra-credit points rather than cash.

In each round, the student monopolist chooses an offer price and production quantity. The monopolist knows his/her cost structure with certainty, but knowledge of the market demand structure (and hence the monopolist’s revenue structure) must be acquired through market experience. The demand response is generated by computer-simulated buyers, thus the profit maximization problem for each individual is independent of other students’ decisions. The software allows for up to twenty different market structures to be specified for each class so that all students are not assigned the same profit maximization problem. A market structure contains parameters, initialized by the instructor, that define a total cost curve, a demand curve, and the number of decision
rounds in the exercise. From a computer-technical perspective, the creation of a “non-interactive” market environment that avoids the need for data exchange among the participants significantly lessened the complexity of the programming task.

The primary educational objectives of this exercise are to stress the importance of the informational requirements of optimization theory and to extend the standard material on price searching into an environment where estimating the firm’s demand curve, and hence revenue structure, is a critical step in analytically approaching the profit maximization problem. This has proven to be a very challenging problem for both students and many seasoned instructors. To solve the problem analytically, one must understand the traditional, full-information profit maximization solution and then be able to apply this concept in a setting where demand information must be acquired through experience in the market.²

Given the difficulty of solving this profit-maximization problem, it is recommended that students be given a detailed strategy for estimating their demand and marginal revenue curves (using either “eyeconometrics” or the regression tool in Excel) from the offer price and quantity sold data. This will help motivate students to take the time necessary to approach the problem analytically using economic theory, rather than using a simple price-quantity guessing game approach. In this regard, the pattern of round-by-round decisions recorded by the computer for each student is quite revealing as to a student’s thinking (or lack thereof) during the problem-solving process.

B. The Voluntary Contributions Public Goods Mechanism

Following the successful implementation of the initial computer-based monopoly exercise in several large classes at Indiana University and the University of Arizona, Williams, in collaboration with Isaac and Walker, decided to extend the technology to an “interactive” group decision-making exercise. This second exercise implements a public goods provision problem where the institution is one of voluntary contributions. In this lesson, the outcome (earnings) for each individual in a group is determined by an aggregation of all the individual contributions decisions of group members. The students gain hands-on experience with a real social dilemma problem rooted in the provision of a pure public good. The essence of the problem facing the students is that each individual in a group must decide how to allocate an endowment of a productive factor between a private good (where consumption benefits accrue only to the individual) and a group good (where consumption benefits accrue to all group members). The conflict between public and private
interest is highlighted as is the allocative inefficiency (losses in group payoff) generated by the free rider problem. Through active participation in this exercise, the students are introduced to the core material of economics related to market failure and externalities. We refer to this computerized lesson as VCM.

The structure of VCM is built around a series of decision-making rounds that are carried out by students outside of class in a computer laboratory. At the start of each round, individual \( i \) is endowed with \( Z_i \) tokens that have to be divided between a “private account” and a “group account”. Tokens cannot be carried across rounds. Each token placed in the private account earned \( p_i \) cents with certainty (typically, but not necessarily, \( p_i = \$0.01 \) for all \( i \)). For a given round, let \( m_i \) represent individual \( i \)'s allocation of tokens to the group account and \( \sum m_j \) represent the sum of tokens placed in the group account by all other individuals \( (j \neq i) \). Each individual earns \( \frac{G(m_i + \sum m_j)}{N} \) cents from the group account. Because each individual received a \( 1/N \) share of the total earnings from the group account (regardless of his/her investments), the group account was a pure public good. This specification of the group account payoff function is one of many that may be utilized to create a laboratory public good.

Allocating tokens to either account results in a well defined monetary payoff. The marginal per-capita return from the group account (MPCR) is defined as the ratio of benefits to costs for moving a single token from the individual to the group account, or \( \frac{G'(*)/N}{p} \). For illustrative purposes, consider the parameterizations we use in our \( N = 4 \) and \( N = 10 \) designs. Displayed in Table 1 are some particular forms for \( G(*) \) for each Group Size/MPCR combination we have investigated. Thus, for example, with \( N = 4 \) and MPCR = 0.30 each token placed into the group account by individual \( i \) costs individual \( i \) \$0.01. The return from the group account to all four members of the group, however, is \$0.003 each, or \$0.012 in aggregate.

<table>
<thead>
<tr>
<th>Group Size</th>
<th>( N = 4 )</th>
<th>( N = 10 )</th>
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<tbody>
<tr>
<td>MPCR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>( G(X) = 1.2X )</td>
<td>( G(X) = 3X )</td>
</tr>
<tr>
<td>0.75</td>
<td>( G(X) = 3X )</td>
<td>( G(X) = 7.5X )</td>
</tr>
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Table 1. Parameterizations for \( N = 4 \) and \( N = 10 \).
In all of the classroom exercises we have conducted, \( p_i \) and the function \( G(\cdot) \) were chosen so that the Pareto Optimum (defined simply as the outcome that maximizes group earnings) was for each individual to place all tokens in the group account (i.e. to set \( m_i = Z_i \)). In addition, for most of our parameterizations the single-period dominant strategy has been for each subject to place zero tokens in the group account because \( p_i \) and \( G(\cdot) \) were chosen so that the MPCR < 1. The outcome \( m_i = 0 \ \forall \ i \) is also the unique, backward unraveling, complete information, multi-period Nash equilibrium. This will be referred to as a complete free-riding outcome.

Figure 1 illustrates a simple graphical method for communicating a dominant strategy free-riding outcome in VCM to students. To establish a clear link to the traditional terminology associated with classroom discussions of externalities the figure uses the term Marginal Private Benefit (MPB) to represent the MPCR from the group account and Marginal Social Benefit (MSB) to represent \( N \cdot \text{MPCR} \). Note that the figure stresses not only the extreme separation of the noncooperative (Nash) equilibrium and the social (Pareto) optimum, but also the magnitude of the external benefits generated by

![Figure 1. Illustration of a Dominant Strategy VCM Design with a Constant MPCR.](image-url)
allocating a token to the group account, and the magnitude of the potential gains from cooperation.

Each student’s information set in VCM includes: the number of rounds, \(Z_i\) (is own token endowment for each round), \(\Sigma Z_o\) (the groups’ aggregate token endowment for each round), \(p_i\) (earnings per token from is private account), \(N\) (group size), and \(G(\cdot)/N\) (per-capita earnings function for the group account presented in tabular form). Prior to the start of each round, students are shown information on their own earnings for the previous round as well as the total number of tokens placed by the entire group in the group account. During each round, subjects can view their personal token allocations, earnings, and total tokens placed in the group account for all previous rounds.

C. The Asset Market Exercise

This exercise does not utilize the familiar supply and demand curve environment used by so many instructors in undergraduate classes. Instead, this is an asset market in which all students are assigned to be “traders” who are given an initial portfolio containing both “cash” and “shares” of a financial asset. Traders may either buy or sell shares that have value across the multiple trading rounds of the market. In addition, the market institution is not the real time “continuous double auction” that many have used for classroom market exercises. Instead, it utilizes a “single-price auction” (also called a “call market” or “clearinghouse market”). Traders submit their buying (selling) price and quantity demanded (supplied) at that price. At the close of a trading period, the computerized market displays to the students the reported supply and demand arrays. The intersection (if one exists) determines the market price and trading volume. All trades occur at this calculated market price. If the revealed supply curve is completely above the revealed demand curve, no trades occur. We typically use the “open book” version of this trading institution where a graph of the current state of the reported supply and demand arrays, and the tentative market price and volume, is always available to traders. This richer information environment promotes intra-round strategizing since changes in traders’ buy and sell orders are communicated to others through the evolution of the demand and supply arrays throughout a trading round. Williams and Walker (1993) illustrate representative reported supply and demand array as well as sample computer screens from this exercise.

Student traders can earn profits in two ways. First, they can earn dividends on shares owned at the end of each trading round. (Dividends are randomly determined using parameters selected by the instructor.) Second, they can earn capital gains (or losses) from selling shares in the market. The relevant
theoretical benchmark here is an equilibrium price path based on a share’s intrinsic value, which is defined as the present discounted expected dividend value of a share over the remaining trading rounds in the market. The software accommodates a per-round interest return on cash holdings, as well as dividends paid on shares, but this complication is not appropriate for introductory classes who have had no exposure to present value calculations. By using a zero interest rate, intrinsic value is simply the expected dividend stream associated with holding a share until the market’s conclusion. Even in such a simplified setting, this is a challenging decision-making exercise for the typical student who has had very little experience thinking about intertemporal market strategies, price change expectations, and how the aggregation of buyers’ and sellers’ limit prices determines market outcomes. In spite of the many differences between the decision-making environment utilized in these education-oriented market exercises and what is typical in research-oriented asset markets, these educational exercises (sometimes involving hundreds of traders) consistently reproduce the familiar price bubble and crash pattern seen previously in the small, single session, cash payment research experiments (see Williams [1998]).

III. PROCEDURES AND PARAMETERS

A. Framework for Computerized Multiple-Session Exercises

Decision settings composed of rounds lasting several days are referred to as “multiple session”. This contrasts with the “single session” procedures typical of laboratory experiments where all decision rounds occur in sequence over a relatively brief time span. The exercises discussed in the previous section all incorporate this crucial modification. They are each composed of multiple-sessions, where decision-making rounds last several days outside the classroom rather than four or five minutes in the classroom. Students have a great deal of leeway as far as when to make their decision outside the classroom.

Figure 2 displays a flow chart of the steps that comprise a multiple session VCM exercise using a salient reward structure based on extra-credit points. The following specific points describe the multiple-session procedure.

1. The software can handle multiple decision-making groups running simultaneously. For example, VCM can handle 20 groups. Before beginning the exercise, a set of parameters is initialized for each decision-making group (called a design cell). For example, a class of size 350 might
(2) Upon logging onto the computer for the first time, students are assigned to a design cell via a quasi-random rotation procedure unknown to the students. This reduces the probability that several acquaintances, accessing Round 1 at the same time, will be assigned to the same group. As part of the initialization process, four priority levels are designated for design cells. All level 1 design cells are filled before the remaining students are assigned to level 2 cells, and so on through level 4. This feature allows the number of partially filled decision groups to be held to a minimum. Inevitably, some students fail to meet the deadline for entering their Round 1 decision and are thus excluded from further participation.
After logging in for the first time, students work through a set of instructions at their own pace and then enter their allocation decision for Round 1. After entering their decision, students log off the computer and leave the lab.

Students are allowed to proceed to the next round only after the “current round” parameter is advanced to allow for the continuation. The current round can be advanced manually by the instructor or, more conveniently, by the use of an “auto-advance” software feature. The auto-advance option compares the current time on the system clock with a preset auto-advance time (to the second) specified by the instructor. The first student to log on after the auto-advance time transparently advances the exercise into the next round and resets the auto-advance time by an increment preset by the instructor. Upon logging on for round 2 and beyond, students are shown the results of the previous round and then routed directly to the decision entry display for the current round. At this point, students have the option to review the instructions and to view the results from all prior rounds.

It is impossible to guarantee that all students will make an allocation decision in each round (a similar problem exists in many field experiments). For this reason, in settings such as VCM where it is necessary for every student to make a decision in every round, the software allows a default allocation decision to be specified. This procedure for handling defaults is explicitly explained to students in the instructions. We discuss the issues for instructors of choosing parameters for the default allocation decision later in this section.

B. Issue No. 1: The Problem of Possible Collusion

One difference between these classroom exercises and traditional in-class, single session, small group exercises is that there is not direct monitoring against student communication. The procedures outlined above represent a logical link between standard in-class laboratory exercises and actual field experiments. Certainly some control is lost relative to a strictly controlled laboratory setting, however, the gain in feasible group sizes, the real time between allocation decisions, and the more “natural” communication opportunities available in this environment add an element of parallelism with field settings that could have important methodological and behavioral ramifications.

It is naïve to think that students never discuss the classroom exercises with one another. The question is, what response should this elicit from us as the
instructors in terms of lesson design and data interpretation. We have approached the problem along the lines of the following three points:

(1) Student discussion is only detrimental to the teaching process if it changes behavior in a way that is not useful to the instruction. One example would be if the lesson specifically excludes non-cooperative behavior and the communication opportunities in the lesson make it profitable for students to change their behavior in some sort of collusive manner. This sounds trivial, but it allows us to rank lessons as to how much we might worry about communication. Monopoly exercises with simulated buyers involve no decision-based interaction between the students. Therefore, the primary purpose of student interaction would be to have some students help others figure out the monopoly-optimal decisions. In terms of pedagogy, this is not necessarily a bad thing. In the asset market exercise, the dividend stream is outside the control of the students, and the capital gains are zero sum. Therefore, collusion against the instructor is not a possibility. However, one could imagine sub-groups of students attempting to “corner” the market against other students. Finally, the public goods exercises are not zero sum. Students could on their own initiative discover what public good researchers know quite well: face-to-face communication in small groups can lead to significantly increased public goods provision in the free-rider mechanism. If the pedagogical point is the existence of free riding in an environment without communication, then the possibility of discussion can be a concern.

(2) Even without the possibility of direct monitoring against collusion, out of class communication leading to collusion can be made more difficult by careful design. A class of 250 can be subdivided by the multiple-session software into numerous subgroups (say 4 groups of 40, 5 groups of 10, and 10 groups of 4). The groups are not identified, so that no student is sure whether her friend, roommate, significant other, etc. is in the same group, even if they log in at approximately the same time. Even within a group, students can be assigned to different parameter types. These facts can all be made clear to the students when the exercise begins. It also ought to be made clear to the students that the faculty member will not enforce any cooperative agreements that the students might make.

(3) The effect of the possibility of communication is itself an object for empirical analysis, and can play an interesting role in the pedagogical delivery in the course. In the next section, we will show results that came from examining the effect of communication in some real classroom environments.
C. Issue No. 2: Student absences

When a decision exercise is conducted inside a classroom in one session, any given student is either present or absent that day. With the multiple session software, a similar effect is present with respect to student participation. Students who do not complete round one are excluded from further participation. (Of course, the fact that round one is generally designed to last for over a week means that participation in round one is more robust to short-term absences). The interesting issue involves a student who participates in round one, and is therefore a participant in the exercise, but who is absent in later rounds. This is least problematic with regards to the monopoly exercise. If there are multiple rounds of the exercise, the computer will simply note that the student did not complete the later rounds. The decisions of other students are not compromised.

Absences do have the potential for affecting the market outcomes in the asset market exercises; however there is an obvious standard response. A student missing one or more rounds simply does not trade, but she does collect the dividends on any shares in her portfolio. The exercise in which the absence of students has the greatest potential for having an impact on the group decisions is VCM. For this reason, the software was explicitly designed to allow for default decisions. An obvious setting for the default decision is to place zero tokens in the group account, since lack of participation can be interpreted as a decision to free ride. There are certainly other reasonable default specifications; in fact, the method for handling default decisions is an interesting question for instructors (and students) to explore. The structure of the default decisions could conceivably influence aggregate outcomes in multiple-session lessons. Later in this section we will discuss some data from classroom VCM exercises that speak to the issue of the default value.

D. Issue No. 3: The problem of the reward medium for large groups

When groups are larger than 10 or 20 students, the faculty member may not be in a position to use cash as a reward medium. There are many time-honored strategies for addressing this problem from similar classroom situations from many years past. One possibility is to make all returns hypothetical. While some students may treat hypothetical the same as the nominal returns, there is no reason that this should have to be the case. The results from research experiments in economics show that low-saliency or hypothetical experiments may suffer from “noisy” behavior that might mitigate the pedagogical power of the classroom exercises. A second tradition in university classrooms is to offer
extra-credit points for special assignments. Thus, we will discuss, in particular, pedagogical procedures and safeguards for rewards based on extra-credit points rather than cash. Here are the mechanics we have used for converting “classroom dollars” into extra-credit points. Extra credit generally has two components, one based on participation and one based on performance. In the VCM and asset market exercises, participation points vary directly with the number of rounds in which the student participates. From a pedagogical point of view, this allows the instructor to reward students who choose to be more actively involved in the particular exercise. In the monopoly and asset markets, subjects receive performance points based on their earnings relative to others – essentially a tournament. In VCM, a tournament mechanism would alter the strategic nature of the dilemma problem. For this reason, an alternative mechanism is used. As explained in the class handout, student’s dollar earnings are converted into the following “performance index” prior to being converted into extra-credit points:

\[
\frac{\text{is Actual Earnings} - \text{is Minimum Possible Earnings}}{\text{is Maximum Possible Earnings} - \text{is Minimum Possible Earnings}}
\]

which can range from 0 to 1 for each individual. At the end of the final round, this fraction can be computed for each individual (based on earnings in all rounds), multiplied by an appropriate constant “C”, and added to the student’s final grade average. Thus, the range of possible extra-credit points is [0, C]. Note that the use of this performance index insures that the maximum and minimum possible extra-credit earnings do not depend upon the “type” to which the student has been assigned. In most of our classes, the maximum possible extra credit would be in the range of 3 points on a 100-point final scale (with minor modifications these classes use a standard mapping of point totals into letter grades (A = 90s, B = 80s, etc.). As a comparison, some universities such as Indiana University which allow + and - letter grades, so a unique letter grade typically comprised a 3 to 4 point interval.

E. Issue No. 4: The Issue of Fairness in Large Group Classroom Exercises

We have spent a great deal of time considering questions of practicability and fairness in the use of extra-credit points as a motivator. On the issue of fairness, it can be reported that, of the thousands of students who have participated in extra credit exercises, there have been no grade appeals in which these extra-credit points were an issue. In fact, feedback from students has been quite positive. Anonymous class evaluations have contained no student objections to the exercises, and it is often mentioned as an attractive feature of the course.
From our colleagues, we have encountered a wide variety of reactions as we discuss the use of extra-credit points. In some disciplines (for example, business school departments) student participation in extra-credit exercises is completely routine. In many of these, we as economists can see that the reward structure is configured like a public good. How many times have we heard students complaining about a colleague in a group project who contributes nothing but obtains the same grade as everyone else.6 On the other hand, some colleagues have indicated that they would never use extra-credit exercises where one student’s performance is somehow linked to other students’ decisions in the exercise.

Furthermore, while it is true that both the use of extra-credit points and the interdependence of student effort as it translates into grades are time-honored teaching techniques in the university classroom, this does not mean that each and every use of these tools is appropriate. Professional educators are hired to deliver a quality service. To the extent that these teaching tools are consistent with meeting the instructor’s educational goals they are appropriate. To the extent that they become an impediment in teaching or a distraction to students, their use should be questioned. Naturally, in using extra-credit points, one is dealing with something that is visible and important to every student, his or her grade. Throughout the conduct of our classes, we have the responsibility of evaluating and assigning grades to each student on the basis of objective exams, class participation, presentations, etc. But we also face questions such as: Do we choose to curve or not to curve our exams? Where do we draw the line between an A and a B? How do we deal with a student who misses an exam because of a medical emergency?

In addition, we were guided by the following simple set of incentives. Regardless of how appropriate, honorable and well intentioned we might be in implementing this methodology, if we are not sufficiently careful and thoughtful in the use of these exercises, we leave ourselves open for much unhappiness (such as a massive number of grade appeals). In fact, there have been no grade appeals or even formal complaints based upon the use of this process. We believe that this success is based upon our use of the following four guidelines, which we offer as recommendations to other instructors:

(1) Full disclosure. Students should know at the beginning of the semester that there will be an extra-credit exercise, and the general potential it has to affect their grade.

(2) No deception. There should be no deception of any kind during the conduct of this exercise. If there are aspects of the design that the students should not know, the instructor must be willing to say, “I can’t tell you”.

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(3) **Fairness.** The use of the extra-credit performance index insures that each student has the same range of possible additions to his or her grade.

(4) **Credibility.** This procedure has been used in classes where the grading scale, which determines the letter grade, is known in advance. The instructor must have credibility that she will not find some way to “take back” the extra-credit points.

(5) **Relevance to course content.** These exercises are useful pedagogical tools focused on important course topics. If the instructor is not planning to discuss monopolies, the free rider problem and public goods provision or asset markets in a course, she should not use these exercises. Feedback from students indicates that they find the exercise to be an interesting and constructive “hands-on” experience. This is the goal to strive for in the use of these exercises.

**IV. SOME INTERESTING RESULTS FROM CLASSROOM EXERCISES**

Instructors using these or similar group teaching technologies may desire to use the same experimental design in multiple sections or courses. This approach can be particularly a useful if the “expected” result makes an important pedagogical point (e.g. the almost universal tendency for groups lacking the possibility of communication to provide the public good at a less than optimal level when using the voluntary contributions mechanism) or if the instructor wishes to track a particular design across many classroom observations. However, there are arguments for an instructor to engage in a systematic process of altering the basic designs from course to course. One argument might be if the courses are so close together in time that there is information spillover from one class to the next, making the results expected and perhaps less meaningful. A second argument is that the process of looking at design treatments can in of itself make a contribution to the pedagogical goals of the exercises. Students can examine the effects of changes in the economic environment and/or institution. In principle, students can even be involved in designing these changes.

Some questions that may be of interest in the classroom require design treatments similar to those already examined in laboratory research. For example, the beneficial effect of non-binding cheap talk in small groups in the voluntary contributions mechanism has been well documented – see Isaac and Walker (1988). Examining classroom groups with and without the opportunity for conspiracies can make a striking comparison for classroom discussion. In
a subsection below, we will present some data on communication that came from very large classroom environments and, therefore went beyond the research literature.

Moreover, classroom exercises provide the opportunity for the instructor or the students to examine parts of the economic environments or institutions that arise out of the specific needs of classroom instruction and which may never have been examined in the research literature. An example of this type of classroom exercise is also presented below. (A cautionary note: the reporting of innovations in pedagogy is in a special, lower risk category in federal regulations regarding human subjects. Nevertheless, how any one college or university’s human subjects committee operationalizes the distinction between reports on pedagogy and covered research should be determined at the local level.)

A. Endogenous Communication

In all of the VCM results reported by Isaac, Walker and Williams, student subjects were randomly assigned to design cells. In most instances, class sizes were quite large and it was virtually impossible for students to discover the identity of others in their particular decision group. What are the behavioral consequences of decision makers knowing the identity of group members, when individual decisions remain anonymous? Prior evidence, from research experiments in which communication among subjects was explicitly introduced by experimenters, shows sharp increases in market efficiency. In these experiments, however, the experimenters presented the communication option to a relatively small group, in a single session laboratory setting, with virtually zero cost of communication [see Isaac and Walker (1991) and Ostrom and Walker (1991) for experimental designs in which “costly” communication was explicitly introduced.]

Herein lies an example in which large-section multiple-session classroom exercises are a perfect forum for using a change in design for pedagogical purposes. In the data reported below, students knew the identity of other group members in the sense that each class was comprised of only one subject group. Thus, if a class had an enrollment of 60 and 40 members of the class participated in the voluntary extra-credit exercise, the students knew that all 40 participants were in the same class. The instructor informed the students of this condition and fostered discussion by announcing that participants should feel free to discuss the decision problem. Students were made aware that the classroom was free for such a discussion 15 minutes prior to class each day. Students were informed that no physical threats would be tolerated, that side
payments were not enforceable, and that any person choosing to make their decision in privacy would be guaranteed that right.

Figure 3 reports a “baseline” condition in which $N = 40$, MPCR = 0.30, and communication was not a feasible alternative. Figure 4 reports the results from 4 decision groups in which the opportunity for endogenous communication was introduced. In groups 1 and 2 the opportunity to communicate appears to have very little, if any, impact. In fact, in the case of group 2, an efficiency level is reached well below baseline conditions. With group 3, there appears to be some efficiency gain relative to baseline. In this case, however, defaults were editable.

![Fig. 3. Baseline Results – No Communication ($N = 40$, MPCR = 0.30).](image-url)
Fig. 4. Decision Groups With the Opportunity for Endogenous Communication.
(unlike the baseline). Thus, some of the improvement may be attributable to this change. Only with group 4 does a change in allocations appear to be attributable to communication. The instructor observed pre-class discussions focusing on the decision problem and the discussion appears to have led to the noted behavioral changes and improvements in efficiency. Thus, in striking comparison to small group success with communication, these larger groups did not automatically find that the opportunities for communication led to improved efficiency. Indeed, the students in these exercises were able to experience for themselves that organizing a group for communication is itself a public goods problem.

B. The Impact of Editable Defaults

As noted earlier, in multiple-session exercises it is inevitable that some participants will miss some decision rounds. What is the appropriate mechanism for setting default decisions? Isaac, Walker and Williams (1994) used a design where the default decision was set at an allocation of zero tokens to the group account. In a new series of results presented below, the default procedure is altered to allow for editable defaults. After making a decision in the first round, the each individual is asked to enter a default decision for any subsequent rounds in which the individual fails to make a decision. The individual can change the default decision at any time. Clearly, if this change has a behavioral effect, it must be in the direction of greater allocations to the group account.

In Figs 5 and 6 we contrast results with the two alternative default mechanisms. In Figure 5, where group size is N = 10 and MPCR = 0.75, there is no significant difference in allocations across decision rounds. In Fig. 6, where N = 40 and MPCR = 0.30, the single group with editable defaults shows a consistent pattern of allocations to the group account above those observed in environments where the default to the group account was zero. Thus, preliminary results suggest that the use of editable defaults has some (but not an overwhelming) efficiency inducing impact.

V. CONCLUDING COMMENT

This chapter has described how experimental economics lessons can be implemented as pedagogical tools for advancing the understanding of economic decision-making in the undergraduate classroom. The multiple-session methodology described here facilitates decision-making exercises with large groups interacting over long time spans. Such exercises are clear
examples of how instructors (using computer networking technology, their imagination, and the broad-based interests of students) can begin to extend traditional classroom activities into an interactive, experiential learning environment. Through personal experience, without the benefit of an advanced mathematical or theoretical superstructure, students observe the difficulties facing a monopolist in estimating demand, they recognize the conflict between individual and group incentives that lie at the heart of a social dilemma, and they experience the formation and crashing of price bubbles in asset markets. As a bonus, the data from classroom exercises with real, salient, extra-credit rewards are complementary to the data from conventional laboratory
experiments with real, salient, monetary rewards. This allows the instructor to link data from extra-credit exercises to the large research literature in experimental economics, and facilitates classroom discussion of laboratory methods as a means of furthering our understanding of behavioral economics.

NOTES

1. For example, the entire Fall 1993 issue of the *Journal of Economic Education* was devoted to classroom applications of experiments. Also, since 1989 over 200 college-level economics instructors have attended a series of three-day professional
development seminars sponsored by the National Science Foundation’s Undergraduate Faculty Enhancement Program titled “Laboratory Experiments for Undergraduate Instruction in Economics” (conducted at the University of Arizona Economic Science Laboratory).

2. For additional discussion of this exercise and associated teaching strategies see Noussair and Walker (1999), Williams and Walker (1993), and Wells (1991). The initial work on the design and programming of the monopoly price search exercise was undertaken by Williams at Indiana University in 1984 with support from a Lilly Foundation Postdoctoral Teaching Fellowship. Subsequent refinements have been supported by the University of Arizona Economic Science Laboratory.

3. Note that we do not explicitly announce other subjects’ p values or the distribution of tokens. Isaac and Walker (1998) report no obvious difference in behavior in similar experiments where this information was common knowledge.

4. Figure 2 was introduced in Isaac, Walker and Williams (1994).

5. In terms of formal, anonymous feedback, students in two of Williams’ Introductory and Intermediate Microeconomic Theory classes were given an end-of-semester course evaluation that included an item stating that the experiment “was an interesting and constructive supplement to this course”. The average responses were both 2.9; where “Strongly agree”= 4, “Agree”= 3, “Neither agree nor disagree”= 2, “Disagree”= 1, and “Strongly Disagree”= 0. In four “honors” sections of Introductory Microeconomics taught by Williams the average responses were: 3.6, 3.3, 3.1, and 3.1. In addition, there were no written comments complaining that the method of awarding extra-credit points was in any way unfair or objectionable.

6. The reality of our society is that such assignments with “free-riding” possibilities are now common at least as early as Middle School.

REFERENCES


