SAT scores to the university, our usable sample is smaller when we include SAT scores, rather than GPA, in the empirical estimation. Qualitative results are unchanged when using SAT scores.

[10] For a more detailed discussion of these issues, see Emerson and Taylor (2004, 2007).

[11] The model test with clustered data is distributed as chi2(k) where k is the number of constraints and d is the number of clusters. The rank of the variance-covariance matrix is at most d. Reserving one degree of freedom for the constant, at most d – 1 constraints can be tested, so k must be less than d. Since we have only 9 clusters, we can test at most 8 constraints when employing the cluster option.

[12] This result is likely due to the fact that students following a bachelor of business administration (BBA) degree plan have 15 required hours of electives – six hours of which must be in a business discipline. Consequently, they are more likely to take an upper division economics course than a student on a bachelor of arts or bachelor of science degree plan who have no such requirement.

[13] We also tested whether attendance might have a non-linear effect, but found no evidence of such an effect in our data.

[14] Students are coded as 'minority' if they self-identify as 'non-white' in that they belong to one of the following groups: Black, Asian or Other. Since Black students are systematically underrepresented in economics, it is theoretically possible that the composition of the 'minority' sub-group in the treatment and control groups differs significantly and that this difference is driving the results. This possibility is not the case in our data, however. The composition of the minority sub-group across the treatment and control groups is not significantly different, nor do the results differ if a control for 'Black' is included in the estimation.

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Experiential Learning with Experiments

Henrik Egbert and Vanessa Mertins

Abstract

This paper discusses the implementation of experiential learning techniques in a behavioural economics class. In order to deepen students' understanding of both behavioural economics and the experimental approach to research students in the course developed and conducted variants of economic experiments. We believe that the process of designing and implementing the experiments fostered a better understanding of the material than simply participating in classroom experiments would have done. Students worked in small groups to develop their versions of the experiments. Thus, the complete process promoted genuine active learning by engaging the students both individually and collectively.

Introduction

There is increasing recognition that economic education is improved by greater use of experiential learning methods, i.e. active, student-centred learning opportunities are superior to direct instruction (cf. Hawtrey, 2007; Watts and Becker, 2008). Recently, Hawtrey (2007) presented the results of a survey indicating that university students have a strong preference for experiential learning techniques (cf. also Kolb, 1984). The advantages of experiential learning include higher student motivation and better retention of knowledge compared to traditional lectures.

Hawtrey (2007) discusses various experiential learning methods, among them economic classroom experiments. Classroom experiments are an accepted method of teaching economics at the university level (see, for example, the textbooks of Holt, 2007; O'Sullivan and Sheffrin, 2006). The effects of classroom experiments have been examined for different courses (Durham *et al*., 2007; Dickie, 2006 for introductory microeconomics) and for different personality types (cf. Emerson and Taylor, 2007; Durham *et al*., 2007). Generally speaking, experiments are at least as

effective as traditional instruction techniques; for most personality types the use of experiments appears to increase learning.

In standard classroom experiments the framework of the experiment is given: the design of the experiment, the roles students play, and calculation sheets, are all given to the students. Students are participants or observers in the experiment but they are not allowed to change the experimental setup. They are active in the sense that they make decisions according to the given rules, but they remain passive in the sense that they do not design the rules of the experiment or consider how the experiment fits within the curriculum of the course. Thus, the use of classroom experiments does not necessarily qualify as active learning. Experiments offer participatory learning opportunities and social interaction, but lack personal involvement. Genuine active learning only occurs when students apply concepts in a variety of situations and experience the issues first hand (Hawtrey, 2007: 145).

To motivate students and get them to engage with the material in a behavioural economics seminar we put them in the role of experimenters. By asking students to design and conduct experiments themselves, we tried to foster active learning in the fullest sense. Our aim was to achieve a deeper understanding of a particular topic and also of methodological skills. The topic was trust and the methodology that of economic experiments, a central research method in applied economics. The acquired methodological skills should make the students capable of designing and conducting an economic experiment. Thus, we expected the students to achieve a deeper understanding of the material than one often aims for in a traditional seminar. Students were encouraged to develop variants of existing experiments. We intended to motivate students from the first to the last lecture. Since students knew that successful completion of the course required a demonstrable understanding of the basic principles and techniques of experimental economics, motivation was provided from the first session.

In the following section we discuss how economic experiments can be used to encourage and motivate students to become active learners. We also describe the course design that we used. Note that experiential learning with experiments is not restricted to behavioural economics, but can be used to teach other areas of economics, such as advanced microeconomics, labour, or environmental economics. In what follows we summarise our experience with a course taught in experimental economics. After outlining the aim and structure of the course, we discuss the pros and cons of this teaching method. Our conclusion is that learning through developing and conducting experiments, i.e. experiential learning with experiments, is a fruitful method.

Experimental learning with experiments: an example

We taught a seminar in experimental economics meeting three hours per week over a 15-week term at Saarland University, Germany, in the autumn of 2005. The 11 students were post-graduates with majors in business administration and economic education. All had passed exams in mathematics, statistics, microeconomics, macroeconomics and some of them also in behavioural economics and introductory game theory. All the students had participated in a classroom experiment conducted during a required introductory microeconomics course (Egbert and Mertins, 2006). The seminar aimed to deepen students' understanding of particular topics in behavioural economics. Additionally, we wanted to make students familiar with ongoing research issues. The particular topic we dealt with was *trust*. We structured the seminar in four stages.

The first stage consisted of a combination of lectures and discussions. The aim of this stage was to get students acquainted with the principal guidelines for conducting economic experiments (Friedman and Sunder, 1994: 74–84), recently developed approaches to measuring trust (Glaeser *et al*., 2000) and the importance of cultural issues in economics (Roth *et al*., 1991; Henrich *et al*., 2001; Camerer, 2003: 63–75 and 445–459). After that, students studied the basic design of the trust game (cf. Kreps, 1990) and a relatively common example of a trust game, the investment game (Berg *et al*., 1995). Several applications of the investment game were considered (Croson and Buchan, 1999; Fershtman and Gneezy, 2001; Koford, 2003; Bouckaert and Dhaene, 2004; Holm and Danielson, 2005).

The best known trust game is the investment game (Berg *et al*. 1995). It is played with two players. Player A has a sum of money at her disposal, player B has nothing. Player A decides how much she sends to player B. Player B gets triple that amount. Then, player B decides how much she returns to player A.

The typical results of investment games are that trusting behaviour is not beneficial in situations with anonymity. However, if anonymity is relaxed, for instance by providing signals that the players belong to the same ethnic group or are members of the same profession, then trusting others may increase individuals' pay-offs. The results of the game reject a basic assumption of the *homo economicus* model: many participants do not behave like selfish individuals but rather engage in trusting behaviour. In this stage students were required to read the respective literature before the lectures. The first stage of the seminar ended after six weeks with a short exam.

With the beginning of the second stage we turned our attention to experiential learning techniques. We randomly divided participants into two teams, one with five members and the other with six members. Both teams were assigned to find

and answer a research question by developing and conducting an experiment using the investment game. The teams could either modify an existing experimental design or develop a new one. In either case, students were required to get an overview of the published literature in the field as a first step. Next, both groups had to select two testable hypotheses and design an experiment for each. After that, both groups had to present and defend their ideas. The better proposal from each group was selected for implementation.

We implemented at this stage two stimuli for learning. First, we relied on the experience that group size influences learning (see, for example, Webb, 1982) and that cooperative teams promote learning (Michaelsen *et al*., 2004). Learning in teams is an essential element within the experiential approach (see Kayes *et al*., 2005). In both teams the possibility to form subgroups existed (cf. Gibson and Vermeulen, 2003) but we did not control for that. Second, we expected an additional motivation through implementing competition between the two teams. A competitive situation reflects a natural environment, for instance in an organisation with intra-team cooperation but inter-team competition. The positive effect of team competition for learning in organisations has been documented by Szarka *et al*. (2004). We expected team competition to be a strong stimulus for learning as it requires everyone to give his best.

The third stage included the preparation for the experiment (instructions for participants, recruiting participants, organisation of payments, etc.) and its realisation. Students were instructed to follow strictly scientific standards in experimental economics. At this stage students began to realise the difficulties in conducting experiments because they had to formulate explicitly the testable hypothesis and to decide beforehand which statistical test is suitable for analysing the data. In this stage they became active learners: they independently read the relevant literature and discussed it among group members. Within each team students specialised on tasks according to individual vocation. We provided assistance when asked for and only intervened in the process to correct some erroneous developments such as unintended framing or ignorance of basic principles in economic experiments. The stage ended with the conducting of the experiments.

The fourth and final stage included the statistical analysis of the collected data and the presentation of results in the classroom. The students engaged in a lively, extemporaneous discussion and the members of each team were required to have internalised their results sufficiently to analyse the other group members' arguments and to defend and modify their own. Several weeks later, both groups were required to provide a written summary of the experimental design, statistical results, conclusion, etc. Students were allowed this extra time to be able to execute a profound research report including all the comments and suggestions made by fellow students and lecturers.

In our seminar, students implemented two variations of the investment game. The first group tested whether trust is higher among participants who are used to working in teams as compared to those who are not used to working in teams. As a measurement they used participants' engagement in different team sports. The second group implemented different interest rates depending on the amount sent from player A to player B: for example, if A decides to send a large sum, B receives four times the amount sent, and if A decides to send a small sum, the sum is only doubled (in the original game the amount sent is always tripled). Both experiments were successfully carried out.

In the winter term of 2008–2009 we tested our course design at the University of Trier in a labour economics course with 26 students. Students in this course only had a few previous courses in economics. We divided the students into six competing teams. Unlike the first trial, we did not force student teams to compete against each other. Nevertheless, we observed them keeping the own achievements a secret and trying to outperform the other teams. From the experience with this course we learned that the course design worked similarly well. Evaluation by a survey revealed that students found the course highly meaningful, motivational, and rewarding.

Pros and cons of learning with experiments

Learning with experiments provides effective teaching by engaging the student's desire to learn. Since students remember only a fraction of what they hear but a majority of what they actively do, Senge (1990) reasoned that personal involvement would help to get students engaged with the subject matter. Our example contains a great deal of learning opportunities (Hawtrey, 2007): students were required to talk with others about their topic, to teach their peers, to apply theoretical knowledge to conduct experiments, and to solve real-life problems. Thus, real learning occurs as students make use of class material. One student told us that this was her first course to emphasise understanding, rather than memorising.

Student feedback suggested that participating in the course was highly rewarding. Students often emphasised personal skill development such as enhanced self-organisation or explaining material to fellow students. The challenge of working effectively in teams also produced positive feedback. Students agreed that team work motivated them to increase their efforts and to support each other. In addition, students seemed to enjoy gaining practical experience and solving real-life problems, such as acquiring funding or recruiting participants. The course was also rewarding for the lecturers. We felt the students' intellectual curiosity and enjoyed our interaction with them. We also took pride in the fact that we could intrinsically motivate our students with this course design.

While the course was quite rewarding, some of the potential problems of this course design should be mentioned. As with most experiential learning techniques, our courses required a significant investment by the lecturer in planning and preparation. Since students are often not acquainted with experiential learning they request quite a bit of feedback from the lecturers. Furthermore, the results of such a course cannot be predicted with certainty. For instance, many factors may influence the results of the experiments and these factors cannot always be controlled by the lecturer. Thus, a high degree of flexibility is required.

In addition, some of the participants did not like the competition between the teams. We think that this competition provided an important stimulus within the course and also resembled some important situations outside of the classroom. In hindsight, we should have stressed to the students that inter-team competition was an advantage of our design rather than a disadvantage, perhaps by providing examples of competition within work environments.

Finally, several students noted that the course was time intensive and rather more work than they expected. This is true because students often focus solely on final exams. However, this course design forces them to work during the whole term. This critique thus appears to be due to students not being familiar with situations in which they learn informally and continuously. Many students noted that the course was time intensive, but well worth it; comments such as "it is extremely time-consuming, but it is fun and I enjoy it, so it's ok" were typical.

Conclusions

Experiments facilitate more active learning than traditional lecture and discussion methods. In standard classroom experiments students are active in the sense that they generate data through their own decisions and are engaged in social interaction. However, classroom experiments do not realise the full potential of active learning.

Our experience can be summarised as follows. Instead of using traditional classroom experiments, students were encouraged to develop variants of existing experiments on their own. Thus, they became active learners both by designing and conducting the experiment, and by conducting an analysis of the generated data. Students were experimenters in an active learning situation. They felt that they were 'doing innovative research' by applying their own ideas, which had not been applied and tested before. Consequently, they gained insight in ongoing research in a particular research field and developed a 'feeling' for the experimental method in economics. They had to solve new and often unexpected problems, some of them associated with the practical details of working in a group, some of them associated with the logistics of conducting experiments, and some of them associated with economic theory. In order to solve these problems, they applied knowledge acquired in other university classes (statistics, microeconomics, game theory) or they made use of their own life experience. Furthermore, problems were tackled by discussions within the groups, with the lecturers monitoring and offering advice. With regard to the answers given in an evaluation questionnaire, students emphasised that the practical orientation of the course as well as the teamwork promoted a positive climate for learning. They emphasised that they acquired knowledge that they did not to expect to gain in an economic course.

Thus we conclude that we achieved genuine active learning by putting students in a new situation which required their personal engagement not in the role of participants in experiments but as experimenters themselves.

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Patents and R&D: A Classroom Experiment

Amy McCormick Diduch

Abstract

Public policy towards patents has assumed a robust positive relationship between the strength of patent protection and the level of innovative research effort even though economic theory and empirical evidence suggest that the impact of patents on research varies considerably by industry. This classroom experiment provides students with an introduction to two competing models of the impact of patents on R&D: the 'winner-take-all' model contains incentives for excessive research effort and the 'knowledge spillover' model contains incentives for free riding. Class discussion explores potential changes to current patent policy and policy alternatives for stimulating R&D.

Introduction

Growth theory asserts that an economy's long run rate of economic growth is strongly related to its rate of productivity growth. Productivity growth, in turn, is determined in part by innovation and technological progress. Thus, governments interested in promoting long run economic growth choose policies that encourage innovation. Granting patents to innovators has long been assumed to be one important part of the policy menu. However, economic theory and empirical evidence indicate that patent protection does not always provide incentives for optimal levels of research and development. Patent law, industry structure and externalities associated with knowledge may result in too much or too little research effort.

This paper describes a classroom experiment that allows students to determine research effort in response to two different incentive structures: a 'winner-take-all' system and one in which there are extensive knowledge externalities. In the 'winner-take-all' structure, firms typically engage in too much duplicative research and the total research expenditures exceed the financial rewards from the patent. In the externalities structure, firms are tempted to free ride on the research efforts of others