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# Landauer Wirtschaftswissenschaftliche Diskussionsbeiträge

Introducing Classroom Experiments to Future  
Secondary School Teachers  
- Concept and Evaluation -

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## Summary

This paper describes a new university course for prospective schoolteachers, introducing them to classroom experiments by letting each of them take the role of the experimenter once during the semester, with their fellow course participants as subjects. We also report on their evaluation of the different classroom experiments and how they perceive their suitability as a teaching tool. According to our survey results, students should receive courses on classroom experiments favourably, and should consider them to be useful.

**Keywords:** classroom experiments, experiential learning, teaching of economics

## Zusammenfassung

Gegenstand dieses Papiers ist die Vermittlung einer innovativen wirtschaftsdidaktischen Methode, der "classroom experiments" (Lehrexperimente) in einem Seminar für angehende Lehrer. Jeder der Teilnehmer dieses Seminars übernahm im Laufe des Semesters einmal die Rolle des Experimentators. Wir beschreiben kurz die einzelnen Experimente und geben einige Hinweise für den möglichen schulischen Gebrauch. Ferner berichten wir über die Evaluierung der Methode durch die Studierenden; wesentliches Ergebnis ist, dass die angehenden Lehrer Experimente für eine sinnvolle Lehrmethode halten. Insgesamt plädieren wir für die Vermittlung von "classroom experiments" im Rahmen des Studiums der Wirtschaftspädagogik.

**Stichworte:** Lehrexperimente, Wirtschaftsdidaktik

## JEL: A21, C9

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## **1. Introduction**

Classroom experiments are increasingly being used in higher education. More recently, the question has been raised whether they could also be successfully applied in secondary schools. Compared to simulations and case studies, which are often advocated for use in secondary school teaching (e.g., Whitehead 1979), classroom experiments are simpler and have a clearer structure. With classroom experiments it is easier to demonstrate certain points vividly, precisely and in an entertaining manner. On the other hand, it can be more difficult to show how these points relate to everyday economic problems. Hence the need for reflections on the suitability of classroom experiments in this environment.

The purpose of this paper is twofold. In section 2, we start with a description of a course in which classroom experiments were introduced to students of economic pedagogy and economy. Here, some simple classroom experiments will be described which might be of interest, especially to those unfamiliar with the use of experiments for research purposes. The paper's second purpose is to describe the students' evaluation of the different classroom experiments: how much they liked the experiments and how much they learned from them, but also - and most importantly - how useful they believe the experiments would be in secondary schools where most participants have already gained some practical experience.

## **2. Design of the Classroom Experiments Course**

### **2.1 Background**

Economic experiments have become a field of academic research in its own right. In 2002, one of the two winners of the Nobel Prize in economics was Vernon L. Smith<sup>1</sup> for his contribution to establishing laboratory experiments as a tool in empirical economic analysis. Reinhard Selten, who received the prize in 1994 for his contributions to game theory, is also a

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<sup>1</sup> Smith used the occasion of his Banquet Speech at the Nobel Banquet to remind us of Benjamin Franklin's famous remark: "Tell me and I forget, teach me and I remember, involve me and I learn." (<http://www.nobel.se/economics/laureates/2002/smith-speech.html>).

dedicated experimentalist. When using economic experiments as a research tool, subjects are confronted with clear rules and incentives in a controlled environment. The experimenter observes what happens, i.e., his benefits are data, whereas the participants' benefits are monetary payoffs - and nothing more. By chance, one of the authors of this paper took part as a student subject in two experiments at the University of Hamburg in the late eighties, and he came home none the wiser after the experiments.

By contrast, classroom experiments are designed not to produce data for research purposes, but for teaching purposes. "Classroom experiments transform students into investigators who demonstrate economic principles for themselves." Hazlett (2000:9).

What are the instructors' benefits? The data from these simple didactic experiments are typically not usable for research purposes, but apart from just keeping the class lively, experiments increase motivation by getting students involved in the economic problem that is being taught. Ortmann and Scroggins (1996:101), make the somewhat Machiavellian observation that classroom experiments tend to lead to good evaluations of courses and instructors by participants. Taking all these aspects together, it is not surprising that classroom experiments have become increasingly popular as a tool for academic teaching, especially in the USA.

On the other hand, as noted by King (1999), there are certain costs for the instructor, though incentives for the participants need not be as high as in research experiments - in fact, they can be very small, stochastic, in kind (sweets like M&Ms), or even hypothetical (Holt 1999; Rubinstein 1999). Furthermore, instructors' opportunity costs have been decreasing due to freely available material (instructions). Meanwhile, the literature on classroom experiments is fairly extensive; the *Journal of Economic Perspectives* ran a series on them, the monographs by Delemeester and Neral (1995), Ortmann and Colander (1995) and Bergstrom and Miller (1997) all come with useful material for the instructor. *Classroom Experiments* is a newsletter, now in its 12th year, dedicated entirely to classroom experiments (<http://www.marietta.edu/~delemeeg/expnom.html>). Another important Internet resource in "Games Economists Play: Non-Computerized Classroom-Games for College Economics" by Greg Delemeester and Jürgen Brauer (<http://www.marietta.edu/~delemeeg/games/>).

From this large body of literature, two small side-streams of research have developed. First, Gremmen and Potters (1997), Frank (1997), Dickie (2000) and Rott (2001) test the hypothesis that classroom experiments actually improve or facilitate the learning of economics (The overall answer is yes, though Rott, 2001, considers the direct contribution to learning to be small and instead emphasises the increase in motivation in introductory courses). Second, classroom experiments are proposed for secondary schools by Denize Hazlett (2000, 2001a, 2001b), Geisenberger and Nagel (2002:ch.VI) and Nagel and Pöppe (2002)<sup>2</sup>. However, no attempt is made to evaluate the actual teaching success.

It is obvious how one would ideally attempt to merge these two streams of literature: by measuring the impact of classroom experiments on pupils' knowledge in secondary schools. Such a study is, however, still in the planning phase. In this paper we largely make use of the perceptions of students who participated in a new course on classroom experiments at the University of Koblenz-Landau. They all study economics for school teaching, most of them will go on to teach in the *Realschule*, an intermediate secondary school for pupils with "medium" capabilities, between 11 and 16 years old. We hope that these prospective teachers will make use of the new method they acquired, and in the very near future, we hope to be able to report on a pilot project in Rhineland-Palatinate, where the ministry of education has shown some interest in this method<sup>3</sup>.

## 2.2 Course Requirements

When we designed this course, we had to observe university requirements or standards, such as the "pass or fail" modus. As a background to the students' evaluation in the empirical part of the paper, we describe the course as it was, not as we would have liked it to be.

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<sup>2</sup> Nagel and Pöppe (2002) document a course with selected highly gifted pupils from various schools "Deutsche Schülerakademie". Like our students, these pupils sometimes took the role of the experimenter, a modus which Nagel and Pöppe (2002) recommend for advanced courses in grammar schools, evidently sharing our opinion that in "normal" school classes, the teacher should be the one who is responsible for the experiments.

<sup>3</sup> Indeed, we received the following letter: "The Ministry of Education, Women and Youth as the responsible institution for public schools in the land of Rhineland-Palatine is looking forward to learning more about the new possibilities of learning with economic experiments and has a genuine interest in the results of the project."

In two introductory weeks, the 16 participants had come into contact with economic experiments for the first time, and were demonstrated using the "dollar auction" (Hauper 1994) and the centipede game (Rubinstein 1982).

*Course organisation and requirements were the following, in chronological order:*

1. In the second of the two introductory sessions, possible topics for 10 classroom experiments were briefly described. The participants - most of them in teams of two or three students - chose one particular experiment. During the semester, these teams developed the necessary course materials and performed the experiments with the fellow participants as subjects.
2. The results were presented, one week after the experiment if possible, though sometimes - and less ideally - presentations had to take place a few weeks after the experiment. In most weeks, the 90-minute session was filled with one experiment plus one presentation.
3. A small joint paper (1 - 3 pages) on the experiment's results had to be submitted by those who performed the experiment.
4. Finally, each participant had to write a paper (5 - 10 pages) on the theoretical background and previous experiments on his or her topic. This is the one requirement where joint work was not allowed. Most participants did not start work on this until after the end of the course<sup>4</sup>.

## **2.3 Experiments**

In this section, the experiments are discussed with a view to giving some idea of their possible suitability for use in school (or for the purpose of introducing future school teachers to experiments). It is not the purpose of this paper to give enough information to actually perform these experiments, but we refer to the relevant literature on the various experiments.

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<sup>4</sup> The typical seminar format of German universities works differently: typically students write a 15 pages thesis on a given topic. This is done before the semester starts. Then one topic per week is discussed, based on the presentations of those who have written a paper on it - typically one to four students. Besides paper and presentation, a written examination completes the course requirements. This was not the case in this particular course, however, one of the reasons being that students were not assigned for the course before the start of the semester.

### *a) Supply and demand*

Reconstructing the decision of the demand and supply side and their coordination in the market is a classic research experiment, pioneered by Vernon Smith (see Davis and Holt 1993: ch. 1 and 3, for an overview; Hazlett 2000, 2001a, for instructions for use in secondary schools). So-called double auctions usually result in efficient market outcomes, but might be too ambitious for some classes. A possible solution is to focus on the demand side, with the teachers offering apples or chocolate bars for sale and collecting pupils' bids (Weidenaar 1972). A very concrete demand curve can then be drawn and the "consumer surplus" calculated in euros and cents. Another possibility is to let buyers and sellers move around and meet in class in an unorganized way; this was tried in this course, but leads to less clear-cut results (just like in Chamberlain 1948).

### *b) The beauty contest*

This is another possible candidate for beginning a university course on classroom experiments. In the first weeks of such a course, the experiments are performed by students who are completely inexperienced even as participants, hence it is only fair to make their task relatively simple. The beauty contest is easy to organize and leads very reliably to (qualitatively) the same results as the established literature. In its basic form, the subjects' task is simply to write a number between 0 and 100 on a sheet of paper, with the aim of guessing two thirds of the average of the others' guesses. Evidently nothing above 66.6 can ever be the best guess, no matter what the others decide on. However, if the others know that, then nobody will guess more than 66.6, hence one should not guess more than  $\frac{2}{3} \times 66.6 = 44.4$ . This process of reasoning goes on until anything but 0 can be ruled out. However, typical first round guesses are in the area of 33.3 ( $\frac{2}{3}$  of one half of 100), and soon get lower if the experiment is repeated.

This game was introduced by Nagel (1995); see Selten and Nagel (1998) for a popular account in German. It is proposed by Nagel (1999) and Rubinstein (1999) for use in class. The beauty contest is so called due to Keynes' reference to a newspaper contest where people had to guess which of a number of portrait photographs is chosen by the maximum number of people. Hence one has to guess which photograph would be liked by the others, or rather which photograph the others guessed would be guessed ... etc. This thought experiment serves



the same purpose as actually playing the beauty contest, illustrating how share prices in the stock market can fluctuate so dramatically, even though the firms themselves have not changed markedly. One reason is that expectations about other buyers in the stock market think and do play such a big role.

*c) The prisoner's dilemma*

The importance of the prisoners' dilemma is obvious, and it is fun to play in class. In our course, the experimenters by and large followed the design proposed for the classroom by Holt and Capra (2000). In the baseline experiment, participants faced each other, choosing one of two playing cards (for cooperate or defect). The chosen cards were disclosed simultaneously. As variants of the game, two things were changed (separately): the worst outcome was replaced by an even worse one, and one-shot encounters were substituted by repeated interactions. We find the latter variant more suitable for class, because the results are intuitively more appealing<sup>5</sup> (Why do friends trust each other more than strangers? Why is competition often more fierce when a new firm enters the market?).

*d) The one-sided prisoner's dilemma*

The one-sided prisoner's dilemma is less well-known than the other experiments in this course. Inspired by Rasmusen (1989: ch. 4.7), it was proposed for class by Ortmann and Colander (1997). It can serve to illustrate a common principal-agent problem: a seller can either cheat or be honest, and the buyer can make the effort to inspect or not. The "social optimum" requires that the buyer does not have to bear the costs of inspecting, and that he is not cheated. However, to cheat is the seller's rational (i.e. dominant) strategy in a one-shot game. The experimenters in this course used the game also to illustrate the difference between one-shot and repeated interactions, which is highly relevant (think of the quality of certain tourists' restaurants versus those who can only survive if the natives come more than once) and within the reach of pupils' intuition.

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<sup>5</sup> By contrast, changing the gains from cooperation or from cheating might be confusing to beginners, as the frequency of cooperation typically changes, though the (Nash) equilibrium in dominating strategies remained the same. Recently developed equilibrium concepts which explain the experimental observations are fairly advanced stuff, e.g., Anderson, Goeree and Holt (2004) or Erlei (2003).

### *e) Auctions*

Auctions are increasing in importance, and with EBAY's success this also holds true for pupils' own economic transactions. It is easy to illustrate how auction rules work in class<sup>6</sup>. A nice thing to demonstrate is the winner's curse: if the object which is sold has only a material value which is the same for all, but unknown at the time of the auction, then the winner is not only the one whose guess of the value was highest, it was probably too high. This usually happens when you sell normal coins in a *Kinder Surprise* plastic egg.

### *f) The Ultimatum Game*

In the ultimatum game, a proposer and a responder negotiate on how to split a pie. The rules are very simple: the proposer makes an offer of how to split a certain stake. The receiver either accepts the offer, and both subjects are paid as proposed, or he rejects it, in which case both receive nothing. The result of the experiment is invariably that too small offers are rejected, and that they are - wisely - rarely made. Both observations are in sharp contrast to the theoretical solution derived from backward induction, according to which the "optimal" offer is as close as possible to zero, apparently neglecting the disutility from being offered an "unfair" share of the stake, or the utility from rejecting it.

For university courses on experimental economics, the ultimatum game is very suitable as it can easily be performed, and even in its simplest form provides insights into a "hot" research topic (the seminal paper by Güth, Schmittberger and Schwarze (1982) initiated a considerable amount of research on the ultimatum game and some variants). However, despite its simplicity, the ultimatum game is possibly too abstract for secondary schools - but see Bergstrom and Miller (1997) for a buyer/seller framing for use in class.

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<sup>6</sup> By now there is an enormous amount of literature on auctions. Rasmusen (1989:ch.11) is still very useful.

### *g) Oligopolies*

The oligopoly experiment that went completely wrong, but in an interesting way. Quite appropriately, a multilateral prisoners' dilemma had been constructed, in which the group of participants, as a whole, earns more "tokens" when all choose their high price strategy rather than their (dominating) low price strategy (see Delemeester and Neral 1995: Experiment 10, for instructions from a similar experiment). The problem was the translation into actual payoff. The participant who won the highest number of points earned a (fixed) prize (in kind), irrespective of whether cooperation occurred or failed, i.e. whether market price and producers' surplus were high or low. Cooperation made no sense at all, as immediately realized by the participants. Based on our experience, student experimenters generally do not like to give small rewards to everyone, but one "big" non-monetary prize, which can sometimes be extremely inappropriate. Those who performed the principal-agent experiment were wiser after this experience and paid participants in units of small sweets<sup>7</sup>.

### *h) Women vs. Men*

There are various experimental investigations which focus on the possible difference between the behaviour of women and men (see Eckel and Grossman 1998, for a brief overview). One group of participants was given a number of these papers and decided to try the trust game as in Croson and Buchan (1999). Their result that women and men do not differ with respect to trust, but that women exhibit more reciprocity, i.e. that they reward trust more, was replicated in this course. However, the behaviour of some participants seemed to be affected by their knowing that gender differences were being investigated.

The following experiments were also offered, but not chosen by students in this course: gift exchange game (an experiment on the relationship between fair pay and workers' effort invented by Fehr, Kirchsteiger and Riedl 1993), a public goods experiment (Brock 1991; Leuthold 1993), and an experiment exploring the firm's production function (see Neral and Ray, 1995, and Anderson and Chasey 1999; a complementary quasi-experiment is proposed by Dabb et al. 2001).

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<sup>7</sup> Hemenway, Moore and Whitney (1987) discuss an oligopoly game with grades as incentives. Ortmann (2003) describes a very simple Bertrand oligopoly experiment with a high stake, but ultimately (due to competition of the students for the stake) low costs for the experimenter.

Note that some of these experiments require an even number of subjects. The course instructor or lecturer can stand by to participate in the experiment in case there is an odd number of students present (which is something one never would do in a research experiment).

### **3. Evaluation**

#### **3.1 General remarks**

Apart from the structured evaluation described in the subsection after next, we also received a number of very favourable informal comments from the students. Nevertheless, there are some things about this course we would like to change next time.

First, the experimenters' post-experimental discussion of the topic would surely benefit if they had to write their term paper before, rather than after, the semester. Second, we should exert tighter control on the design of the individual experiments *ex ante*. Holt lets "bright undergraduates in their third and fourth years" (1999:609) read introductory papers on certain experiments and perform these in (economics majors) class. In our case, students were less experienced. Instead of just being invited emphatically to discuss their design with us before the experiment (which saved the auction experiment, for example), they should therefore be obliged to do so (which would have saved the oligopoly experiment). Third, at least for some sessions, one should try to invite secondary school pupils as subjects. This is the ultimate test for aspects like the quality of the instructions or the optimal time span for the experiment. If possible, one could also arrange an "excursion" to the pupils' natural environment, i.e., their usual classroom, to try some experiments<sup>8</sup>.

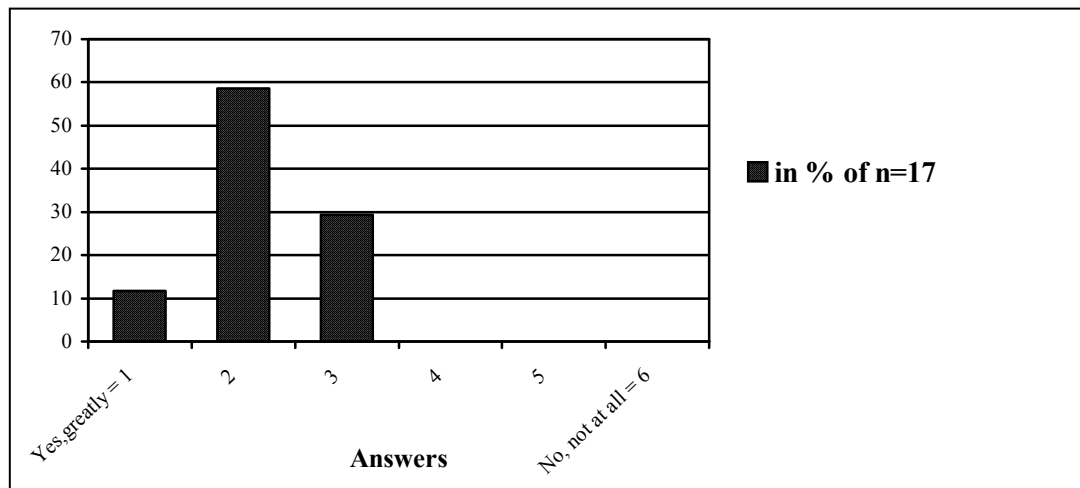
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<sup>8</sup> We are indebted to Scott Simkins (North Carolina A&T State University) for this recommendation. Professor Simkins told us that he has actually performed a market experiment in his son's high school, with varying results depending on the composition of the classes.

### 3.2 Pupils' evaluation - the first contact

In return for receiving instructions and literature on market experiments from us, we asked a teacher of a 9th class in a secondary school for a brief survey. We were not present when the experiment was performed<sup>9</sup>, hence we can only report on the bare results. According to these, pupils enjoyed the experiment (see figure 1).

**Figure 1: Answers to the question "Did you enjoy the experiment?"**  
(coded on a six point scale from 1 = *Yes, greatly* to 6 = *No, not at all*)



Asked whether they would like to take part in any other experiment in this course, all but one answered yes (16 out of 17 or 94,11%). 14 pupils (82%) said they thought that they had learned something new by doing the experiment.

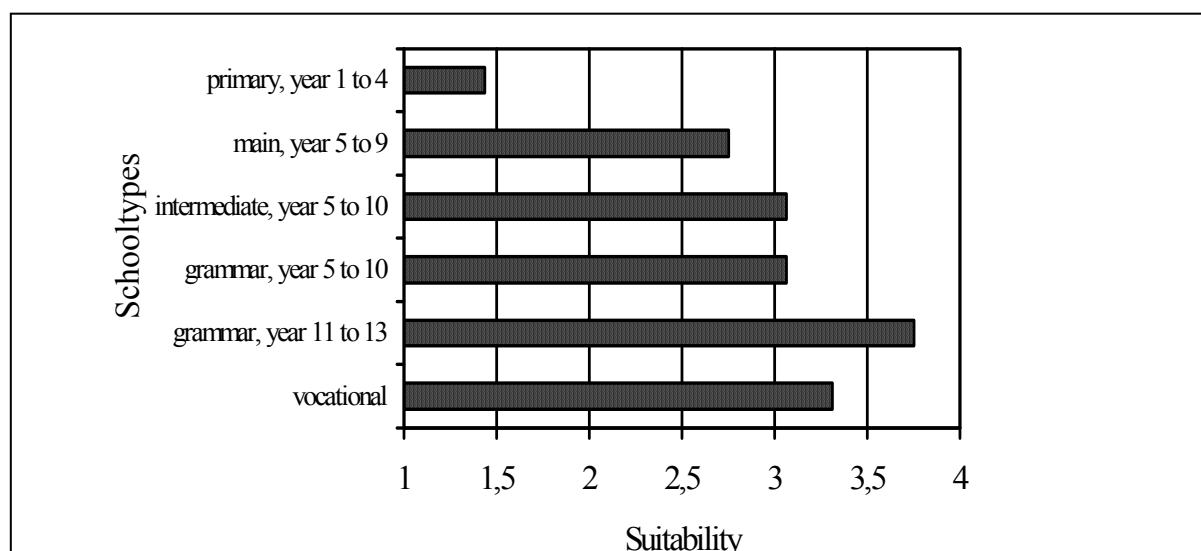
### 3.3 Students' evaluation

As already emphasised, the larger part of our empirical evidence is based on the perception of the participants in our course, most of whom already had practical insights on teaching through internships. Based on their experience with experiments during the semester, the

prospective schoolteachers who took part considered experiments to be suitable for secondary school, though not for the primary school<sup>10</sup> (figure 2). After the fourth class (in most of the German *Bundesländer*), pupils attend school according to their capabilities, with main school (*Hauptschule*, equivalent to secondary modern or junior high school) representing the lowest regular level, while the "median" pupil attend the intermediate school (*Realschule*), which is where most of our participants are going to teach.

According to our survey, highest suitability is presumed for the final classes of the grammar school, the attendance of which is a prerequisite for entering university. For those who do not go to university, an apprenticeship in a firm in the first years after school also involves part-time enrolment in a vocational school, where the curriculum often includes some basic economics education.

**Figure 2: Perceived suitability by school type**  
(on a 4-point-scale from 1 = *unsuitable* to 4 = *very well suitable*)

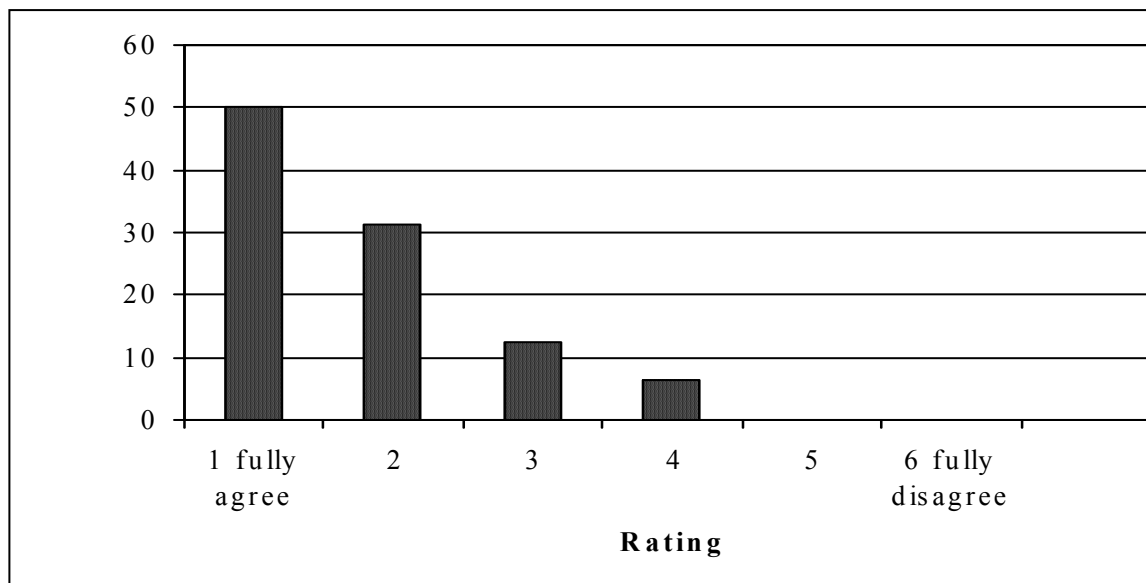


<sup>9</sup> The "supply and demand" experiment from Bergstrom and Miller 1997, performed by Sylvia Gümüs at Realschule Schifferstadt.

<sup>10</sup> Bill Harbaugh and collaborators (<http://nanoeconomics.org/>) do experiments with very young children (e.g. Harbaugh, Krause and Liday 2002), but mainly for research rather than teaching purposes. Nevertheless, their research at least shows that suitable instructions for certain experiments can be understood by anyone, of any age.

A few questions were asked in order to determine which positive features the participants ascribe to classroom experiments. Figure 3 shows the extent to which they agree with the statement that experiments increase the vividness of economics. The average rating is 1.75.

**Figure 3: Agreement with the statement "Experiments increase the vividness of economics"**  
(coded on a six point scale from 1 = *I fully agree* to 6 = *I fully disagree* in % of n = 17)

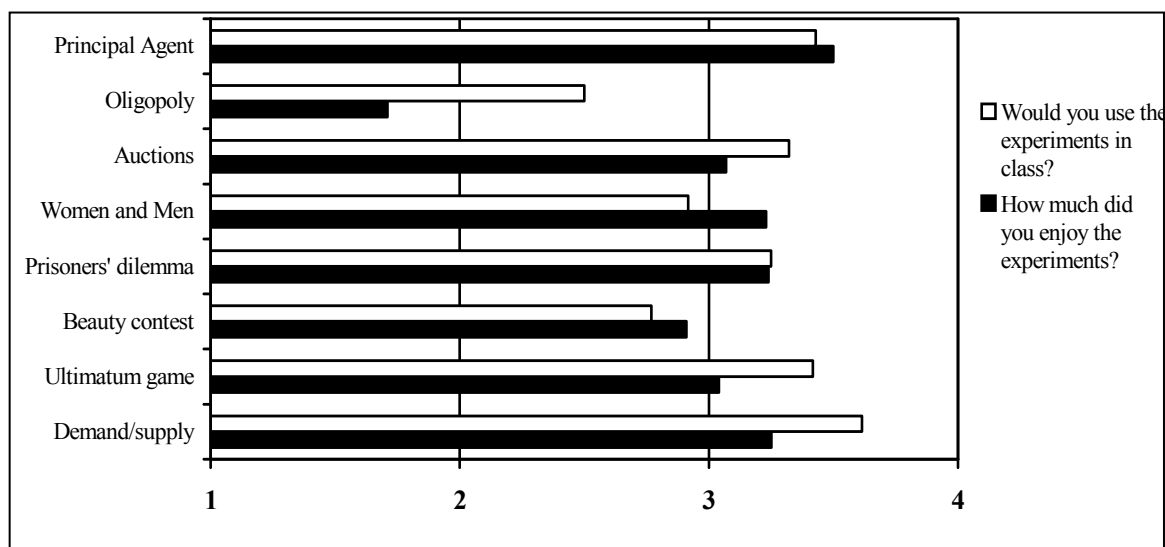


These are the degrees of agreement with further statements, again on a six-point scale with 1 = fully agree:

- Experiments facilitate the understanding of economic principles: 2.1
- Experiments stimulate social interaction in class: 2.3
- Experiments can be flexibly integrated in class: 2.4
- Experiments help to acquire economic terminology: 3.5.

The last result is no surprise, because compared to other teaching methods, classroom experiments involve less abstract and more non-verbal interaction. As far as the stimulation of social interaction is concerned, we actually expected an even higher level of agreement with the statement quoted above, as social interaction in our class seemed to develop very well. It should, however, be borne in mind that participants were asked about the expected stimulus of classroom experiments on social interaction in school classes, the composition of which they probably presumed to be less homogenous than in this course.

**Figure 4: Answers to the questions “Would you use experiments in your class?”**  
 (on a 4-point-scale from 1 = definitely not to 4 = surely - upper bar)  
**and “How much did you enjoy the experiment?”**  
 (on a 10-point-scale with rating from 1 = *worst* to 10 = *best*, here normalized to a 4 point scale  
 for better comparison - lower bar)



We also asked the students about their thoughts on the individual experiments: about the likelihood of them using these experiments in their own class, and how much they enjoyed the experiment in our class (Figure 4). Most interesting is the result for the oligopoly experiment, which had gone wrong as described above. To a certain extent, students seem to be able to abstract from the peculiarities of the session they experienced. At least this is our interpretation of the difference in the size of the two bars - i.e. between the rating of the experiment as a teaching tool and the rating of the session. Nevertheless, it is very likely that a better performance of the experimenters would have led to a higher rating of the oligopoly experiment on both scales.

We hypothesised that participants would like the experiment more when they were in the role of the experimenter, but the difference between participants' rating for their own experiment, compared to the average rating they gave for all, was not significant. In fact, six out of 16 students gave a lower rating for their own experiment. It seems that the benefits from increased involvement and creativity were outweighed by the costs of increased effort, at least in this course.



## **4. Conclusion**

Starting with a rather modest conclusion: for economists who have to give a course for prospective schoolteachers, a course like the one described in this paper might be something they would enjoy. Furthermore, according to our survey, these students also think that teaching in schools could be improved by using this experiential learning method (section 3.3.). Pupils also seem to like it (section 3.2.).

A higher methodological standard would be met if we were already able to report on actual teaching success based on a comparison of experimental and control groups with random assignment of pupils, as generally demanded for education research by Angrist (2003). Our survey results encourage us to make such an attempt; however, the logistics of a pilot study are still in the planning phase.

Nevertheless, we could already present some limited evidence. Yet our description of a new course on classroom experiments for prospective teachers not only provides the background story for the empirical part. We also hope that it is useful for others who wish to support the idea of teaching with classroom experiments at school. We would therefore be pleased to hear about similar courses for students of economics education, or about further experiments actually in use in secondary schools.

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