@tic
revista d'innovació educativa
Universitat de València

Decisions, externalities and public economy in a location context

Juan Miguel Benito Ostolaza
Profesor Ayudante Doctor. Departamento de Economía. Universidad Pública de Navarra.
jon.benito@unavarra.es

| **Fecha presentación:** 25/10/2009 | **Aceptación:** 24/11/2009 | **Publicación:** 04/12/2009

Resumen

En este trabajo, se propone una aplicación en el aprendizaje de la teoría de fallos de mercado como parte de un grado en Economía. En particular, se propone un experimento en clase para entender el concepto de externalidad positiva en la toma de decisiones de los individuos. Con este experimento los estudiantes participan directamente en un juego que les permite ver cómo las externalidades aparecen en otras situaciones. Nos estamos alejando de los ejemplos típicos sobre el bienestar de un consumidor o las posibilidades de producción de una empresa que se ve afectada por las acciones de otro agente económico. Incluso con esta ligera contribución de nuestra experiencia en clase, podemos decir que es extremadamente motivadora para el alumnado, y que abre un nuevo marco metodológico en el que la participación del estudiante en el aprendizaje se vuelve crucial.

Palabras clave: Microeconomía, externalidades, economía experimental

Resum

En aquest treball, es proposa una aplicació en l'aprenentatge de la teoria d'errades de mercat com a part d'un grau en Economia. En particular, es proposa un experiment a classe per entendre el concepte d'externalitat positiva en la presa de decisions dels individus. Amb aquest experiment els estudiants participen directament en un joc que els permet veure com les externalitats apareixen en altres situacions. Ens estem allunyant dels exemples típics sobre el benestar d'un consumidor o les possibilitats de producció d'una empresa que es veu afectada per les accions d'un altre agent econòmic. Fins i tot amb aquesta lleugera contribució de la nostra experiència a classe, podem dir que és extremadament motivadora per a l'alumnat, i que obre un nou marc metodològic en què la participació de l'estudiant en l'aprenentatge es torna crucial.

Paraules clau: Microeconomia, externalitats, economia experimental

Abstract

In this paper, we propose a learning application of the theory of market failure as part of a degree in Economics. In particular, we propose a classroom experiment to understand the concept of positive externality in the decision making of individuals. With this experiment, students participate directly in a game that allows them to see how externalities can appear in other situations. We are moving away from the typical examples over the well-being of a consumer, or the production possibilities of a firm affected by the actions of another agent in the economy. With even just a slight effect from our classroom experience, we can say it is extremely motivating for students, and also, it opens a new methodological framework in which student participation in learning becomes crucial.

Keywords: Microeconomics, externalities, experimental economics

Introduction

In the training-learning process that occurs at university, the relationship between teachers and students is central. The objective of teachers must be to transmit a body of knowledge but at the same time, to guide students to discover and learn for themselves. To achieve this dual objective, teaching should be structured and planned properly.

Knowledge has to be general but applicable. Generality is important in the development of abstract ability, which is crucial for necessary modeling and underpins much of the theories discussed in class. However, this is not in contradiction with the applicability of concepts to analyze real situations.

In our view, teachers should be able to convey enthusiasm about the subject they teach, i.e., communicate the reason why the content is relevant. This content has to be positioned in relation to reality, with other materials (in order to give an overview) and, if possible, with research that occurs in their field.

An interesting approach may be to examine applications or exercises which students take part in, and which can be implemented in class. These tools can be a boost to activity in the classroom, with a view to motivating students. These participatory classes generate a critical spirit in which students learn to form their own opinions on the concepts relating to the subject matter. Thus, learning becomes the primary objective and a challenge, giving real meaning to the teaching that goes far beyond passing exams in order to obtain a degree.

To achieve this goal, experimental economics can be very helpful. Experimental economics has accumulated a set of relevant results, some of which have constituted a major contribution to central issues in economics. Some authors have found that student participation in one game or experiment improves understanding of the specific topic addressed in the game. Frank (1997) found that students exposed to a short classroom experiment about use of common-property resources performed better on a test about the *tragedy of the commons* than students in control groups who did not witness the experiment. Gremmen and Potters (1997) tested the effectiveness of a classroom game relative to lectures on the same topic. Emerson and Taylor (2004) found that students in microeconomics sections employing 11 experiments had significantly larger achievements gains than students in sections with no experiments. Maybe this is the reason for an increasing interest in the use of classroom experiments to teach economics. Textbooks for introductory courses often come with supplements of classroom games (Delemeester and Neral (1995); Ortman and Colander (1995); Yandell (1999); Hazlett (1999)), include experiments in the text (O'Sullivan and Sheffrin (2003), or focus exclusively on classroom experiments (Bergstrom and Miller (2000)). Textbooks for more advanced classes also sometimes incorporate games or experiments (Stodder (1998)), and professional journals, including the Journal of Economic Perspectives, Economic Inquiry, the Southern Economic Journal and the Journal of Economic Education, have published articles on instructional use of experiments[1].

In this piece of work we will try to illustrate how experimental economics can make contributions relevant to teaching in economics. In particular, we explore the case of externalities (within the theory of market failure), which appears in most intermediate microeconomics programs; Nicholson and Snyder (2002) or Varian (2009) among others. An externality occurs whenever the activities of an economic agent affect the activities of another agent in a way that is not reflected in market transactions. Indeed with price-taking behavior, the market is precisely the mechanism that guarantees a Pareto optimal outcome. This suggests that the presence of an externality is not merely a technological phenomenon but also a function of the set of markets in existence. Externalities can also occur if an agent's activities directly affect the utility of an individual. From an economic perspective there is little difference in the fact that these effects are caused by businesses (in the form of, for example, toxic waste or the noise of the aircraft) or by other individuals (rubbish, or maybe the noise from a radio). In all these cases the amount of activity is incorporated directly into the individual's utility function. This is very similar to the way the production company X is incorporated into the production function of firm Y. Thus, a situation without externalities can be considered simply as an intermediate, in which the activities of other agents have no direct effect on earnings of individuals. This paper presents a case of externalities in the decision making of an individual, in which the actions taken by an individual myopically affect the actions of other players in the game directly. To do this we use a simple example based on the one-dimensional model of spatial proximity of Thomas Schelling.

The example

There are two basic variants of the *model of spatial proximity* of Schelling. The first version of this model is a one-dimensional model presented in Schelling (1969). In Schelling (1971a) a two-dimensional version was presented, which also appeared later in Schelling (1971b, 1978). In this paper we will analyze the one-dimensional model, and we based our experiment of externalities on it.

In the one-dimensional version of Schelling's spatial proximity model (1969, 1971a) a society is modeled through a sequence of N individuals of two clearly differentiated types (blacks (B), and whites (W)) distributed along a line[2]. The neighborhood of each subject is defined as well as the $r>0$ adjacent neighbors to the left and the right, which is to say, every individual has $2r$ neighbors: the r ones to his left and the r ones to his right[3]. In this way, the number of neighborhoods in the line is equal to the number of individuals that compose it, N. The model is defined by the following properties: first, subjects are assumed to have a utility function according to which they reach happiness when they have at lest $2r\text{-}m>0$ neighbors of their same type; second, discontent subjects move sequentially and without cost (the first one decides first, then the following one decides, and

[1] We are aware that implementing an experiment in class can be a task that takes too long, given what students can learn with this exercise. We must do the experiment and then explain student's findings in class.

[2] The number of individuals can be infinite, but Schelling (1971a) refers to the possibility of an infinite continuous line or a circle. The advantage is that in these cases all the individuals have the same number of neighbors. Even though it is not necessary, symmetry is assumed to mean that the number of subjects N is even and that there are N/2 subjects belonging to each type.

[3] Consequently, if we say that each individual has four neighbors, there will be the two on his right-hand side and two on his left.

[4] The decision made by the subject who starts moving is random. But starting from the first one, all the rest move in a consecutive way, for example towards the right. Whether individuals move to the right or to the left hand side is not relevant, what matters is that there is an order of movement and this movement has to be clear.

so on to the N-th agent[4]). The individuals who compose this society are utility maximizers, that is to say, they look for their best interest. The preferences of an agent are marked by his level of tolerance regarding the number of neighbors equal to him. For example, a *slightly* tolerant agent would be one who demands that all his neighbors next to him are of his same type, while a *moderately* tolerant agent would accept that half of his neighbors were like him.

The Schelling dynamics consist of three important ingredients: the first one is the information set of each agent which corresponds to her neighborhood of radio r; the second one is a positive number $m \in \{1, \ldots, 2r\}$ called the tolerance, which determines the maximum number of unlike neighbors that each agent is able to admit. In other words, tolerance could be understood as a threshold of dissatisfaction that each agent admits in her neighborhood; and the individual utility measures in a binary form the individual satisfaction level generated by her neighborhood. Formally, the information set of each agent i, her neighborhood of radio r at stage t denoted by $V^t(i,r)$, is equal to an element of $\{B, W\}^{2r+1}$ centered on i and the utility of agent i at stage t is represented as follows:

$$U^t(i,r,m) = \begin{cases} 1 \text{ if } \left|\left\{ j \in V^t(i,r) \text{ such that } j \neq i \right\}\right| \leq m \\ 0 \text{ if } \left|\left\{ j \in V^t(i,r) \text{ such that } j \neq i \right\}\right| > m \end{cases}$$

The utility function says that each individual is concerned only with the number of like and unlike neighbors. More specifically, each agent wants at most m unlike neighbors to be happy ($U^t(i,r,m)=1$); otherwise agents are unhappy ($U^t(i,r,m)=0$).

The dynamic is an iterative process, where agents choosing myopic best-responses given agents' local information set. Specifically, this is a sequential mechanism. At each stage, all dissatisfied agents are put in some arbitrary order. Schelling's movement arbitrarily let the discontented members move in turn, counting from left to right. When it is their turn to move, each member will move to the nearest satisfactory location[5], without regard for if they had studied the prospective decisions of others whose turn comes later.

Since all positions are relative only, she simply intrudes herself between two agents (or either at the end of the line). Similarly, her own departure does not lead to an empty position. This process continues until no agent wants to move anymore.

Let us introduce a very simple case in order to understand the apparently simple dynamics of Schelling's linear model. Suppose 8 individuals of two types, four of them are black (B) and the rest four are white (W). These individuals are distributed along a ring under the following configuration:

$$\{B,W,B,W,B,W,B,W\} \qquad (1.1)$$

which is circularly connected. We can denote the individuals as their location on (1.1) starting from left to right, therefore the first B will be agent 1, the first W will be individual 2, and so on until agent 8 who will be the last W. This configuration is represented as a ring in Figure 1.

Likewise, suppose that each individual of (1.1) accepts up to 50% of unlike agents[6], over a neighborhood composed by one individual at each side of him ($r=1$, $m=1$). Notice that in

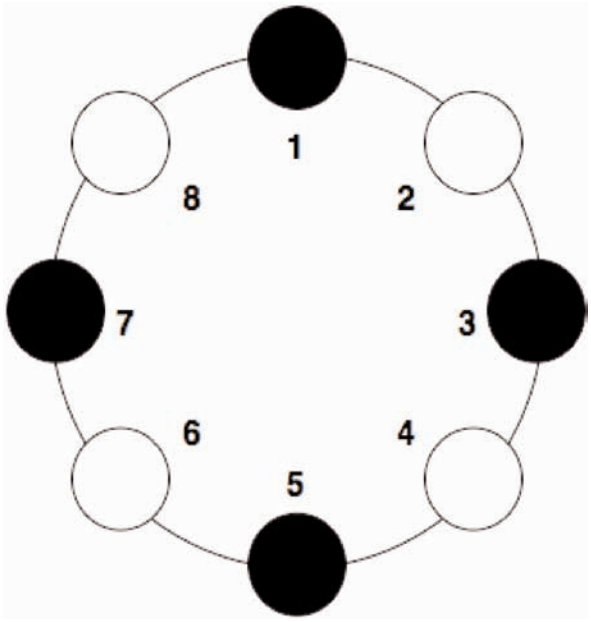

Figure 1: Initial configuration of a society.

(1.1) all individuals are unhappy, there aren't happy agents in this particular case because all individuals want to live with at least one neighbor like them. Schelling's myopic best-response dynamics works as follows. All unhappy individuals are put on a list in some arbitrary order, in this case all agents are in this list, and we suppose that, as Schelling, unhappy agents move in turn, starting from the left of (1.1). When an agent's turn comes, if he is still discontent, he moves to the nearest available satisfactory position inserting himself between two others; when there are two nearest satisfactory positions we solve this situation moving the discontented individual to the right. At the next stage (when all the individuals of the list have had their innings), a new list is compiled, and so on until no individual wants to move anymore. Figure 2 illustrates this dynamic. The first unhappy individual is agent 1 in (1.1), who is not satisfied with his neighborhood's configuration. He has got two satisfactory positions to go, the position between agents 2 and 3, or the position between agents 7 and 8. As we said before, this kind of problems are solved by moving agent 1 to the right, this is to move him between agents 2 and 3. (Figure 2(a)). Because of the movement of agent 1 individuals 1, 2, 3 and 8 become happy, then the next unhappy agent is individual 4, who moves to location between 5 and 6, (Figure 2(b)), converting 5 and 6 into happy individuals like him. The next, and in this case the last, unhappy individual is agent 7, who moves to position between 2 and 1, which it is the nearest satisfactory position to the right, (Figure 2(c)). Notice that although individuals 2, 3, 5, 6, and 8 were initially unhappy they didn't move because they were content when their turns came. This process ends here because all individuals are happy; no one wants to move to the other location, (2(d)).

This apparently mild condition states that individuals are satisfied if at least 50% of their immediate neighbors are of their type, and if those who are unhappy according

[5] Nearest means the point reached by passing the smallest number of neighbors on the way.
[6] As in the original Schelling model. Schelling (1971, 1978) also considers the possibility that agents accept other percentages of unlike neighbors.

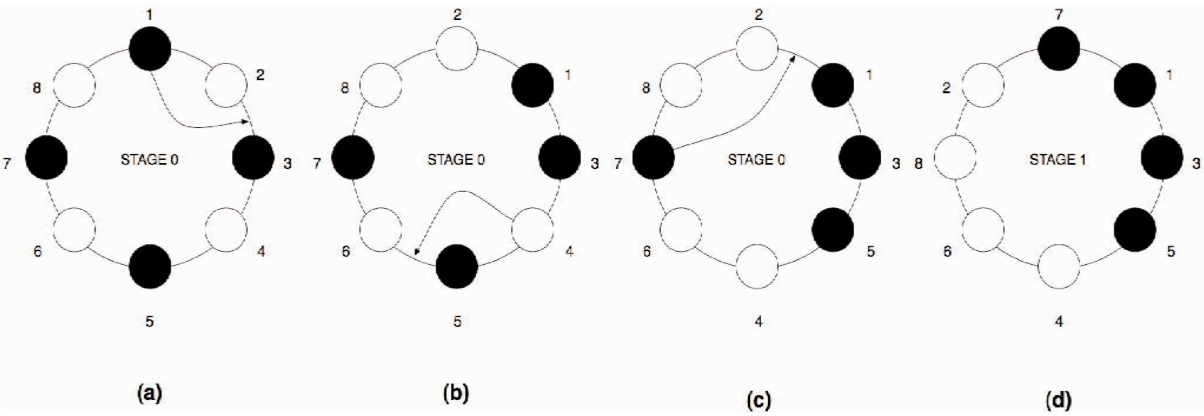

Figure 2: The figures (a), (b), (c) and (d) illustrate the dynamics of myopic best-response over the particular case of Figure 1.

to this criterion move to the nearest locations where they become happy, and this process is repeated until every individual is contented, (Figure 2), the outcome is a highly segregated environment. This is although none of the individuals required it for their happiness and their counterparts may even have preferred less segregation.

In short, a surprising result of the Schelling model is that even in a society where individuals are fairly tolerant of conditions as defined above, the sum of individual choices generates a totally segregated community. Figure 2 illustrates how starting from a situation of complete social integration (circle (a)) we arrive, after the individuals are allowed to move to a complete segregated society, at (circle (d)).

Although this solution is very powerful from a theoretical perspective, we are more interested in the dynamics of this model of Schelling. Two things happen when people move. Some are unhappy when before they were happy, because members leave their neighborhoods, or because in their neighborhood there are now unwanted members. And some who were dissatisfied would come to be happy. While it is true that this model was not designed to account for externalities, some changes in its implementation and its effects occur when someone moves. This makes them a good candidate for our students who are experiencing an externality and thus learning their same effects. For simplicity in this paper we focus on a positive externality, although it is relatively easy to reproduce the experiment to have negative externalities as well. If we consider the example of Figure 2, individuals 2, 3, 5, 6 and 8 in the initial situation in Figure 2(a) have decided to move because they were unhappy. When their turn came the effect in their neighborhood, caused by individuals who moved, 1, 4 and 7, radically changed their behavior; they had a positive effect on their decision. They benefited from the actions of other players.

Design and implementation of the experiment.

The experiment is conducted using an instruction booklet (set) to explain the rules of the game and how subjects could obtain maximum happiness (see a copy of the instructions in the Appendix). In order to ensure that each of the subjects in the experiment has a preference regarding the composition of their neighborhood, by which they could achieve happiness, they are paid two euros; that is if at least one of their adjacent neighbors (either to the left or to the right) is of their same type by the end of the experiment. If none of the adjacent neighbors are of their same type, the subjects receive zero euros (the individual is unhappy). The initial configuration is that of maximum unhappiness for all the subjects comprising the society (Figure 1). Under this initial framework, no one would obtain payment. The only way for subjects to receive payment is for them to move in such a manner as to reach maximum happiness. For the sake of simplicity, 8 subjects are used in each group. It is possible to use any even number greater than four, so that there are at least two individuals of each type. Note that the larger number of participants in each group, the longer the experiment becomes.

The 8 subjects were placed in a circle as in Figure 1[7]. The subjects were given a white or a black scarf to identify them as a *white* typed or a *black* typed subject and asked to identify the color of the scarves of their adjacent neighbors. This initial position allowed each subject to verify that his neighbors were different from him, and therefore all the subjects were unhappy. Subjects had to wait their turn to decide if they were going to move or not (observing what had happened). The subjects were given a control sheet to inform them of their position and the position of the other players (see an example in Figure 3 of the Appendix). The experiment was run only once (a one-shot game).

Before explaining the externalities, they must complete the game. The game being proposed is as follows:

1. Divide the class into groups of eight. (This could also be any sufficiently large even number)
2. In each group half of the individuals are of one kind and half of another (white and black for example)
3. Members of each group are numbered between one and eight and placed in a circle
4. Each participant has two neighbors on their left and their right
5. The utility of each participant depends on the composition of their neighborhood, if at least one of the two neighbors is the same type that him, he is happy, if none are like him, not happy

[7] Alternatively, they can be placed in two rows of 4 subjects each, making a rectangle, and told they must form a circle between both rows.

In each group, individuals are initially placed as in Figure 1. Importantly, none of them are happy in this initial situation. This is achieved by following the instructions given for the game, which depend on the color of each player (see Appendix).

Before starting the game, and after the directives have been read, there are some questions that students must write on a sheet to be collected. The questions are as follows:

- Are you happy with the composition of your neighborhood?
- Indicate where you want to move to be happy.

Once the game has been implemented re-ask the students. Those players who have not moved are asked why they have not moved, and the players who have moved are asked if they were aware that they became happy individuals as a result of their movement. The answer is usually that they do not move is because at least one individual of the same type is in their neighborhood when they have to move, and so they decide to stay where they are. Likewise, those who decided to move answer that they moved to the new location because they will be happy there, and have no regard for the welfare of another individual. They are only concerned with their own welfare. These responses are presented in class and demonstrate the existence of these external effects that most of them have suffered. Then define the externalities, both positive and negative, and when asked what type of external effect has been implemented, there is no doubt that it is a positive externality.

In short, the timing of the class is as follows:

- Stage 1: Divide the class into groups of eight, so that in each group four individuals are black and four white. Place them as in Figure 1.
- Stage 2: Read the instructions of the experiment (See Appendix). Make sure that students have understood the instructions.
- Stage 3: Before starting to run the experiment, ask to the students the following questions:
    - o Are you happy with the composition of your neighborhood?
    - o Indicate where you want to move to be happy.
- Stage 4: Collect the questions from Stage 3.
- Stage 5: Run the experiment.
- Stage 6: Ask the players who have not moved why they have not moved. And the players who have moved if they were aware that they became happy individuals as a result of their movement.
- Stage 7: Define externalities.

Concluding remarks

This article provides an example and a methodological proposal to motivate students and arouse their interest, particularly helping them understand positive externalities. We have formulated an interesting classroom experiment of positive externalities. Our experience is that this sort of game is a good way to introduce the concept of positive externalities. Not only does it permit students to see the mechanism in action, but also to comprehend the difference between a theoretical abstraction and practice. Students see that externalities are more common in the decisions or actions that we make every day than those that they can infer from the theoretical examples, of which we normally discuss in our lectures. This experiment is a perfect complement to balance our classroom and it helps students to understand externalities. However, the experiment itself does not replace the theoretical lecture on externalities but facilitates the understanding of it to our students.

The classroom experiment needs some careful preparation to make conveniently mixed groups. However, once everything is ready to go, it should run quite smoothly and increasingly quickly. Although for our purpose, groups of 8 individuals and one round in each of them is enough, it would be easy to play it with as many players as you want.

Once the experiment is done and the post-experimental session is concluded, it is possible to run other experiments. Students in turn realize how theory training helps them to solve interesting (and sometimes lucrative) puzzles.

References

Bergstrom,. Theodore C., and Miller, John H., (2000). *Experiments with economic principles: Microeconomics*. New York: Irwin McGraw-Hill.

Delemeester, Greg. and Neral, John (1995). *Classroom Experiments To Accompany Taylor's economics: A user's guide*. Boston: Houghton Mifflin.

Emerson, Tisha, and Taylor, Beck (2004). Comparing student achievement across experimental and lecture-oriented sections of a principles of microeconomics course. *Southern Economic Journal* 70 (3), pp. 672-93.

Frank, Bjorn (1997). The impact of classroom experiments on the learning of economics: An empirical investigation. *Economic Inquiry* 35 (4), pp. 763-69.

Gremmen, Hans, and Potters, Jans (1997). Assessing the efficacy of gaming in economic education. *Journal of Economic Education* 28 (Fall), pp. 291-303.

Hazlett, Denisse (1999). *Economic experiments in the classroom*. Reading, MA:Addison Wesley Longman.

Walter, W. and Snyder, Christopher (2008). *Microeconomic Theory. Basic principles and extensions*. 10th Edition. USA: Thomson.

Ortman, Andreas and Colander, David (1995). *Experiments in Teaching and Understanding Economics, to accompany Economics (2nd. Edition) by D.C. Colander*. Chicago: Irwin.

O'Sullivan, Arthur, and Sheffrin, Steven (2003). *Economics*. Upper Saddle River, NJ:Prentice-Hall.

Schelling, Thomas (1969). Models of Segregation, *American Economic Review, Papers and Proceedings* 59, pp. 488-493.

Schelling, Thomas (1971a). Dynamic Models of Segregations, *Journal of Mathematical Sociology* 1 (2), pp. 143-186.

Schelling, Thomas (1971b). On the Ecology of Micromotives. *The Public Interest* 25, pp. 61-98.

Schelling, Thomas (1978). *Micromotives and Macrobehavior*. New York: Norton.

Stodder, James (1998). Experimental Moralities: Ethics in Classroom Experiments, Journal of Economic Education 29 (2), pp. 127-138 (Spring).

Varian, Hal (2009). Intermediate Microeconomics. New York: Norton.

Yandell, Dirk (1999). *Using economic experiments in the classroom*. Upper Saddle River, NJ: Prentice-Hall.

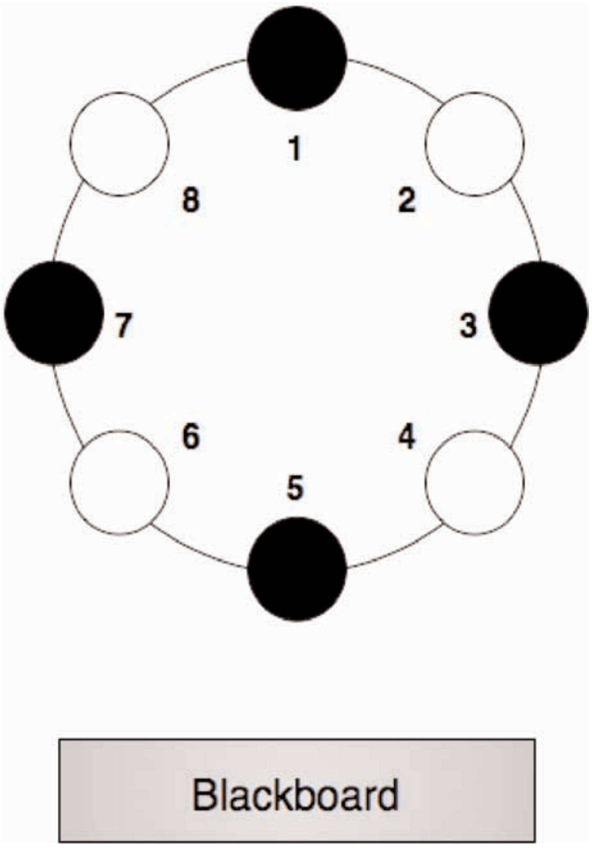

Figure 3: Control Graph for each group.

Appendix

Below are the instructions for the subjects who participated in the experiments. The subjects were divided into groups of eight. The instructions that follow are for subjects with black handkerchiefs. For subjects with white handkerchiefs instructions are the same by changing the color that identifies the subject matter and color of the neighbors that make you happy.

Instructions Case A:
1. Please tie the scarf around your neck.
2. Eight subjects will participate in the task. Four will sit in one row of desks and another four will sit in the row of desks behind them. Please turn around to face all your partners.
3. There are two types of subjects: those with a white scarf and those with a black one. As you already know, you are Black.

How do I earn money?
4. If at the end of the exercise AT LEAST ONE OF YOUR NEIGHBORS is of your same color, you will earn 2 euros as follows:
   • If both the neighbor to your right and to your left are white, then you will NOT earn anything.
   • If the neighbor to your right or to your left (or on both sides) is black, you will earn 2 euros.
5. You are allowed to move (if you want to!). You can seat yourself in the closest space that you wish. A space is the distance between two persons. You can jump as much as you wish (a place, two places, etc). You can only move to your right, that is, counter-clockwise.
6. How can I move? To move, you have to write the place you want to move to on your sheet. Write your current position in blue on your sheet and the position where you want to move to in black. If you do not move, mark your current position in black. Your sheet will be picked up and then you will be told the new set up.

Well, now we are going to play
7. We will now throw a dice. The dice will decide who will be the first person to move. The rest of the players will then move in consecutive order (towards the right). The first player will make his choice (not moving, moving, jumping one place, jumping two places,..., jumping six places). When you are told, you will have to make your choice. Write your current location in blue and the position you are moving to in black on your sheet. If you are not moving, write your current location in black.
8. We will then collect your sheet and tell you your new set up.
9. If at the end of the exercise AT LEAST ONE OF YOUR NEIGHBORS is of your same color, then you will earn 2 euros.

Figure 3 shows the graph given to the subjects so that they could clearly identify both their position and that of the rest of the individuals in their group. The same graph is passed from one subject to another, considering the order of movement. The graph is therefore automatically updated with each subjects' annotations. The graph is then collected to determine the decision made by each subject.

| Cita recomendada de este artículo

Benito Ostolaza, Juan Miguel (2009). Decisions, externalities and public economy in a location context. *@tic. revista d'innovació educativa* (3)., URL. Fecha de consulta, dd/mm/aa