# CLASSROOM EXPERIMENT AS A TEACHING METHOD IN NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS COURSE

# EKSPERIMEN KELAS SEBAGAI METODE PEMBELAJARAN DALAM MATA AJAR EKONOMI SUMBER DAYA ALAM DAN LINGKUNGAN

**ALIN HALIMATUSSADIAH**

Departemen Ilmu Ekonomi Fakultas Ekonomi Universitas Indonesia
Alamat: Gedung Departemen Ilmu Ekonomi Lantai 1, Fakultas Ekonomi dan Bisnis Universitas Indonesia. Email: alin.halimah@gmail.com

## ABSTRACT

The use of classroom experiment as teaching method in economic courses is increasing overtime. However, it is not widely used in developing world. In the experiment, students can learn using their own experience how economic agents behave and how they make decisions in a certain situation setting. This paper aims to describe the advantage of the method, practical issues in conducting classroom experiment, and examples of two classrooms experimental games in natural resource and environmental economics course: a public goods game and a CPR (common pool resource) game. In the games we introduce different rules of the game to give an understanding the impact of different rules of the game to the result of the game. We also discussed the relation between individual characteristics and his/her decision in the game.

*Keywords*: classroom experiment, public goods game, CPR (common-poolresource) game, natural resource and environmental economics.

## BACKGROUND

The idea of using experiments in class was started when Chamberlin (1948) conducted an experiment on imperfect market. Today, all leading economic journal has published articles on experimental economics which become more recognized when Daniel Kahneman and Vernon Smith received their Nobel Price in 2002 (Holt & McDaniel, 1996; Balkenborg & Kaplan, 2009).

Classroom experiments are short, interactive and designed to facilitate understanding of key economic ideas. Doing classroom experiments are fun not only for the

students but also for the teacher. Classroom experiments can stimulate thoughtful discussion and can inspire students to learn more about a topic (Holt & McDaniel, 1996; Balkenborg & Kaplan, 2009). The discussion after the experiment enhances the effectiveness of the Socratic method, as opposed to traditional lecture. Not only experiencing as participants, students can also act as the experimenters who run the experiments in their own class and lead the discussion afterwards (Holt, 1999).

It works well to all level of students, from 6$^{th}$ grade elementary to graduate students. No need for high mathematical skill. It is effective as medium of learning because students are placed directly into the economic environment being studied (Balkerborg & Kaplan, 2009).

Classroom experiment design now is available for diverse topics in economics, including natural resource and environmental economics. This paper intends to present two examples of classroom experiments conducted in Natural Resource and Environmental Economics class at Faculty of Economics University of Indonesia. We discussed how the experiments conducted and what kind of result that can be discussed to enhance student's understanding on the topics.

## CLASSROOM EXPERIMENT AS TEACHING METHOD: A LITERATURE REVIEW

### What is an experiment?

In general, there are two types of empirical data: happenstance data and experimental data (Friedman & Sunder, 1994). In the happenstance or observational data or field data, data are gathered under uncontrolled process in a naturally occurring environment. The other is experimental data that are gathered under controlled conditions.

In the experiment, controlled conditions are built in some kind of laboratory situation or in an artificial environment with design that customize to meet the purposes. In controlled economic environment, agents live in an institution through which the agents interact. Institution specifies the rules that represent actions available to agents and the outcomes that result from each possible combination of agent's action. This institution is defined by the experimental instructions that describe the messages and procedures of the game, which are most often computer controlled. In this controlled environment,

monetary rewards are used to induce the desired specific action. Each agent has its own economically relevant characteristics such as preference, endowment and information and will consider the environmental and institutional setting of the laboratory in order to make specific action (Friedman & Sunder, 1994; Smith, 1994).

There are questions about validity of data gathered from laboratory experiment. It relates to question about internal validity and external validity. Internal validity is a matter of whether the data can answer a correct causal inference. To meet internal validity, proper experimental controls, experimental design and data analysis should be done. External validity is about whether the result of the experiment is parallel to the world outside the laboratory. To make sure that the experiment is compatible to the real world, we should follow the general principles of induction i.e. behavioral regularities will persist in new situation as long as the relevant underlying conditions remain substantially unchanged (*ceteris paribus*) (Friedman & Sunder, 1994).

In experiment, a reward medium is used to allow the experimenter induced pre-specified characteristics in experimental subjects, and the 'original' characteristic become quite irrelevant. The experimenter can induce agents' characteristics properly under these three conditions (Friedman & Sunder, 1994):

1. Monotonicity. Subject must prefer more reward medium to less, and not become satiated.
2. Salience. The reward received by the subject depends on his actions (and those of other agents) as defined by institutional rules that he understands. The relation between action and reward has to be clear.
3. Dominance. Change in subjects' utility is come from the reward medium and other influences are negligible.

**Why we conduct an experiment?**

There are several purposes for conducting an experiment. First is to test a theory. Like observational data, data gathered from the experiment that functions as empirical evidence for testing a theory. Moreover, it can improve a theory because it can observe irrational behavior, reveal unobserved behavior (e.g. trust, cooperation, altruism, willingness to pay, reservation wage, risk preference, time preference,

preference of fairness, preference of status), and test the effectiveness of several institutional setting or policy. It is also useful as medium of learning to a certain subject related to human behavior (Friedman & Sunder, 1994; Nam, 2014).

It can eliminate the problems that may happen in observational data such as confounding effects and causality. In economic experiment, we randomized the participants to eliminate selection bias and control the exogenous and endogenous variables to derive the causal effect. By controlling the environment, we can keep variables unchanged, and let one variable varies to find out the impact of that variable. By controlling variables we reduce our dependence on complicated econometric models. Experiments also allow us to replicate the research, as it is impossible in observational data (survey) (Friedman & Sunder, 1994; Nam, 2014).

**What is the advantage of classroom experiment for teaching economics?**

Several studies tried to look the effectiveness of classroom experiment in economics teaching. Experiments increased significantly student's scores in a standardized test for understanding college economics (TUCE) (Emerson & Taylor, 2004; Dickie, 2006). Frank (1997) showed that a simple classroom experiment in environmental economics leads to a better result of the student performance in answering a multiple-choice test on the "tragedy of the commons". Ball, Eckel and Rojas (2006) ran a wireless experiments and found that it improved the mark on final examination for principal of economics subject. Classroom experiment increased the TUCE score for both males and females but helped females reduced the gender gap benefited weaker students (Emerson & Taylor, 2004). Males were benefited more than women from the experiment. It is more effective for first year students. It improved student's evaluation on the lecturer and students found that the course is stimulating (Ball, Eckel and Rojas, 2006). Students who prefer learning by doing were benefited more than read-write learners' type of students (Durham, McKinnon and Schulman, 2007; Emerson and Taylor, 2004).

## PRACTICAL ISSUES IN CLASSROOM EXPERIMENT

In economics experiment, there are several terminologies that used to appear. Table 1 describes

the definition of each terminology (Hadnes, 2014). Duffy (2008) listed several practical points to be considered in conducting classroom experiment as follows:

1. Choose experiments relevant to the classroom material.
2. Choose experiments where everyone can participate in some role.
3. Read instructions aloud. Ask for any questions before beginning, butavoid leading students toward any particular outcome - allow studentsto learn via their participation in the experiment.
4. Award points (not money) for individual performance in accordancewith the induced payoff objectives. For stronger incentives, pointsmight count in some way toward the final course grade. (Someinstructors prefer candy/cookies).
5. No deception!
6. Leave time to provide an extensive debriefing, and relate the experimental findings to the course material.
7. For time consuming game, save time by giving out written instructions in advance. Alternatively, focus on simpler experiments and save more time for discussion.

Table 1. Technical Terms and the Definitions in Economic Experiment

| **Technical Term** | **Definition** |
|---|---|
| Subject | Participant in a research project/experiment |
| Endowment | Money subjects' receive to take decisions |
| Treatment | Particular condition in an experiment |
| Session | Group of subject doing the experiment at the same time (an experiment mostly consists of several sessions) |
| Matching procedures | Way of grouping subjects |
| Within-subject design | Compare the subjects' behavior over different treatments |
| Between-subject design | Compare behavior of different subjects (subjects play only one treatment) |
| Repeated games | In contrast to one shot games, subjects play several rounds and can learn from their decisions |
| Strategy method | Subjects state their hypothetical decisions at each action set (prevents learning and allows more information) |
| Belief | Subjects' expectations about another's decision |
| Deception | Lying to the subjects (or hiding relevant information) |

**CLASSROOM EXPERIMENT IN NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS COURSE: SOME EXAMPLES**

Nam (2014) listed main research topics of behavioral economics [1] i.e. decision theory, decision making under risk and uncertainty, inter-temporal choice, fairness and social preferences, strategic interaction, and social interaction. On environmental subject, experimental economics can be applied for environmental valuation and preferences, management of common property and public goods, pollution management (regulation and compliance), and economics of climate change which include disaster risk management, climate change mitigation and adaptation, and decide discount rates in climate change scenario.

Several experimental classroom games sources is provided in the websites as follows:

1. Veconlab web pages (Holt)
2. FEELE web pages, University of Exeter
3. Econport web pages (Cox, Gjerstad) http://www.econport.org
4. Game Theory Website (Rubinstein) http://gametheory.tau.ac.il/ instructor/
5. The Economics Network web pages: http://www.economicsnet work .ac.uk/
6. Experiments in Macroeconomics (Denise Hazlett) http://marcus. whitman. edu/ ~hazlett/econ/
7. Experonomics web pages

In the field of natural resource and environmental economics, some websites has been developed. Jim Stodder developed an experiment on externality rights [2] . Another game called fishing game is designed to capture the formal and informal rules regarding the use, ownership, and transfer ofproperty. The objective of the game is to prove that ownership generally provides an incentive for peopleto consider the value of property in the future. Therefore, people tend to take better care ofthings they own and value. This lesson helps students experience and understand the influenceof property rights on scarce resources[3].

Department of Economics, Appalachian State University, North

[1] Experimental economics is the main tools in behavioral economics.

[2] http://www.marietta.edu/~delemeeg/ expernom/s96.html#stod

[3] https://www.fraserinstitute.org/upload-edFiles/fraser-ca/Content/education-programs/teachers/classroom-resources/Lesson-Plan-Property-Rights.pdf

Carolina has listed several classroom games on their website[4]. The games include experiment on fishery[5], global warming[6], paper river game (about externalities and Coase's Theorem)[7], pollution trading game[8], environmental regulation simulation[9], and willingness to pay experiment[10]. CeDEx (Centre for Decision Research and Experimental Economics - University of Nottingham has a plenty of research papers including experimental instructions on their website[11], which some of them has topic related to natural resource and environmental economics.

Beside framed experiment[12] such as fishery and forest game, we could conduct an experiment using the concept that closely related to this field such as public goods game, externalities, uncertainty and risk preference, ambiguity, inter-temporal (time) preference, etc. Several topics related to sociology also come up in this field such as social capital (trust), leadership, identity and other topics on social preference.

Below is the list of game topics that used to have relation with natural resource and economics research:

1. Externalities
2. Public goods
3. Uncertainty and risk preference
4. Open-access resource
5. Ambiguity
6. Leadership
7. Regulation – command & control, tax & subsidy, market mechanism, regulation, enforcement of regulation
8. Communication
9. Identity
10. Coordination problem
11. Altruism
12. Real effort task
13. Auction

We will describe the implementation of two kinds of games that widely used: public goods game and common-pool resource game. In public goods game classroom experiment, students could understand better the concept of public goods, the characteristics of public goods (non-excludable and non-rivalry), under-

[4] http://www.appstate.edu/~whiteheadjc/teaching/games/index.htm

[5] http://www.appstate.edu/~whiteheadjc/eco3620/games/fishery/index.htm

[6] http://www.appstate.edu/~whiteheadjc/eco3620/games/publicgoods/index.htm

[7] http://www.appstate.edu/~whiteheadjc/eco3620/games/paperriver/index.htm

[8] http://www.appstate.edu/~whiteheadjc/eco3620/games/trading/index.htm

[9] http://www.appstate.edu/~whiteheadjc/ECO3620/games/regulation/index.htm

[10] http://www.appstate.edu/~whiteheadjc/ECO3620/games/auctions/index.htm

[11] http://www.nottingham.ac.uk/cedex/index.aspx

[12] Experiment that is framed by using specific real-world problems in the instructions.

provision problem, free-rider problem, the possibility of voluntary provision of public goods, and what kind of individual characteristics affecting contribution to public goods provision (e.g. gender, department). The game also provides us intuition on how different institutional setting could lead to better provision of public goods (sanction, communication, etc.).

Common pool resource (CPR) gamedescribes the problem of overexploitation of open access resources such as forest product (timber) and fishery. In this game, the problem is framed by forest situation in which exploitation by one individual could lead to decrease in social benefit. CPR game represents social dilemma: what is rational for individual becomes irrational for society as a whole (Keohane & Olmstead, 2007). CPR game is best in explaining the relation between open-access property right regime, negative externalities, and the tragedy of the commons.

**Public Goods Game**

Holt and Laury (1997) introduced a famous classroom public goods game. The game uses cards and very simple to conduct. Appendix 1 describes instructions and a form to be filled during the game. In short, the game is designed as follows. Every participantis given four cards, 2 black cards and 2 red cards with the same number. The game will be played for several rounds. In every round after participants make a decision, the experimenter will come to each participant to take two of the four cards given. For each red card kept the value is $4 and for each red card given to the experimenter the value is $1. Black cards have no value. Participant's earnings are determined by what he/she does with the red cards. Earnings of each participant in each round will be determined this way: $4 for each red card that he/she kept plus $1 for total red cards that experimenterhas collected. The experimenter needs to announce that participant's decision is anonymous and no communication is allowed.

From this standard game, we could modify the game for the next rounds. Here is a list of possible modifications (Holt & Laury, 1997; Kagel & Roth, 1995; Hoaas & Madigan, 1996):

1. Reduce the value of red card kept, e.g. $2 for each red card kept.
2. Impose regulation; we apply a rule that each participant has to

give at least 1 red card to the experimenter.

3. Enforcement of regulation; we check whether participants comply the rule. We could impose the enforcement to all participants of just several participants by picking randomly one or several participants check whether he/she complies the regulation. We could also modify the enforcement by putting probability on the checking process; if we have picked one participant to be checked, we randomized again to decide whether we will really check it or not. Please note that anonymity of enforcement should be applied in the experimental design.
4. Allow communication between participants.
5. Increase the number of participants; by merging two or several groups into one.
6. Release the ID of participants (not anonymous).
7. Announce contribution.
8. Put threshold value; if the total contribution did not met the threshold, the public good will not be provided. We could modify by increasing or decreasing this provision point.
9. Apply two stage of contribution. We could assign or ask voluntarily anonymous participant who wants to move first as the first contributor. We will announce his contribution to the rest of the participants who act as the second mover (second contributor). This kind of game is usually called by leading-by-example or leadership game (see Rivas & Sutter, 2011).

**An Example of Public Goods Game**

A public goods game was conducted on Tuesday, 2 September 2014, using 13 undergraduate students that enrolled Natural Resources and Environmental Economics courses as participants. Participants were divided into two groups; one with 7 participants and the other group has 6 participants. Another 4 students became experimenters of the game; 2 students to serve each group. The game lasted for about one hour, starting from explaining the game, preparation, conducting the game and in the end paying the (randomly selected) students. Only two students got the payoff, one was randomly chosen from the first group and the second was randomly chosen from the second group. We announced that the exchange rate for the game is USD1 = IDR10.000.

We played for 9 rounds. In the first three rounds (round 1 – round 3) we played the standard public goods game and used instruction as in Appendix 1. In the second three rounds (round 4 – round 6) we modified the value of red cards kept from $4 to $2. In the beginning of round 7 we allowed all the participants to communicate with their own group members. After counted total contribution in each round, we announced it only to group members, so participants could not know the total contribution of the other group.

After the game was over, we discussed the game with the students. We could discuss about non-excludability, non-rivalries, and free rider problem from the game. We could discuss also the result of the game, at least the data on the total contribution. We could compare the total contribution between rounds and between groups.

**Discussing the Results**

A week after the game was conducted, we discussedabout the game and the statistical result. Table 2 provides information on participant's characteristics and statistical result of participant's contribution related to the characteristic. In the two groups, female is dominant then men. However in group 2, proportion of students from economics is higher then group 1 (4/6 versus 2/6). Average total contribution from group 2 (3.89) is significantly lower then group 1 (8.11). We have strong prediction that the high proportion of economics students relates to lower contribution, as found in several experiment (Kagel & Roth, 1995; Carter & Irons, 1991).

On average, females' contribution is lower than men. The same result found repeatedly from classroom experiment of Holt & Laury (1997) although Kagel & Roth (1995) found ambiguous result. However, females-economics of group 1 exhibit different average contribution from females-economics of group 2 if we compared with females-accounting. We presume that higher contribution of females-economics of group 1 compared to females-accounting due to lower proportion of economics students in group 1. This could be an indication of the existence of conditional cooperators (people who are willing to contribute more to a public good the more others contribute) (Fischbacher, Gachter & Fehr, 2001).

Table 2. Descriptive Statistics of Classroom Public Goods Game

| **DESCRIPTION** | **GROUP 1** | | **GROUP 2** | |
|---|---|---|---|---|
| Number of Observations | 7 | | 6 | |
| Proportion of Female | 4 out of 7 | | 4 out of 6 | |
| Proportion of Econ[1)] | 2 out of 6[3)] | | 4 out of 6 | |
| **STATISTICS** | **OBS** | **VALUE** | **OBS** | **VALUE** |
| Average Total Contribution | 7 | 8.11 | 6 | 3.89 |
| Average Female | 4 | 1.11 | 4 | 0.56 |
| Average Male | 3 | 1.22 | 2 | 0.83 |
| Average Acc[2)] | 4 | 1.17 | 2 | 0.72 |
| Average Econ | 2 | 1.22 | 4 | 0.61 |
| Average Female Acc | 2 | 1.00 | 1 | 0.67 |
| Average Female Econ | 2 | 1.22 | 3 | 0.52 |
| Average Male Acc | 2 | 1.33 | 1 | 0.78 |
| Average Male Econ | 0 | 0.00 | 1 | 0.89 |

Note: [1)] economics student; [2)] accounting student; [3)] data lost

Table 3 provides statistics of the total contribution of the two groups for every round. The trends are shown in Figure 1. In class, we coulddiscuss these trends, particularly to answer two kinds of questions: (1) whether there are differences in total contributions in each round due to the change in rule of the game; (2) whether the total contribution of the two groups is different and why.

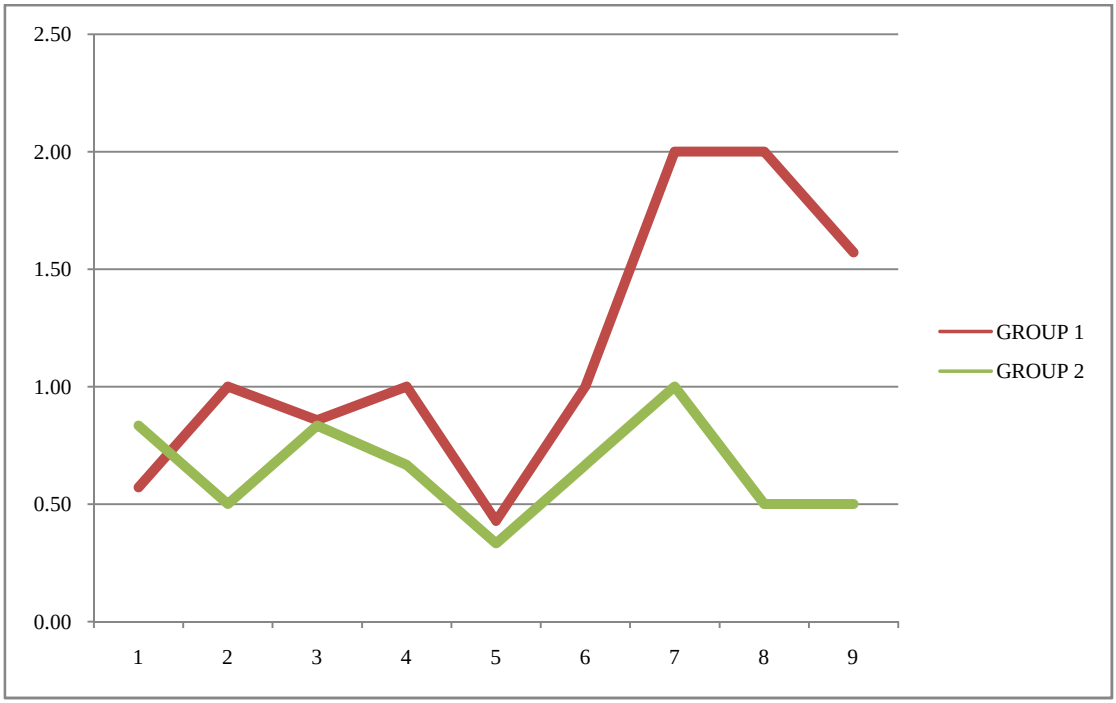
Table 3. Total and Average Contribution per Round

| **ROUND** | **TOTAL GROUP CONTRIBUTION** | | **AVERAGE GROUP CONTRIBUTION** | | **RULE** |
|---|---|---|---|---|---|
| | **GROUP 1** | **GROUP 2** | **GROUP 1** | **GROUP 2** | |
| 1 | 4 | 5 | 0.57 | 0.83 | baseline |
| 2 | 7 | 3 | 1.00 | 0.50 | |
| 3 | 6 | 5 | 0.86 | 0.83 | |
| **average** | **5.67** | **4.33** | **0.81** | **0.72** | |
| 4 | 7 | 4 | 1.00 | 0.67 | decrease opp. cost of contributing |
| 5 | 3 | 2 | 0.43 | 0.33 | |
| 6 | 7 | 4 | 1.00 | 0.67 | |
| **average** | **5.67** | **3.33** | **0.81** | **0.56** | |
| 7 | 14 | 6 | 2.00 | 1.00 | communication allowed |
| 8 | 14 | 3 | 2.00 | 0.50 | |
| 9 | 11 | 3 | 1.57 | 0.50 | |
| **average** | **13.00** | **4.00** | **1.86** | **0.67** | |

In general, total contribution of group 1 is higher than group 2 in almost every round (Table 2; average total contribution: 8.11 versus 3.89). The highest difference occurs in the last three rounds (1.86 versus 0.67). The last three rounds are when we allow communication within group. In the time where we allow communication (before they made decision in round 7), a group could have a deal that everyone have to give two red cards because this is the only decision that is socially optimal. However, the problem with this deal is there is no sanction (formally or informally) to the cheater. We can see that in group 1, each participant give his/her two red cards in round 7 and round 8 while in group 2 the average red cards given to the experimenter is only 1, not two cards. Looking at the existence of cheater at round 7, participants in group 2 'punish' the cheater by lowering their contribution (the average decrease from 1 to a half); even tough they all know that this will bring to inefficiency in common (socially inefficient because of all participants become worse-off). Decreasing contribution of group 1 in round 9 relates to the 'last round' dilemma, where participants tend to contribute less to grab better payoff since it is the last round.

If we assumed that the first three rounds is the baseline, we can discuss the trend change in the second three rounds and the last three rounds. If we reduced the opportunity cost of contributing by reducing the value of the red cards kept, the total contribution must increase because the benefit from the red cards given to the experimenter relatives to the value of red cards kept is increasing. However, we cannot see the increasing trend of total contribution in round 4 – round 6 from the two groups. Instead, in group 2 we see decreasing average contribution. How can theory explain this? This is the beauty of experiment. We can found anomaly from the observed behavior that we found in this classroom experiment from what the theory predict (Holt & Laury, 1997). For communication treatment, in general our findings are the same with almost public goods experiments have found: increasing contributions (Kagel & Roth, 1995). However, looking at the huge difference in incremental average contribution between two groups, we can conclude that communication is effective only when participants execute the deal has been made.

Figure 1. Average TotalContribution




Note: we can use total contribution if the two groups have the same number of participants.

**Common Pool Resource Game**

Murphy & Cardenas (2004) designed a famous game on enforcement strategies for managing a local environmental resource. This game is often called by 'forest game'. The game describes a situation in which a group of family must make decisions about how to use a shared resource i.e. a forest. The participants will play for several rounds that represents years or harvest seasons. Detailed instructions are in Appendix 2. The students are asked to read the instructions before class. They are not allowed to discuss it to each other. During the experiment, no communication is allowed.

At the beginning of the experiment, the participants will receive a PAYOFF TABLE (see Appendix 2). The payoff table describes the payoff of each months of the participant's work in the forest (to harvest) [my months in the commons] given the months of work of other participants (in total) [their months in the commons]. The more a participant work in the forest [my months in the commons], the higher the payoff for the participant given a

certain months of work in the forest of other participants [their months in the commons]. However, the higher the months in the forest of others, the less a participant's payoff is. The social optimum is to work less in the forest for all participants. This represents a social dilemma, what is rational for individual (work higher) becomes not optimal for social (work less). The months in the forest represents an effort to exploit forest's resource.

The amount of work in the forest is ranged between 0 until 8 months. Each participants will be given EXPERIMENT CARDS and have to write his/her decision on his months in the forest in each round in one EXPERIMENT CARD. He has to write it again in the RECORD SHEET [column A]. The EXPERIMENT CARD will be given to the experimenter and after the experimenter sums up the total months, the experimenter will announce the total months of work in the forest for the group. The participants have to write down the announcement in the column B on the RECORD SHEET. After finding their months in the forest (column A minus column B), they have to look at their payoff in the PAYOFF TABLE.

From this standard game, we can modify the rule by:

1. Impose regulations, e.g. no one should work more than a certain months of work.
2. Impose an enforcement of regulation, e.g. we pick randomly several participants to check whether they comply the regulation.
3. Introduce a new environment setting, e.g. disclose the ID of the participants (not anonymous anymore) or allow communication among participants.

**An Example of Common Pool Resource Game**

A common pool resource (CPR) game was conducted on Tuesday, 14 October 2014, using 16 undergraduate students that enrolled in Natural Resources and Environmental Economics courses as participants. Participants divided into two groups, each group consisted of 8 participants. The experimenters were the lecturer and one administration staff. The game lasted for about one and a half hour, starting from explaining the game, preparation, and conducting the game. The students got the instructions one week before and they have to read it before the class begins. The payoff of this game was 5% of total student's final grade. We

counted the grade like this way: the total payoffs of every rounds multiplied by 0.15 is the student's grade.

We played the game for 12 rounds. In the first three rounds we used the instructions as in Appendix 2. For the rest 9 rounds we played the modified rules as follows:

1. Round 4 – Round 6: we introduced a regulation that no one should have the months in the forest more than 3 months.
2. Round 7 – Round 9: we introduced enforcement for the regulation in point 1. We picked randomly 4 participants; 2 from group 1 and 2 from group 2. When we have the participants to be checked, we tossed a coin to decide whether we will really check it or not. For participant who got checked and his months in the forest was more than 3, then for one additional month we imposed a penalty of $100 that reducedhis payoff of that round. In round 9, we picked only 1 participant from each group. This represent lower enforcement rate.
3. Round 10 – Round 12: we allowed communication between participants within a group.

After the game was over, we discussed the game with the students. We could discuss about the characteristics of common-pool resource: non-excludability and rivalries. This feature could bring into overexploitation of resources unless we have an effective institution (rule of the game) to manage the resource. We then compared the effectiveness between several institutions that represents in the game (regulation in R3-R6, regulation with enforcement in R7-R8, regulation with reduce enforcement in R9, and communication-without regulation in R10-R12).We could compare the result between group and whether individual characteristics relevant to their months of work.

Discussing the Results. After the game was conducted, we discussed about the game and the statistical result. Table 4 provides information on participant's characteristics and statistical result of participant's months of work related to the characteristic. Female dominates in group 1 than group 2. Average total extraction (months in the forest) is higher in group 1 than group 2. However, if we decompose the average per set of rounds that represents a rule, then we can see the dynamic of the months of work between groups.

In general, males work more than females. However, the difference of months of work between male and female is much

higher in group 2 than in group 1. Economics student seems don't have any effect on months of work since it has different months of work compared to accounting student.

Figure 2 describes the trends of group months of work. If we refer to the rule in each round, we can find something interesting to be discussed. Round 1 until round 3 is the baseline condition, where open-access property right regime of a resource (forest) leads to high months of work. Declining tendency from the rule imposed only occurs in group 1. Enforcement of regulation seems effective to reduce months of work for both groups. However, reducing enforcement has different impact for both groups: decreasing in group 1 (as not expected) and increasing in group 2 (as expected). The last three rounds gives conclusion that the most effective rule is by allowing participants to communicate and make a deal on months of work. However, we discussed also that communication that is conducted before round 10 only is fragile to cheater occurrence, especially in the last rounds. In round 10, group 1's total extraction level is 9 and group 2's extraction level is 8. There is one participant that puts two months in the forest while the rest of the group put 1 month. The cheater's was punished by this way: the next round's extraction level jump up into 29 while in group 2 the increase only one month compared to round 10. For the last round, as a common findings, everyone tries to grab the maximum months that he/she think will give maximum benefit with respect to what he/she thinks on other's contribution.

Table 4. Descriptive Statistics of Common Pool Resource Game

| **DESCRIPTION** | **GROUP 1** | **GROUP 2** | **TOTAL** |
|---|---|---|---|
| Observations | 8 | 8 | 16 |
| Proportion of Female | 6 out of 8 | 4 out of 7* | 10 out of 15* |
| Proportion of Economics | 2 out of 8 | 3 out of 8 | 5 out of 16 |
| **STATISTICS** | | | |
| Average Months | 3.95 | 3.51 | 3.73 |
| Av Months R1-R3 | 4.63 | 5.29 | 4.96 |
| Av Months R4-R6 | 4.67 | 3.67 | 4.17 |
| Av Months R7-R8 | 3.63 | 3.38 | 3.50 |
| Av Months R9 | 3.50 | 4.25 | 3.88 |
| Av Months R10-R12 | 2.92 | 1.42 | 2.17 |

| | | | |
|---|---|---|---|
| Av Months Female | 3.83 | 3.08 | 3.53 |
| Av Months Male | 4.29 | 4.53 | 4.43 |
| Av Months Economics | 2.21 | 4.08 | 3.33 |
| Av Months Accounting | 4.53 | 3.17 | 3.91 |

*) data lost

Figure 2. Total Months of Work


## CONCLUSION

After using classroom experiment for several times, I found that this method is effective to give understanding on how economic agents behave. This understanding comes up from the fact that the students itself play a role as the agent that makes economic decisions. They can understand also why in some situation setting the decision could different and how can we set the institution that could bring the result that similar to our goal. However, some practicalities have to be considered: it is time consuming, some parts of the game design could not match to our materials (to broad or not capture all sub-topics), it has to be well planned in the preparation, and the result could be biased if there was no incentive.

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## APPENDIX 1. Instruction of Public Good Game (Holt & Laury)

Appendix: Instructions

This is a simple card game. Each of you will be given four cards, two of these cards are red (hearts or diamonds), and two of these cards are black (clubs or spades). All of your cards will be the same number. The exercise will consist of a number of rounds. When a round begins, I will come to each of you in order, and you will play *two* of your four cards by placing these two cards face down on top of the stack in my hand. Your earnings in dollars are determined by what you do with your red cards. In each of the first five rounds, for each red card that you keep you will earn four dollars for the round, and for each black card that you keep you will earn nothing. Red cards that are placed on the stack affect everyone's earnings in the following manner. I will count up the total number of red cards in the stack, and everyone will earn this number of dollars. Black cards placed on the stack have no effect on the count. When the cards are counted, I will not reveal who made which decisions. I will return your own cards to you at the end of the round by coming to each of you in reverse order and giving you the top two cards, face down, off the stack in my hand. To summarize, your earnings for the round will be calculated:

earnings = \$4 times the # of red cards you kept
+ \$1 times the total # of red cards I collect.

After round 5, I will announce a change in the earnings for each red card you keep. Even though the value of red cards kept will change, red cards placed on the stack will always earn one dollar for each person. I will announce another change after round 10 and we will complete another 5 rounds.

Use the space below to record your decisions, your earnings, and your cumulative earnings. (Optional: At the end of the game, one person will be selected at random and will be paid ____ % of his or her actual earnings, in cash.) All earnings are hypothetical for everyone else. Are there any questions?

**Earnings Record Sheet** your name: _____

| round | # red cards kept | $ per red card kept | earnings for cards kept | $1 x (total # red cards in stack) | your total earnings this round | cumulative earnings |
|---|---|---|---|---|---|---|
| 1 | _____ | _____ | _____ | _____ | _____ | _____ |
| 2 | _____ | _____ | _____ | _____ | _____ | _____ |
| 3 | _____ | _____ | _____ | _____ | _____ | _____ |
| 4 | _____ | _____ | _____ | _____ | _____ | _____ |
| 5 | _____ | _____ | _____ | _____ | _____ | _____ |
| | *(In the remaining rounds, $ per red card kept = $2.)* | | | | | |
| 6 | _____ | _____ | _____ | _____ | _____ | _____ |
| 7 | _____ | _____ | _____ | _____ | _____ | _____ |
| 8 | _____ | _____ | _____ | _____ | _____ | _____ |
| 9 | _____ | _____ | _____ | _____ | _____ | _____ |
| 10 | _____ | _____ | _____ | _____ | _____ | _____ |
| | | | *(break)* | | | |
| 11 | _____ | _____ | _____ | _____ | _____ | _____ |
| 12 | _____ | _____ | _____ | _____ | _____ | _____ |
| 13 | _____ | _____ | _____ | _____ | _____ | _____ |
| 14 | _____ | _____ | _____ | _____ | _____ | _____ |
| 15 | _____ | _____ | _____ | _____ | _____ | _____ |

## APPENDIX 2. Instruction of CPR Game (Murphy & Cardenas, 2003)

### INSTRUCTIONS FOR CLASS EXPERIMENT

Please read through these instructions carefully **before class**. Be sure to bring these instructions along with you to class. PLEASE DO NOT DISCUSS THE EXPERIMENT WITH OTHERS IN THE CLASS. However, I encourage you to begin thinking about the types of decisions you might make in the experiment. If you have questions, feel free to call or email me before class. Before the experiment begins, everyone will be given an opportunity to ask questions. Once the experiment begins, you may raise your hand if you have questions. Talking with the others during the experiment is NOT permitted.

In each round of the experiment, you will have the opportunity to earn cash in experimental dollars (E$). After the experiment is over, we will compute your average earnings per round. Then, I will draw the names of two individuals who will be paid in cash the US$ equivalent of your experiment earnings at an exchange rate to be announced. I would like to point out that, in terms of cash earnings, your incentives are identical in this set-up with a random drawing for two names as they would be if everyone were paid his/her earnings. The more you make in E$, the more you will make in US$ if your name is called.

### Introduction

This experiment attempts to recreate a situation in which a group of families must make decisions about how to use a shared resource, for example, a forest, a water source, or a fishery. In this experiment, the resource will be referred to as the forest. You will play for several rounds that are equivalent, for instance, to years or harvest seasons. Make no assumptions about the number of rounds.

### The payoff table

At the start of the experiment, you will receive a PAYOFF TABLE identical to the one attached at the end of the instructions. All participants will have the same payoff table as you. This table contains all the information that you need to make your decision in each round of the experiment. The numbers that are inside the table correspond to the experimental dollars (E$) that you would earn in each round for a given set of decisions. Each of you must decide the number of MONTHS that you want to allocate to "time extracting from the forest" (in the columns from 0 to 8).

To play in each round you must write your player ID (which the instructor will give you), the current round number, and your decision (a number between 0 and 8) on an EXPERIMENT CARD that the instructor will give you. (There is an example attached to the end of the instructions).

It is very important that you keep in mind that your decisions are completely private and you may not show them to the rest of members of the group. Moreover, the instructor will not know what you decided and will not divulge your decisions to anyone.

After everyone has made his/her decision, the instructor will collect the EXPERIMENT CARDS from all 8 group members, and will calculate the total of months that the group decided to spend extracting from the forest. When the instructor announces the group total, each of you will be able to calculate the E$ that you earned in the round. An example follows.

In this experiment, we assume that each player has available a maximum of 8 MONTHS to work each year extracting a resource like firewood or logs. In the PAYOFF TABLE this corresponds to the columns from 0 to 8. Each of you must decide from 0 to 8 in each round. But to be able to know how much money you earned, you need to know the decisions that the rest in the group made.

**Table 1: An example of how the payoff table works**

| | | My Months In The Forest | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **Their Months In The Forest** | **19** | 488 | 520 | 550 | 578 | 603 | 625 | 645 | 661 | 674 |
| | **20** | 475 | 506 | **535** | 561 | 585 | 606 | 625 | 640 | 653 |
| | **21** | 461 | 491 | 519 | 544 | 567 | 587 | 605 | 619 | 630 |
| | **22** | 447 | 476 | 502 | 527 | 548 | 567 | 584 | 597 | 608 |

- You decide that "MY MONTHS IN THE FOREST" will be 2.
- The instructor collects all the Decision Cards and announces that a TOTAL of 22 months were spent in the forest.
- Therefore, you know that "Their months in the forest" was 20, and your earnings for the round are 535.

## The Record Sheet

OK, let us look how the experiment works in each round. Each participant will receive a RECORD SHEET like the one attached to the end of these instructions.

Using Example 1 above, let us see how to use this RECORD SHEET. Suppose that you decided to spend 2 months in the forest this round. On the EXPERIMENT CARD, you should write 2 next to "My months in the forest." You must also write this number in the first column (A) of the RECORD SHEET. (You are writing your decision down in 2 places: the EXPERIMENT CARD you give to the instructor, and the RECORD SHEET you hang onto…).

The instructor will collect the EXPERIMENT CARDS from everyone in your group and will calculate the total time spent in the forest by the group. The instructor will announce this total to the group. Suppose that the total was 22 months. Write 22 in column B of the RECORD SHEET. To calculate "Their months in the forest," subtract column A from column B, and record this in column C. In our example, "their months in the forest" is 20. To calculate your earnings, use the payoff table as described earlier. If "my months" equals 2, and "their months" equals 20, then your earnings would be 535. So in this example, you would have written the following on your RECORD SHEET:

**NAME:** _____ **PLAYER NUMBER:** _____

| | **Column A** | **Column B** | **Column C** | **Column D** |
|---|---|---|---|---|
| **Round No.** | **My Months in the Forest** (Your decision) | **Total Group Months in the Forest** (Announced by the Instructor) | **Their Months in the Forest** (Column B minus Column A) | **My Earnings in this Round** (Use your PAYOFF TABLE) |
| 1 | 2 | 22 | 20 | 535 |
| 2 | | | | |

It is very important to clarify that nobody will know your decisions in each round or your earnings for the experiment. Only the **group total** is announced in public. No one, including the instructor, will know what each participant in your group decided.

If you have any questions about how to earn money in the experiment, please email me, or ask before the experiment begins.

## Summary of Steps for Playing One Round of the Experiment

**How is it played:** In each round, you must decide how many months in a year between 0 and 8, you want to devote to extracting resources from a forest. Your earnings in each round depend on both your decision and the decisions by the rest of the group, according to the PAYOFF TABLE.

**What you need:** To play you need a PAYOFF TABLE, a RECORD SHEET, and several EXPERIMENT CARDS. You also need a player number. The instructor will provide all of this.

**Steps for each round:**

1. Using the **PAYOFF TABLE,** decide how many months you will spend in the forest.
2. On the **RECORD SHEET,** write your decision (My Months in the Forest) in Column A for the current round.
3. On an **EXPERIMENT CARD,** write the round number, and your decision (My Months in the Forest). Make sure it corresponds exactly to what you wrote on the RECORD SHEET. Hand the experiment card to the instructor.
4. The instructor will collect all the experiment cards and announce the **TOTAL GROUP MONTHS.**
5. On the **RECORD SHEET,** write this total in Column B (Total Group Months in the Forest).
6. On the **RECORD SHEET,** calculate Column C (Their Months in the Forest). This equals Column B minus Column A.
7. On the **RECORD SHEET,** write in Column D the total amount you earned for this round. To know how much you earned, use the PAYOFF TABLE and columns A and C (My Months and Their Months).
8. Play another round (Go back to step 1).

**RECORD SHEET**

**NAME:** _____ **PLAYER NUMBER:** _____

| | Column A | Column B | Column C | Column D |
|---|---|---|---|---|
| **Round No.** | **MY MONTHS IN THE FOREST** (From your decision) | **TOTAL GROUP MONTHS IN THE FOREST** (Announced by the Monitor) | **THEIR MONTHS IN THE FOREST** [Column B minus Column A] | **MY EARNINGS IN THIS ROUND** (Use your PAYOFF TABLE) |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| … | | | | |
| 20 | | | | |
| | | | **TOTAL** | |

| **EXPERIMENT CARD** | |
|---|---|
| Player Number: | |
| Round Number: | |
| My months in the forest: | |

## PAYOFF TABLE

| THEIR MONTHS IN THE COMMONS | MY MONTHS IN THE COMMONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 0 | 619 | 670 | 719 | 767 | 813 | 856 | 896 | 933 | 967 |
| 1 | 619 | 669 | 717 | 764 | 809 | 851 | 890 | 926 | 959 |
| 2 | 617 | 667 | 714 | 760 | 804 | 845 | 883 | 918 | 950 |
| 3 | 615 | 664 | 711 | 756 | 798 | 838 | 875 | 909 | 940 |
| 4 | 613 | 660 | 706 | 750 | 792 | 831 | 867 | 900 | 929 |
| 5 | 609 | 656 | 701 | 744 | 784 | 822 | 857 | 889 | 917 |
| 6 | 605 | 651 | 695 | 737 | 776 | 813 | 847 | 877 | 905 |
| 7 | 600 | 645 | 688 | 729 | 767 | 803 | 836 | 865 | 891 |
| 8 | 595 | 638 | 680 | 720 | 757 | 792 | 824 | 852 | 877 |
| 9 | 588 | 631 | 672 | 711 | 747 | 780 | 811 | 838 | 862 |
| 10 | 581 | 623 | 663 | 700 | 735 | 768 | 797 | 823 | 846 |
| 11 | 573 | 614 | 653 | 689 | 723 | 755 | 783 | 808 | 830 |
| 12 | 565 | 605 | 642 | 678 | 711 | 741 | 768 | 792 | 813 |
| 13 | 556 | 594 | 631 | 665 | 697 | 726 | 752 | 775 | 795 |
| 14 | 546 | 583 | 619 | 652 | 683 | 711 | 736 | 758 | 776 |
| 15 | 536 | 572 | 606 | 638 | 668 | 695 | 719 | 739 | 757 |
| 16 | 525 | 560 | 593 | 624 | 653 | 678 | 701 | 721 | 737 |
| 17 | 513 | 547 | 579 | 609 | 636 | 661 | 683 | 701 | 717 |
| 18 | 501 | 534 | 565 | 594 | 620 | 643 | 664 | 681 | 696 |
| 19 | 488 | 520 | 550 | 578 | 603 | 625 | 645 | 661 | 674 |
| 20 | 475 | 506 | 535 | 561 | 585 | 606 | 625 | 640 | 653 |
| 21 | 461 | 491 | 519 | 544 | 567 | 587 | 605 | 619 | 630 |
| 22 | 447 | 476 | 502 | 527 | 548 | 567 | 584 | 597 | 608 |
| 23 | 433 | 460 | 485 | 509 | 529 | 547 | 563 | 575 | 585 |
| 24 | 418 | 444 | 468 | 490 | 510 | 527 | 541 | 553 | 561 |
| 25 | 402 | 428 | 451 | 472 | 490 | 506 | 520 | 530 | 538 |
| 26 | 387 | 411 | 433 | 453 | 470 | 485 | 498 | 507 | 514 |
| 27 | 371 | 394 | 415 | 434 | 450 | 464 | 476 | 484 | 490 |
| 28 | 355 | 377 | 396 | 414 | 430 | 443 | 453 | 461 | 466 |
| 29 | 338 | 359 | 378 | 395 | 409 | 421 | 431 | 438 | 442 |
| 30 | 322 | 341 | 359 | 375 | 389 | 400 | 409 | 415 | 418 |
| 31 | 305 | 324 | 341 | 355 | 368 | 378 | 386 | 392 | 394 |
| 32 | 288 | 306 | 322 | 336 | 347 | 357 | 364 | 368 | 371 |
| 33 | 272 | 288 | 303 | 316 | 327 | 335 | 341 | 345 | 347 |
| 34 | 255 | 270 | 284 | 296 | 306 | 314 | 319 | 323 | 324 |
| 35 | 238 | 253 | 266 | 277 | 286 | 293 | 297 | 300 | 300 |
| 36 | 221 | 235 | 247 | 257 | 265 | 272 | 276 | 278 | 278 |
| 37 | 205 | 218 | 229 | 238 | 245 | 251 | 254 | 256 | 255 |
| 38 | 189 | 200 | 211 | 219 | 226 | 231 | 233 | 234 | 233 |
| 39 | 173 | 184 | 193 | 201 | 206 | 211 | 213 | 213 | 212 |
| 40 | 157 | 167 | 175 | 182 | 188 | 191 | 193 | 193 | 191 |
| 41 | 142 | 151 | 159 | 165 | 169 | 172 | 174 | 173 | 171 |
| 42 | 127 | 135 | 142 | 148 | 152 | 154 | 155 | 154 | 152 |
| 43 | 113 | 120 | 126 | 131 | 134 | 136 | 137 | 136 | 133 |
| 44 | 99 | 106 | 111 | 115 | 118 | 119 | 119 | 118 | 115 |
| 45 | 86 | 92 | 96 | 100 | 102 | 103 | 103 | 101 | 99 |
| 46 | 73 | 78 | 82 | 86 | 87 | 88 | 88 | 86 | 83 |
| 47 | 61 | 66 | 69 | 72 | 73 | 74 | 73 | 71 | 68 |
| 48 | 51 | 54 | 57 | 59 | 60 | 61 | 60 | 58 | 55 |
| 49 | 40 | 44 | 46 | 48 | 49 | 48 | 47 | 45 | 43 |
| 50 | 31 | 34 | 36 | 37 | 38 | 37 | 36 | 34 | 32 |
| 51 | 23 | 25 | 27 | 28 | 28 | 28 | 27 | 25 | 23 |
| 52 | 16 | 18 | 19 | 20 | 20 | 19 | 18 | 17 | 15 |
| 53 | 10 | 12 | 12 | 13 | 13 | 12 | 11 | 10 | 8 |
| 54 | 6 | 7 | 7 | 7 | 7 | 7 | 6 | 5 | 4 |
| 55 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 |
| 56 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |