Multilevel Selection In-Class Activities

Accompanies the article:

O'Brien, D. T. (2011). A modular approach to teaching multilevel selection. *EvoS Journal: The Journal of the Evolutionary Studies Consortium, 3*(1), 12-23.

Multilevel Selection **Online Teaching Materials**
In-Class Activity **Sequential Prisoner's Dilemma**

The Sequential Prisoner's Dilemma is a protocol from the field of experimental economics. It provides a relatively simple set of measures of social behavior. In the game, players are able to do one of two things: cooperate or defect. The results can be used to demonstrate aspects about human prosociality, including how groups that can punish have superior performance.

Rules

Payoff Matrix

1. The payoff matrix I use is shown in Figure 1. The main rules for payoff matrix are that:
    a. Defecting on a cooperator always has the greatest payoff.
    b. Cooperating with a defector always has the least payoff.
    c. Two cooperators receive more money than two non-cooperators
    d. The sum of two cooperators should always be more than the sum of a cooperator and a defector (in this example, $60 vs. $55). This rule can be changed in order to demonstrate how ecology might influence the relative success of cooperation or defection.

Play

1. In the sequential version of the Prisoner's Dilemma, there is a first mover and a second mover. The first mover plays with no knowledge of the second player's intentions. The second player then responds to the first player's choice.
2. I play the game anonymously, with students not knowing whether they will be the first or second mover. Thus, they have to provide three pieces of information:
    a. How would you play as a first mover? (a measure of trust)
    b. How would you play as a second mover if the first mover cooperated? (a measure of trustworthiness)
    c. How would you play as a second mover if the first mover did not cooperate? (a measure of self-sacrifice)
3. I follow by playing the game again but this time allowing players to invest their winnings in punishing non-cooperative partners. For every $1 a player pays, his or her partner loses $5.
4. Response sheets for each of these versions are included in the following pages.

Class Implementation

1. It is only necessary to distribute the actual money if you are intending to use the results for publishable research. When I do this, I let the students know that we'll play the game twice—once with punishment, once without punishment—meaning that four of them will receive money.
2. I select two response sheets at random from each stack, randomly select first and second movers, and describe the interactions and their outcomes accordingly.
3. In class, only anonymous ID Codes are announced, and money is distributed in private.

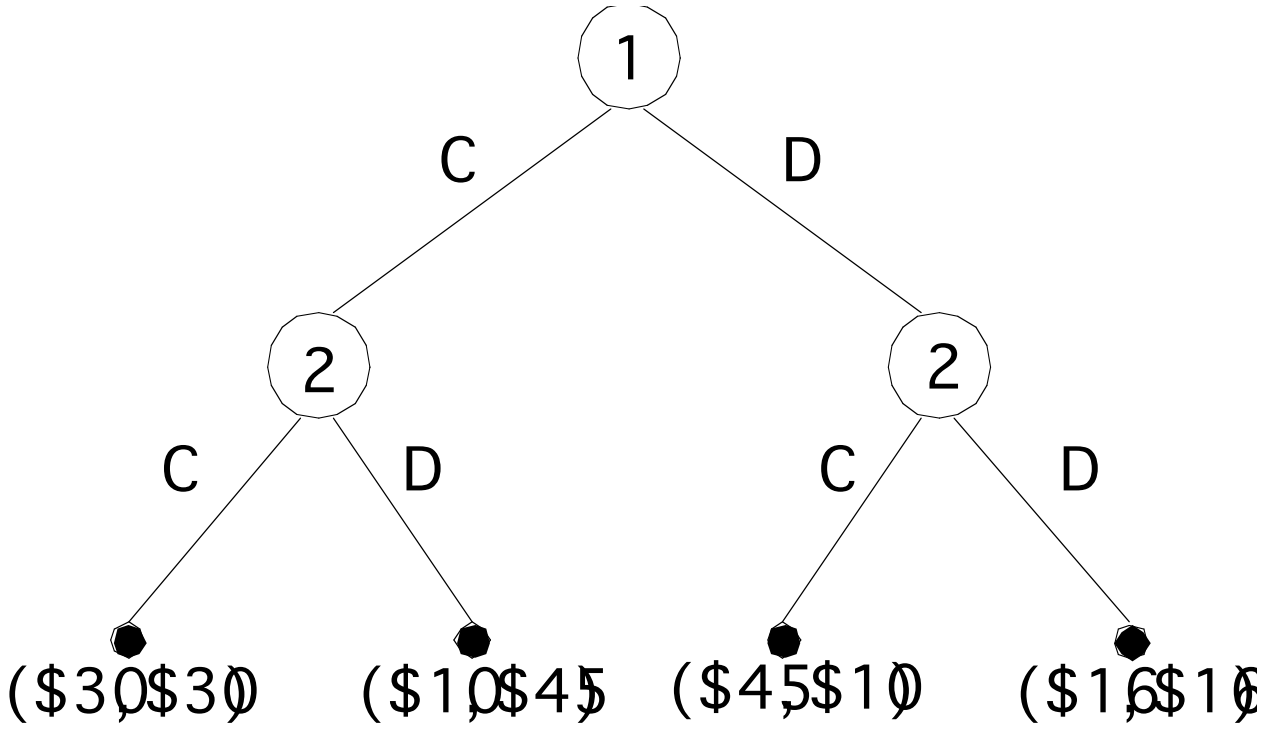

Figure 1. Schematic describing the options of the first and second players in the Sequential Prisoner's Dilemma, and consequent payoffs (first player's payoff listed first).

Sequential game experiment Part I.

Enter Your Eight-Character Code _____

Given the payoff matrix shown on the screen…

1) How will you behave if you are allowed to play first (circle one)?

Cooperate Don't Cooperate

Please explain why you made this choice in one or a few sentences.

2) You are playing second and the first player cooperated. How will you behave (circle one)?

Cooperate Don't Cooperate

Please explain why you made this choice in one or a few sentences.

3) You are playing second and the first player did not cooperate. How will you behave (circle one)?

Cooperate Don't Cooperate

Please explain why you made this choice in one or a few sentences.

Sequential game experiment Part II.

Enter Your Eight-Character Code _____

Given the payoff matrix shown on the screen…

In this version of the game, each person is given the opportunity to punish defectors. Every dollar one invests in punishment is used to deduct five dollars from the winnings of his/her partner.

1) How will you behave if you are allowed to play first (circle one)?

Cooperate Don't Cooperate

How many dollars will you pay to punish if B doesn't cooperate? _____

Please explain why you made this choice in one or a few sentences.

2) You are playing second and the first player cooperated. How will you behave (circle one)?

Cooperate Don't Cooperate

Please explain why you made this choice in one or a few sentences.

3) You are playing second and the first player did not cooperate. How will you behave (circle one)?

Cooperate Don't Cooperate

How many dollars will you pay to punish if A for no cooperating? _____

Please explain why you made this choice in one or a few sentences.

Catan© is a relatively complex board game, but one that can be easily simplified to illustrate between-group competition in the classroom. The game revolves around having four players compete to dominate an unsettled island. There is no opportunity for war, meaning the between-group competition is distilled to a single measure of success. Note: This activity could feasibly be done with any board or computer role-playing game that has between-group competition, be it Risk©, Sid Meier's Civilization©, World of Warcraft©, or Age of Empires©.

Rules in Brief (Note: The rules provided here are the simplified rules for the in-class version and leave out finer details that are part of the actual game.)

Materials

For each game being played at a time (assuming a class too large for all students to be involved in one game):

- 20 land tiles (5 each: forest, hills, fields, pastures)
- 19 number markers (2 each for 2-12, with 2, 8, and 12 represented only once)
- About 15 "cards" representing each resource type
- A set of dice
- 4 distinguishable sets of 5 2-D markers to act as settlements (I use pennies, nickels, dimes and quarters)
- 4 distinguishable sets of ~8 linear markers to act as roads (I use colored toothpicks)

Setup

5. The island of Catan© includes four land types, each producing its own resource: forests provide wood; hills provide brick; fields provide wheat; pastures provide wool.
6. The island consists of nineteen land spaces (I provide five of each land type and have the students randomly select which land type is only represented four times) organized randomly in the shape depicted in Figure 1.
7. All lands have a marker numbered between 2 and 12. 2, 8, and 12 are represented once, making for nineteen markers. These markers are also distributed randomly. During game play, when a dice roll adds up to the marker on a land tile, that land produces resources.
    a. Example: Player A rolls a 9, and the 9 marker is on a pasture. That pasture produces wool.
8. When players receive resources, they are noted using the resource cards.

Game Play

1. During game play, players have settlements and roads. Settlements are worth a point each. Roads are not worth points. Settlements must be placed at vertices of land tiles, and roads along sides of land tiles, as seen in Figure 1.
2. During a player's turn, he or she rolls the dice. Any land tiles with the value of the dice's sum produce resources. Players receive one resource for every settlement they have adjacent to a tile whose number was rolled.
    a. Example: Player A rolls a 9, and the 9 marker is on a pasture. Player B has a settlement on one of that pasture's vertices. Player B can take one wool card. The other 9 marker is on a forest, and Player D has two settlements adjacent to that tile. Player D receives two wood cards.
3. At the end of a player's turn, he or she can choose to build settlements and/or roads. Settlements are purchased at a cost of one wool card, one wheat card, one brick card and one wood card. Roads are purchased at a cost of one brick and one wood card.
4. Newly built roads must connect to old roads or emanate from a settlement.
5. Newly built settlements must be placed along or at the end of pre-existing roads belonging to the player who places the settlement. Also, settlements cannot be placed on consecutive vertices.
6. Play continues until one player has five settlements (five points).

Beginning the Game

1. Each player rolls one die. The player with the highest roll goes first.
2. Starting with that player, each player places one settlement and one road (connected to that settlement) wherever he or she likes on the board. This continues in a clockwise fashion.
3. The last player places *two* settlements and roads in the fashion just described. Then everyone else places a second settlement, moving counter-clockwise.
4. Everyone collects one resource for each land tile adjacent to the *second* settlement they placed.

Note: This document is accompanied by a Powerpoint file intended to facilitate teaching these rules to the class quickly and efficiently.

Implementation as a Teaching Tool

Playing to five points, the games go very quickly. I encourage students to create their own new rule and play again, making predictions about how it might change the outcome. This leaves open possibilities for "new environments" that alter the nature of the between-group competition. I also ask them to keep track of who won and why they were successful, bridging to the role that between-group variation plays in this competition.

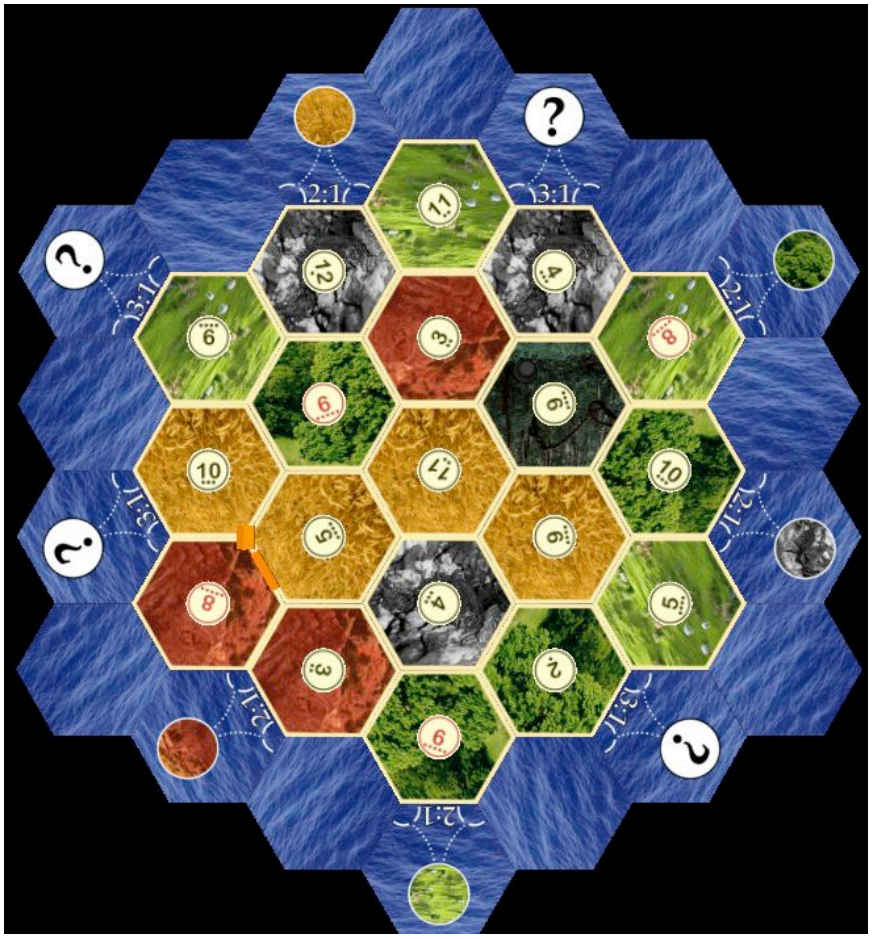

Figure 1. A Prepared Board for Playing Catan, with Example Placement of a Settlement and Road (Lower Left).

"The Popsicle Stick Game" is a dynamic classroom activity that works best with a small-to-medium sized class (<50 students). It is a manipulation of the Sequential Prisoner's Dilemma (see that file for more information).

Rules in Brief

Materials

Popsicle sticks with either an A or an S written on each. There should be enough to give each member of the class one of each.

Basic Rules

9. During a single interaction, a player uses either their A stick or S stick, playing as an altruist or selfish individual, respectively.
10. Points are counted for each interaction as follows:
    a. A-A: 3 points each
    b. A-S: 3 for selfish, 0 for altruist
    c. S-S: 1 point each
11. At the end of play, points are tallied.

Game Play: Part I

7. Divide the class arbitrarily in 2 in such a way that they don't know which category each classmate is in. (By birth month, or initial of middle name.) Denote one half as obligately selfish, the other as obligately altruistic.
8. Allow them to play with the rule that they cannot interact with the same person more than once. This will involve the students moving around the room freely. Interaction can involve conversation before showing one's "type," but must end after the counting of points.
9. At the end, tally the average score for selfish and altruistic individuals. Selfish individuals should fare better.

Game Play: Part II

1. Add a third category to the division, with these individuals being phenotypically flexible (i.e. able to be altruistic or selfish).
2. Allow them to play again, still with the rule that they cannot interact with the same person more than once.
3. At the end, tally the average score for selfish, altruistic and flexible individuals. Ask flexible individuals how often they used each strategy and how they made their decisions.

Game Play: Part III

1. Keep the three categories.
2. Allow them to play a third time, but with multiple interactions between two individuals allowed. This essentially provides an environment that permits the creation of cooperative groups.
3. At the end, tally the average score for selfish, altruistic and flexible individuals. Also, ask flexible individuals how often they used each strategy and why.

The three steps of the game should demonstrate different contexts within which cooperation is advantageous for an individual, and how cooperative individuals can form groups that will out-compete non-cooperative groups.