Title: Teaching the commons
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Note: This version of the paper needs to be updated to move technical details to appendixes and add more "teaching philosophy." I hope to have this new version ready for WOW, but I will definitely emphasize teaching for my WOW talk.

Abstract

In this paper, I describe "Common Pool Management" (CPM), a course I designed to help students understand the difficulties in managing a real commons, how I taught and evolved CPM, and how CPM impacted my teaching and research. CPM has three important elements. First, students are randomized into groups that are "too big to succeed." Second, students choose and tackle a "commons dilemma" within the duration of the course (Ostrom et al. 1994). Third, student grades depend on collective success and peer assessments.

After teaching CPM seven times, I have these observations on the three elements above. First, students in "too-large" groups need time to organize themselves productively, but they realize the importance of frequent, face to face communications and discipline to prevent free-riding. Second, students struggle to establish institutions to transforms common-pool dilemmas into common-pool situations. Most groups fail for lack of a simple, enforceable regime for, say, parking in the bike rack or collecting washed clothes from the laundry room. In a few cases, a group's "pilot" intervention altered informal norms or inspired policy changes. Third, students learned a great deal about conflict and cooperation within their group, how to manage free-riders and reward cooperators, and the importance of endogenous rule-making and monitoring.

As a teacher, I learned how to better manage students and incentives across all my courses, how to better communicate with my students, and how to reform course structures in response to student suggestions, struggles and surprises. As a researcher, I am pleased to present this paper as an inspiration to anyone who wants to think about putting theory into practice and improving public and academic understanding of the complexities of the commons.

TEACHING THE COMMONS THROUGH EXPERIENCE

DAVID ZETLAND

1. Why this course is relevant

Most students learn common-pool resource management (CPRM) by reading textbook descriptions of the theory and participating in brief online or classroom experiments.[1] Sometimes students also read academic papers describing more complex theoretical situations or case studies. Very few students learn CPRM by actually addressing a real CPRM problem. This paper describes how I taught a CPRM course in which students in small teams not only identified and worked on real CPRM problems but also faced CPRM problems *within* their teams. This "play within a play" structure greatly enhanced learning by exposing students to the reality of cooperation and free riding outside the classroom, inside their groups, and within themselves.

2. The commons and the classroom

Many problems can be traced to "common-pool dilemmas," which Ostrom et al. (1994) define as the over-appropriation of common-pool goods or under-provision of public goods. Dilemmas occur due to the non-excludable nature of these types of goods, which means that people can exploit them without permission or pay for their use, respectively.

Students do not usually learn about non-excludable goods in university economics courses that tend to focus on excludable (private and club) goods that are provided and allocated in markets. This focus probably reflects the relative clarity with which

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[1]See `http://www.econport.org/content/handbook/commonpool/Experiments.html` or `http://veconlab.econ.virginia.edu/cp/cp.php` for online versions.

the supply and demand for excludable goods can be explained in the classroom and thus used to teach economic theory.[2] Economists may also avoid teaching the commons because CPRM often relies on social and political mechanisms and institutions that are hard to understand or present in a simplified, analytic manner. These "complications" may prevent CPRM from fitting nicely into a disciplinary silo, but they also show how useful CPRM can be to other topics and disciplines, from funding in the arts, to property rights in law, to diffusion in chemistry, or unsustainable practices in ecology.

Elinor and Vincent Ostrom accounted for these inconveniences when they founded the Workshop in Political Theory and Policy Analysis at Indiana University in 1973. They wanted participants to bring interdisciplinary perspectives and solutions to CPRM problems so they kept the Workshop independent of academic departments. Their choice ran against the specialization that had separated economics from political science in the 19th century and facilitated cooperation among scholars from the humanities, social sciences, and physical sciences. The Ostroms and their many collaborators used case studies to explore how groups with diverse histories, cultures and geographies succeeded or failed in managing their commons.

Most courses present the perspective and knowledge of the instructor's discipline, and most assessments focus on the individual student's understanding of the lecture material. These norms make sense in terms of the instructor's specialization and the student's diversified set of courses, but they do not work so well for inherently interdisciplinary subjects like CPRM, at liberal arts colleges that emphasize interdisciplinary learning and research, or in a working world where successful organizations combine individuals into effective teams. It is with these factors in mind that I set out to design a course that would not just make students aware of CPRM but teach them how CPRM succeeds or fails.[3]

It is also useful to add here that I needed to design the course to fit into our interdisciplinary environment, such that students from environmental policy and

[2]The supply and demand curves for non-excludable goods are harder to draw and explain. The lack of a "market price" makes it hard to show or even explain where equilibrium might lie.
[3]Course syllabus, assessments, and grading spreadsheets available at [URL TO BE ADDED].

sustainability sciences could both understand and benefit from the ideas, examples and learning outcomes. The mix of students also made it easier for them to choose local CPRM problems that other students would agree need attention. Some of the CPRM problem they choose were noise in study areas, congestion in bike parking areas, "inefficient" use of machines in the laundry room, and so on.

3. Experiments and learning in the classroom

Colander (2004) argues that content matters more than form in teaching since students ultimately remember content. He praises active and cooperative learning as useful supplements that should not dominate traditional methods. He points out that much learning happens outside class when students struggle with the readings or argue with each other. When it comes to teaching economics, he acknowledges that competition can impede cooperation on joint assessments, and that it is not always easy to relate tidy blackboard economics to the messy real world. Reimann (2004) and Zetland et al. (2010) make similar points when it comes to teaching economic theory to new learners who might struggle, but they disagree with Colander's conclusion regarding theory. Reimann suggests that students from diverse backgrounds might find a "problem-first" method of tackling economic questions easier than a "theory-first" method because students can approach the problem from different perspectives. Zetland et al. (2010, p. 127) point out that needlessly complex theory "may lead the marginal student to take fewer economics classes or quit the major — results that teachers of economics probably want to avoid." It may be harder for teachers to design and run classes using hands-on, experiential learning methods, but those methods can help students understand unfamiliar ideas and expose teachers to naive and perhaps innovative solutions that can enrich classroom dynamics.

I designed this course to test students' understanding of theory by grouping them into teams that are trying to foster cooperation among outsiders at the same time as they try to maintain cooperation among themselves. These struggles fuel passionate debates in class as students experience and battle free riding that weakens

their group and hinders the group's effectiveness in addressing their common-pool dilemma.

Economics professors have several decades of experience with using classroom experiments to teach students how economic theories work in practice. Emerson and English (2016) summarize much of the published literature reporting learning outcomes from classroom experiments as well as results from their own extensive documentation of students in different treatments. They report (p. 297) that "students exposed to classroom experiments exhibited significantly higher positive learning on the [general economics exam] than students in the no-experiment control group... [perhaps because] students who participated in certain experiments became more engaged in the course material in general and likely gained economic intuition through participation that carried over to enhance their overall understanding" of economics. In their survey of teaching undergraduates, Allgood et al. (2015) say that instructors are enthusiastic about cooperative learning but often hard pressed to show consistent improvements from cooperative learning environments. They suggest that their variety complicates the collection of reliable, comparable data. Those mixed results should not discourage instructors from piloting experiments or cooperative tasks — especially when they suit the material. I have found that experiments help students understand and apply economic concepts, so I was willing to build a course on experiential learning foundations. Students wouldn't just do an experiment in one class session. The entire course would be an experiment.

The design for this CPRM course falls somewhere between a natural and framed field experiment in the typology of Harrison and List (2004). They define a natural field experiment as having an environment "where the subjects naturally undertake these tasks and where the subjects do not know that they are in an experiment" whereas they are subject to some artificial rules in a framed field experiment (p. 1014). In this course, students are constrained by some rules (grades, randomized

allocation to teams) but free to choose their group project as well as determine how they will interact.[4]

In some ways, this design resembles a service learning course in terms of exposing students to a real world problem (see, e.g., Ziegert and McGoldrick (2008)), but it differs in how the rules (and changes in the rules) force them to deal with CPRM problems. More importantly, course assessments motivate students to collaborate in identifying and tackling real problems in their local commons. That process (and the need to make progress during the 8-week duration of the course) often forces students to pay less attention to their grades and more attention to their impact and effectiveness in reaching their goals. Reality is a useful reference and disciplinarian in this course. Theobald (1997) examines how students in rural schools are more likely to be integrated into their communities and how curricula can strengthen those ties as well as students' community-orientation. This course brings the same local focus by asking students to pay attention to a local problem (in the school or community) rather than allowing them to look abroad for examples that may be easier to identify and will certainly be easier to "fix" theoretically. How many times have we told students to "fix" externalities by adding a tax or "make markets" by adding suppliers? Reality doesn't always bend to theory, and students get abundant experience in that reality as they attempt to motivate others to contribute to the commons. Murphy and Cardenas (2004) explore how experimental results in the classroom may miss or match field realities, and this course helps students appreciate that difference (external validity). As one (anonymous) student said:[5]

> I definitely learned a lot. More life lessons I'd say than anything else. The group project trying to resolve an actual issue has been an incredible life lesson in the frustrations and benefits of working as a group on an issue. Also it is interesting to see how what at first glance seems like a simple issue can actually be incredibly complex once you

[4]This structure necessarily avoids any need for Institutional Research Board approvals on experimental protocols, etc., as there is no deception and students are responding to normal (grade) incentives.

[5]Quotations in this paper came from various feedback forms students completed during the course. Some feedback was anonymous, some not.

> get more into it. Exploring creative solutions and trying things out whether or not they fail or succeed has been really fun. And it is actually quite empowering to take on what seems like an impossible mission and break it down into little doable bits and then actually do it. And yes, it is so refreshing to have something practical in LUC for once, and not just theories and more theories. So well done!

4. Designing the commons into a course

When teaching a CPRM course, it is critical that students understand how cooperation or free-riding are important in, respectively, protecting or destroying a commons. Cooperation is necessary for preventing over-appropriation of common-pool goods and avoiding under-provision of public goods, just as free-riding can be sufficient for destroying or preventing those outcomes. These claims are explained in the first class, and they are immediately meaningful to students when they learn that they have been put into groups of 6–10 with the task of finding and addressing a local CPRM problem using their wits and effort, rather than theoretical assumptions.

The design of assessments reinforces the need for students to cooperate effectively. A discussion over assessments on day one (described below in detail) creates a common knowledge about choices and consequences that helps students understand how extrinsic incentives are going to reinforce their cooperative efforts how the instructor will referee those efforts.

The course structure includes several surprises as well as progressively deeper engagement with core topics, so it is better to begin the course with a general overview and leave detailed explanations to the "right time and place." This timing makes it easier to have "just in time" discussions of theory as students experience it in their projects.

I will use the following subsections to describe how I ran the third (most recent) edition of this course. This outline is neither perfected nor exhaustive, but it should give readers a few ideas of how they might teach a similar course or include this

module into a longer course. Our teaching schedule uses 8-week blocks with 20 students meeting for 2 hours, twice per week for seven weeks. In the last week ("Reading Week"), students hand in their final group report and give one final feedback on each other (more on this below).

4.1. **Textbook.** We use Ostrom et al. (1994) as a textbook, which might be a bit tough for undergraduates (especially when they have no economics background), but we treated it more as a guide than a bible.[6] One of the most important elements in Ostrom et al.'s book is their differentiation between a "common-pool situation" in which a good is non-excludable in access and a "common-pool dilemma" — a subset of common-pool situations in which the provision or use of the good is suboptimal *and* it is institutionally feasible to manage the good in a different way (p. 15). Ostrom et al. make this distinction to expand what they see as an over-prescriptive (too small) set of "solutions" associated with other scholars. In particular, they single out Hardin (1968) and Olson (1965) as over-pessimistic in implying (or being interpreted to imply) that a tragedy of the commons is both inevitable and non-actionable, respectively. They do not mention Coase (1960) by name, but it is clear that their theories (and empirical work) require neither a top-down regulatory regime nor private property rights to prevent common-pool dilemmas. It is worth repeating here that Ostrom et al. include both public goods and common-pool goods in their analysis of common-pool situations, with dilemmas arising when either public goods are under-provided or common-pool goods are over-appropriated.

4.2. **Individual assessments.** Just under half of the student's course grade depends on individual work, i.e., two homework assignments, one in-class presentation, and participation in class discussions. This share is just large enough to give students a reason to work but not so large that they neglect group work (see next section). After running this course three times, it seems useful to focus the homework assignments on individual student understanding of Ostrom et al. In the first

[6]Anderies and Janssen (2016) wrote their own version of Ostrom's book for their undergraduate course. I have not reviewed it extensively, but it is free to download and thus worth considering as a text.

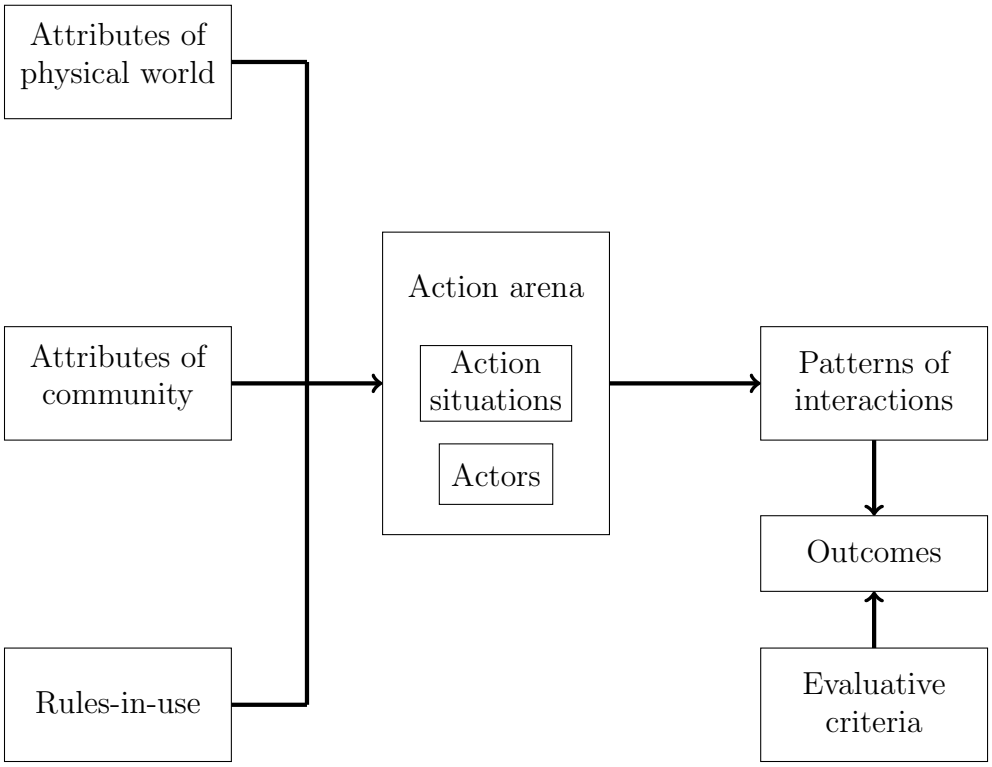

FIGURE 1. Adopted from Ostrom et al. (1994, Fig 2.2)

homework, I ask them to apply basic definitions to their own real world examples. In the second, I ask them to explain their team project using Ostrom et al., e.g.:

> All of these questions refer to your group project, but you should answer these questions on your own. I am curious to see how each of you understand Ostrom's framework, the purpose/goals of you/your team, and how you connect existing or proposed interactions to outcomes.
>
> Question 1: Following on Fig 2.2 [reproduced in Figure 1], describe how the current pattern of interactions leads to outcomes that you (using your personal evaluative criteria) see as "non-optimal" and thus worth an intervention to change those outcomes.

Homework (20 percent of course grade) reveals how well individual students understand basic concepts. It also gives students the chance to reflect on their own beliefs and understanding, away from others who may dominate class or team discussions (Grodner and Rupp, 2013). Critical thinking is furthered by individual

assessments of student participation in class discussions (15 percent) and each student's presentation of a CPRM dilemma they found in the news (10 percent). Active class discussions create a public good that benefits everyone.

4.3. **Team assessments.** Students receive 20 and 30 percent of their course grade from their "individual contribution to group presentation" and "individual contribution to the group report," respectively. At first it seems like it would be easier to give all group members the same grade for the presentation and report, because it is practically impossible for me to observe or measure each student's contribution to the final product, but such a rubric would clearly tempt some students into free riding — a result that would led to conflict with "cooperative" students and problems for me — the one who put them in groups.

Luckily, it was easy to turn this grading bug into a feature by asking students to qualitatively and quantitatively rate themselves and their peers several times during the course, which made it possible to modify group grades to reflect individual contributions. On the qualitative side, they gave answers to "How has the team done, in terms of organizing and producing the project?" "What role have you filled, in terms of helping the team and producing the project?" "How could you or other members improve the team's work?" and "Who (besides you) has been most helpful? Why?"

These questions forced the students to stop and reflect on their ongoing team dynamics, with an emphasis on the positive side of their cooperation. They also gave me some insights into each student's thoughts and how well their thoughts matched others in their team. In the quantified section, students allocated 100 percent among *other* team members, e.g., 15 percent to 4 members and 20 percent to 2 members in a team of 7. Those "shares" allowed me to use a formula (see below) that would normalize their feedback and then add or subtract points from the base, group grades for the presentation and report, to arrive at individual grades.

I did not tell students the exact formula for adjustments because I wanted to keep them focussed on their contributions, but I adjusted their base (team) grade

by 10 percent (assuming a 0–100 percent scale) times the weighted, average percent share they had received across three ratings, i.e., the following formula for G_i, or the individual grade for team member i:

$$G_i = G + 0.10(W_i - 100)SD$$

where G is the group base grade, 0.10 is the ten percent adjustment, $W_i = 0.2p_{1,i} + 0.3p_{2,i} + 0.5p_{3,i}$ (where each p is above or below the 100 midpoint of shares given and weights rise from the first to the third rating to allow for learning about team members), the -100 reduces W_i to a smaller positive number if rankings were above the mean or a negative number if they were below the mean, and SD is the standard deviation of all W_i values. Put differently, this formula gave a larger positive bump to individual grades when the individual is rated "more helpful than average," gave no adjustment to average teammates, and penalized less helpful (freeriding) team members — without affecting mean grades. The size of the adjustment was arbitrarily anchored at 10 percent of the base grade to limit its impact, but that impact was larger for members that were excessively helpful (or not) in comparison to the norm, i.e., greater than one standard deviation from the mean. Table 1 gives a simplified example of how peer assessments increased or decreased each student's grade against the group's base grade.[7]

Besides mentioning peer grading ("your individual role will be assessed by your peers"), the syllabus warned students of other (but not all) factors relevant to their team project. They knew they were placed in random teams that would have to choose a realistic but challenging project to tackle. They did not know that I had

[7]The use of the standard deviation for each group give an idea of each group's "cohesion" but it means that adjustments will be larger for more fractious groups and smaller for more harmonious groups. If this feature seems more like a bug, then a target adjustment of, say, 10% can given to the individual student whose peer ranking is most distant from the average. Applying this idea to the (less disbursed) numbers in Table 1, we start with Student D's greatest distance of -15 ($= 85 - 100$) and normalize that to -10% by dividing by 1.5 ($|100 - 85|/10\%$ goal), which is the adjustment factor. That factor can then be used to raise Student C's grade by $(105-100)/1.5 = 3.3$ and Student E's grade by $(110 - 100)/1.5 = 6.7$, leaving Students C, D and E with final grades (given a base of 88%) of 91.3, 78 and 94.7 percent, respectively. This method brings certainty in the extremes while removing variation on group cohesion, but it does nothing to change student incentives.

TABLE 1. This simplified example uses one rating and five students to show how peer assessments modify the team's raw grade to find each student's individual grade. The process begins with each student allocating 100 points (in each row) to other team members. Each student then has a credit received total in their column. Credits are normalized (subtracting 100 and multiplying by the standard deviation) and scaled (multiplied by 0.1) to find a final adjustment. In this example, Students A and B get neutral weights, Students C and E get more credit, and Student D gets less credit. Given a base grade of 88% (a B+ grade) and standard deviation of 3.24 among the credits that range from 20 to 35 (0s do not count), Student C get a 90 (A-), Student D gets a 83% ($G_d = 88 + 0.10(85 - 100)3.24 = 88 + 0.10(-15)3.24 = 88 - 5.95 = 82$) or B, and Student E gets a 91% (A-). Students A and B get the same grade as the base grade, or B+.

Student	A	B	C	D	E	Credit given
A	0	25	25	20	30	100
B	25	0	25	20	30	100
C	25	25	0	20	30	100
D	25	25	30	0	20	100
E	25	25	25	25	0	100
Credit received	100	100	105	85	110	500
Base grade	88%	88%	88%	88%	88%	440
Adjustment	0	0	+1.62%	-4.86%	+3.24%	0
Final grade	88%	88%	89.62%	83.14%	91.24%	440

made the teams as large as possible (10 students in each for the most recent course) and that I would swap a significant minority of randomly chosen students between teams in the middle of the project (e.g., 4 of 10 students in each group). I choose large teams because they make monitoring harder, and thus freeriding easier (Olson, 1965). The team swap was meant to test the team's cohesion by disrupting their tacit knowledge and institutions (Bandiera et al., 2006).

4.4. **The Quiz.** In the first class, students play "the fishing game" — a well-known appropriation game that instructors use to demonstrate the over-exploitation of a commons (Foundation for Teaching Economics, 2012). In our version of the game, 6–7 students stood next to a table (others were watching from behind) where they were told that they could not talk, but could "take as little or as much of the fish (euro coins valued from €0.05 to €2) as they wanted in the first 20 second period, after which point the fish 'would have babies' of matching value that could be collected by any of them in the second period of 20 seconds." This class demonstration usually

TABLE 2. "Expected payoffs" (grades) *as if* students 1 and 2 are paired with each other. (They are paired with other students, by design.)

		Student 2	
		Correct	Incorrect
Student 1	Correct	A, A	F, A
	Incorrect	A, F	F, F

ends quickly, when one student's grab results in others grabbing everything else before the end of the first period. Sometimes students wait nervously until the fish have babies and *then* grab the doubled stakes at the start of the second period. The exercise is meant to give students a visceral experience of panic and disorder in a non-exclusionary environment, but it does not make them vulnerable to another student's free riding. The Quiz (originally worth 10 percent of the course grade but now 5 percent) is designed to alert them to their interdependence.

In its current form, the quiz is simple:

> Another student will get an A if you get this question right but an F if you get it wrong. You will receive an A *or not*, depending on how another student answers this *same* question. You are *not* paired with another student in the sense that their decision affects you or vice-versa.
>
> What is 1+1?

As you probably noticed, the quiz is a trick, as there is no incentive for any student to give the wrong answer. Table 2 shows payoffs *as if* each student was paired with an "expected partner." (The game is not a simultaneous 2x2 game since Student 1's answer affects Student 2 but Student 2's answer affects Student 3, and so on, via a randomized set of one-way pairings. The students are therefore choosing whether to award another student an A or F, without strategic considerations.) As can be seen in the payoffs, there is no dominant strategy in the presence of interdependent play, which leaves players indifferent between choices. In the *absence* of such interdependence, that indifference is even stronger. That said, most players are likely to choose the "correct" answer as it is Pareto Optimal.

This easy solution was not obvious to students unfamiliar with the game. They needed to play quickly and without communication with the knowledge that grades were at stake. Many students were nervous and unsure of how to answer "correctly." I will describe how they answered this question later in the paper, as this assessment creates several learning opportunities by forcing students to face free riding (or defection) early in the course.

That said, I decided to modify the game by raising the stakes and allowing communication — on the suggestions of students and other professors, respectively. Students wanted "to make the quiz more relevant" by creating zero-sum payoffs. Professors suggested communication to focus less on a Prisoner's Dilemma and more on a Herder's Problem in which communication dynamics more closely resemble everyday interactions (Cole and Grossman, 2010).

I raised the stakes by changing payoffs to create a tension between risk-averse generosity and risky selfishness, i.e., "any student who gets the answer right will get a B (no matter what the student answering for them gets). Any student who answers incorrectly will get an A and give a B to the student they are answering for, but their A will turn into a C if the student answering for them *also* gets the answer wrong." Table 3 shows these payoffs *as if* each student was paired with an "expected partner." The lack of a pure equilibrium in this design (and absence of a repeated structure that would support a mixed strategy) leaves students with a nerve-wracking dilemma. The addition of communication (pure cheap talk) to this payoff structure is meant to help students engage with their choices and consequences in a payoff-relevant setting. Whether or not cheap talk reduces (or increases) tension, it gives students a direct experience in how "commons dilemmas" can be partially reduced via assurance mechanisms that help players do the right thing (Ostrom et al., 1994; Cole and Grossman, 2010).

TABLE 3. "Expected payoffs" (grades) *as if* students 1 and 2 are paired with each other. (They are paired with other students, by design.)

		Student 2	
		Correct	Incorrect
Student 1	Correct	B, B	B, A
	Incorrect	A, B	C, C

5. The flow of the course

Students do not usually understand the "play within a play" structure of the course until they *experience* working within a group dependent on voluntary cooperation that is trying to get a larger group to reduce free riding. This slow revelation is useful because students are more interested in solutions to problems they face personally, and their experience makes them return and reflect on the theory they may have read in haste (if at all) only a few weeks prior.

The course timing is designed to reveal challenges over time. In week 1, we discuss the definitions of CPRM problems. Students are assigned randomly into "too large" groups (more below) and told to find a CPRM problem to tackle, i.e.,

> Your group must identify a *real* CPR challenge and analyze its origins, consequences (costs and benefits) and persistence (barriers to change). You will suggest *and attempt to implement* one or more solutions to this challenge and report on how and why your efforts succeeded or failed.

In recent years, students have addressed CPRM dilemmas with bike parking (bikes outside stalls increase congestion), elevators (skipping the stairs increases congestion), the study area (talking disrupts study), the laundry room (wet laundry needs to be moved or gets dumped on the floor), the garbage area (bags left at the entrance block others from putting bags in dumpsters), Facebook (excessive cross-posts in numerous groups increase search time), and student governance (a lack of a platform for consensus decreases student voice).

When choosing their project, students know that it must address a valid CPRM problem and produce measurable, useful results against baseline data within the 8 weeks of the course. Section 6 discusses their project results.

By week 2, we are a few chapters into Ostrom et al. (1994). The book's organization matches nicely with the course development, progressing from theoretical models in Part I through laboratory testing of those models (falsifying predictions of free-riding Nash Equilibria, for example) in Part II to descriptions of (non)working CPRM-mechanisms in Part III. In the beginning, students assume that plans and promises will result in outcomes. After a few weeks, they start to understand how some of their ideas are unrealistic. By the end of the course, they are more humble about the challenge of CPRM dilemmas.

As an example of this process, consider Olson (1965, p. 53), who writes:

> The greater effectiveness of relatively small groups... is evident from observation and experience as well as from theory. Consider, for example, meetings that involve too many people, and accordingly cannot make decisions promptly or carefully... When the number of participants is large, the typical participant will know that his own efforts will probably not make much difference in the outcome...

Compare that excerpt to these (anonymous to them, known to me) replies to a question that's asked in week 3 for the first (of three) progress surveys: "How could you or other members improve the team's work?"

> "I could take some more initiative instead of just helping when the others ask for it."
>
> "I have asked my group members in the Facebook group whether they were available, but there were only negative responses or no responses at all."
>
> "Communication could be better in the team, not all members respond to questions or attend the group meetings."

> "We could possible choose a leader, because it's hard to coordinate with so many members."

Although I dropped Olson's book in the most recent version of the course (we were using his book when students gave these replies in 2014), we still discuss his insights on (non)cooperation in larger groups. Students really understand Olson when they experience the struggles he describes.

By week 4, we are nearly done with Part II in Ostrom et al., students are between homework 1 and 2, we have discussed the (anonymized) results from the first progress survey, and students are presenting their own CPRM examples. It is at this point that we have The Quiz (described above), which pushes them to think about trust, dependency, and asymmetric information. Students are not allowed to talk during the five minutes they have to answer the question ("what's 1+1?") and most of them take the full five minutes — perhaps hoping that others will answer correctly if see thoughtful angst.

Most of the learning benefit from The Quiz comes from debriefings via an online survey and class discussion. In the online survey, I ask "What was your strategy?" "What do you think others' strategy was?" "What would you think/feel if others did *not* pursue your strategy?" and "What would you say/suggest as a means of increasing the number of people answering 1+1 = 2?" We then use their anonymized answers to motivate an discussion on risk, communication, repeated games, and so on in class.[8]

In the most recent year, all students answered "2," but that didn't happen the first time I gave The Quiz, when one student wrote "3" and another scratched out their answer. I had not thought to run a debriefing survey, but those answers gave me an opportunity to make sure that those two students really wanted me to assign a zero score to two other students. I wrote the following email to the students:

> Hi everyone,

[8]To read and appreciate the diversity, humor and angst of student responses, please visit the online annex at [URL TO BE ADDED].

> The quiz results were interesting. A few of you answered the question incorrectly, which means that a few of you (randomly) are scheduled to get 0/10 points on the quiz.
>
> My girlfriend suggested that this result may not be intended, as it's possible that incorrect answers were given in the belief that everyone else was going to do so (rather than, say, trying to lower another's score for no reason or to raise one's *relative* score*).
>
> To allow clarification, I propose the following:
>
> Those few of you who answered incorrectly can stay with your answers *or* reduce the points lost by another student by taking 0-10 points onto yourself, i.e., you will decide how many points they will lose and you will lose, as long as the total is 10 points. Oh, and please send a brief explanation of why you're changing your decision that I can share, anonymously, with the class.
>
> I will assume you want to leave things as they are *unless* I get an email with the point change and explanation by 23:59 tonight.
>
> Best,
>
> David
>
> * That strategy is unlikely to work. The course "curve" is based on the *top* score, not the average. The odds of hitting that top student are 1-in-14, and that student is unlikely to be 10 points ahead of everyone else anyway.

We had a long discussion in class on the fact that two of their peers had defected. In private emails, one of those students wrote "I made a 'mistake' in my answer, and do not feel as if someone who answered correctly should pay for this. Therefore I would like to lose the 10 points." The other wrote:

> I would like to reduce another student's loss of points but I still want to stick to my position to an extent, knowing that I chose to defect in the first place, without any mean intentions simply out of curiosity,

> I guess. Therefore I would lose 4 points and someone else 6, instead of 10.
>
> I indeed thought many others would be defecting as well. . . I thought it would be too easy if we all cooperated in terms of grading and that some would be defecting which would be unjust with regards to other players and myself. I guess that's the reason why I defected but now, as the rules of the game have slightly changed, I decide to reduce someone else's loss.

At the same time as I was reading these emails, another student suggested "sharing the pain" among all the students, such that everyone lost the same number of points. This suggestion would have nullified the quiz results, as I had already promised to increase everyone's course grade by the number of points it took to raise the top student's score to a target of 95 percent (A).[9] I agreed to distribute the points in that way, provided students voted unanimously — and anonymously — in favor of the proposal. They did, and everyone cheered their collective success.

In week 5, I swap 30-40 percent of (randomly chosen) students among groups, without warning. At this point, students are not too surprised by another change, but they are annoyed that they need to rearrange themselves, redefine roles and tasks, and introduce their new members to the informal institutions that the group has already created. (Grades on group assessments for swapped students are prorated 50/50 between their old/new groups.) We often practice "trust falls" (one student falling backwards into the arms of two other students) after The Swap, as this exercise is both fun and effective in actually building trust.

In week 6, we finish discussing Ostrom et al. (1994). By this point, students are usually well on their way to understanding their CPRM dilemma and the impacts of their intervention(s). They are often putting a lot of energy into trying out last-minute ideas, while pushing others in their groups to devote more time to the group project. In many cases, we talk about how to measure impacts when their baseline

[9]Our administration later said this adjustment violated a rule. I found another way to honor it.

data do not seem to be compatible with their actual interventions or "unexpected" outcomes.

In week 7, students give in-class presentations of their projects and receive feedback. Presentation grades are based on the following equally-weighted criteria: project justification using baseline data, intervention rationale and results, challenges and surprises, lessons learned, and a one-page summary handout.

Groups use presentation feedback to prepare their final group report, which is due in week 8. For their final report, half the grade depends on economics (i.e., need/analysis/incentives/intervention), 15 percent depends on writing quality, and 35 percent depends on their "practical success relative to the difficulty of the CPR challenge." Many students are exhausted by the time they turn in their reports because some students need to make up for others who fail to deliver on time. Just after handing in their report, they fill in the third, and last, survey that focuses on lessons learned, i.e., "what was the best part of your project and team work?" "What part would you have done differently, if you had to do it again with new, random partners?" and "What lessons have you learned that you would apply to future team projects and/or common-pool problems?" These questions (and the allocation of percentage shares to team mates) help students vent at partners who failed and recognize those who really helped.

If the schedule allows, we usually meet later that day (or week) to have a potluck dinner in which everyone brings food and drink to share with others. The dinner presents another opportunity for free riding, but we usually get plenty of good food (and many bad jokes).

6. Results

All classes produce learning outcomes for students and provide insights to instructors, but this course is also designed to improve CPRM in and around LUC. In this section, I will give some feedback for each of these areas.

When it comes to CPRM dilemmas that student groups tried to mitigate, most interventions had temporary benefits that endured in proportion to their impacts

on formal and informal institutions. Bike parking got a little better, but limited supply means that even small defections result in problems with using the space. There are still signs in the parking area asking students who are "feeling strong today" to put their bikes in upper racks (these slide out and tip down, so bikes can be lifted onto them and then tilted up and slid back in), so the parking is better than when it started. Elevator crowding has returned to pre-intervention levels and is often used as an example of dysfunctional congestion and bad design. Noise in study areas has improved somewhat, with signs suggesting that students talk in one area and study quietly in another. Results for the laundry room were improved due to efforts to clarify confusing or non-functioning systems, but there are still problems with students occupying machines for too long, and all the baskets provided to keep wet laundry off the floor have been stolen. The garbage areas are much better due to the rearrangement of dumpsters within (newly) marked areas and signs reminding students to toss their bags properly. The situation with Facebook (too many groups and reposts) has slightly improved, but bigger gains will not come until LUC's students and administration have built better (non-Facebook) channels for communicating events. The group's efforts to improve communications on Facebook have definitely pushed reform efforts forward. The student governance project collapsed as soon as the team disbanded, as there was nobody to organize meetings or push for future actions.

Although these results do not impress, students have helped by calling attention to issues and encouraging others to get involved. In this year's course, students made the very helpful suggestion that new student orientation week have an extra "informal norms" segment, to push LUC out of suboptimal path-dependencies. That idea may address a number of annoyances that had not received enough attention in years past. It may be useful to note here that LUC was founded in 2010, so this course has been useful in identifying and addressing issues that other schools may have worked out long ago. On the other hand, I've been surprised every year by the issues that students identify and tackle, so we may be seeing helpful interventions far into our future. Institutions take time to build.

For student learning outcomes, we can look at anonymized quantitative and qualitative feedback on teaching evaluations in the past three years. On the quantitative side, three classes gave average scores of 4.5, 4.2 and 4.4 (out of 5.0) to the question "this course stimulated critical thinking" and scores of 4.3, 4.4, 4.4 in reply to the question "the instructor stimulated my interest for the subject of the course." Similar classes at LUC average scores of 4.2 and 4.3 on critical thinking and stimulated interest, respectively.

On the qualitative side, students were invited to give any feedback they wanted. Most of their negative feedback was that the course was "too much work." This response may suggest that this course would be easier to run across a 10- or 16-week instructional period, but it may also reflect the difficulty of coordinating "too many" group members and/or efforts to reduce free riding. Besides comments of that nature, students also wrote: "a strength of this course is that it combines concepts of economics and sustainability and applies it to real world problems." "The book was really annoying to read but in retrospect I am glad you made us struggle through it as I now really understand the concepts better!" "Quite intense course, however very worth is in the long run. Learned so much that can be applied in and out of class."

Turning other data, it is interesting to see that the standard deviation in percentage shares allocated in peer evaluations (recall Section 4.3) did not fall as projects advanced, as would be the case if team cohesion was improving over the project's duration. In two runs of the course divergence *increased* in later evaluations, which meant that students were giving more credit to some of their peers and withholding more credit from others. Those results might reflect friction within teams over work effort — an issue mentioned in their written comments and visible in class discussions. In response to "how could you or other members improve the team's work?" a typical reply was: "They could do what they said they are going to do. Last week was okay but the week before that we had some internal deadline's and X was the only one together with Y and I who actually kept to the deadline which is very annoying. So I am curious to see how the internal deadline we set for coming

Monday will turn out. People also sometimes do not communicate clearly which makes it difficult to get things done. . . ”

Those remarks were from the second feedback in the most recent running of the course. In their third (and final) feedback form, students said the following:[10]

What was the best part of your project and team work?

- Delving deeper into LUC’s problems and also to see how some people bitch about the smallest things.
- . . . we actually got to improve the Facebook groups at LUC. The best thing about the team work was that it actually reflected our readings.
- . . . to see the entire project come together. There were a lot of ups and downs as well as stressful moments, but we were able to really bring everyone and all the parts together.
- . . . we got other people to get enthusiastic about solving the problem. It feels that the community of LUC is actually more aware of certain rules on Facebook.
- Seeing that I can rely on my team to self organize and make an effort. I think we were relatively similarly motivated.
- That we actually got to have an event and create something that has the potential to make a difference. This really differs with other assignments I have done so far, where you just produce something that only your teacher is going to look at.

What part would you have done differently, if you had to do it again with new, random partners?

- Having more coordination, meaning that less work falls on one person and more work to 3 or 4 people. Even if that person is keen it’s not fair for them or the rest of the group.

[10]These verbatim responses were sampled one out of every three forms, shifting for each question (student 1 then student 4 and so on for the first question, student 2 and then student 5 and so one for the second question, etc.), such that each student has one response here.

- I would communicate more of my thoughts with the team and start sooner with the theoretical framework part.
- Identify the CPR problem immediately, and why it is a problem, if possible by the end of week 2. Having the exact same idea of what the CPR problem is will reduce any conflicts that may arise with regards to progress of the project.
- I would have chosen a different topic as it was hard to quickly learn about the structure of LUC as an exchange student.
- I would've had more present and straightforward goals that we had to perform. Also, I would've had a stronger enforcer (surprisingly, we didn't).
- Instead of asking "everyone" to give feedback or do something, I would ask specific people because "everyone" is essentially nobody.

What lessons have you learned that you would apply to future team projects and/or common-pool problems?

- I have learned that it is not very easy to do a project in a very big group, and in order to do a good job, there should be a good plan, division of labor and starting a project earlier.
- Probably that internal team dynamics are not nearly as important if the external actors are not properly informed of your change.
- Transparency is important, and everyone should be keeping track of what they are doing. In that way stuff is not left until the end.
- I need to learn to be passionate, dedicated and involved without having to take over the whole project.
- Don't trust others to be right. Communicate misunderstanding of different perspectives.
- Communication really is key to a good group project. Free riding is extremely annoying and super difficult to stop.

These responses demonstrate how students took meaningful lessons from their projects and team interactions. As their instructor (and behind-the-scenes spectator), I learned a lot from the differences between how they perceived themselves and were perceived by others (on surveys) and how they presented themselves and/or their projects (in class sessions). This course helped me appreciate different student personalities from a useful and new perspective.

This course has also changed my teaching style. I spend more time talking over incentives, intentions and interactions with students in class because I realize how my presentations or the textbook may be perceived in different ways. These interactions have improved my teaching in other courses.

From a professional perspective, the course has also opened or contributed to a number of conversations on the provision of public goods or appropriation of common-pool goods at LUC. I don't just have a deeper perspective on how students study (or do their laundry), but also how they struggle to bring issues to the attention of the administration. The course has also helped me think of ways to improve knowledge sharing among professors (e.g., new papers or teaching techniques) — an essential practice in any department, but especially important with LUC's model of interdisciplinary teaching and research.

7. Discussion

Every teacher must present facts and theories within the time and space constraints of the classroom, with the hope that students will be able to relate those ideas to their experience and apply theory in the real world. In some subjects, the distance between the classroom and outside world is quite small. In others, it is large — making it harder for the teacher to transmit useful knowledge to students. Experiments and experiential learning make it easier to bridge the gap by putting the ideas into a "model" context that is more familiar to students yet simple enough for teachers to explain.

Some economic subjects can be hard for students to understand on first exposure, and the details of our complex theories and models can create barriers to student

comprehension. CPRM can fall into this category when it is presented in pure game theory form or via examples of tropical villagers and other unfamiliar scenarios. This course reduces those problems by putting students into "large enough" groups to make cooperation is a challenge at the same time as those groups try to improve common-pool dilemmas that directly affect their lives.

Students come out of this course with a much stronger idea of how theory translates into reality. They understand Olson's analysis of collective action problems from their own frustrations and negotiations. They appreciate Ostrom's distinction between a common-pool situation and dilemma because they have tried to modify institutions to improve outcomes. They see how CPRM problems are not only relevant to academic economists but every discipline and group interaction. They know why repeated interactions are supposed to improve cooperation but not guaranteed to succeed. "Free riding," "incomplete contracts" and "institutions" are no longer vague words but important elements in the design of interventions and their success (or failure). Students even have a bit more respect for "what works" in the world around them, i.e., institutions reflecting years (or centuries) of evolutionary effort rather than random chance or the biases of dead white men.

I designed this course to teach CPRM to students from different academic and social backgrounds, but the course has also taught me and improved the commons at LUC. I hope you can use some of these ideas for your own teaching.

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