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A Computer Simulation Comparing the Incentive Structures of Dictatorships and Democracies

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The draw of simulations is that by replicating a simplified version of reality they can illustrate the repercussions that individual choices create. Students can play the role of a judge, an ambassador, or a parliamentarian and can experience first hand how their decisions play out. As a discipline, we assume that such practices are an improvement over textbook-based lectures. However, sometimes the difficulty implicit in designing and implementing large-scale or semester-long simulations can be a tangible drawback to their adoption. This article discusses the use of simple, small-scale computer-based simulations or games and argues that they can be used as an uncomplicated way of implementing active learning goals. The authors argue that small-scale simulations can be used as a discreet, one-time game that assists student comprehension of complex theoretical concepts. In order to assess the effectiveness of the simulation, the authors conducted a randomized experiment where participants were assigned to a traditional classroom lecture or a class using a computer game simulation. Student performance was evaluated by a posttest and a delayed posttest. Results show strong evidence that epigrammatic simulations are as effective as traditional classroom lectures in the short run and produce better concept retention in the long run.

Keywords comparative politics course, computer-based simulation, randomized experiment, student learning

The goal of any interactive educational game is to produce real-world choices within a simulated reality (Dorn 1989; Jones 1995). Much has been written about the efficacy of these strategies as teaching tools. The general consensus is that simulations work because they motivate students to learn, they effectively get complicated concepts across, they improve a sense of rapport amongst students, they enhance the classroom environment vis-à-vis the professor, and they help students empathize with the difficult decisions others have to make (Dorn 1989). Furthermore, simulations enhance student learning because they get students to use higher order thinking skills in the decision-making process that the traditional class setting may not always do (Rackaway and Goertzen 2008). Pedagogically, the main drawbacks to using simulations might be the lack of empirical findings linking their use to positive learning outcomes. The strongest critics argue that much of the evidence is anecdotal in nature (Kahn and Perez 2009; Wheeler 2006) or lacks methodological rigor (Frederking 2005; Shellman 2006).

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Computer-based simulations, like any type of simulation, bring active learning dynamics to the classroom. Today, we see very clever uses of large-scale computer-based simulations being implemented in political science lectures with much touted success. For instance, simulations that replicate the security concerns of countries in an anarchic world stage are very powerful teaching tools that can illustrate a host of international relations theories. However, there are some drawbacks concerning cost and programming expertise that might dissuade wider use. We propose that short computer-based games can produce similar learning outcomes without many of the downsides inherent in experiential learning[1] strategies. Lectures that incorporate brief simulations can focus students' attention and can enhance learning by providing an interactive activity that encapsulates the lecture's teaching objective. Epigrammatic simulations do not supplant the lecture but instead reinforce the learning experience. As evidence of their efficacy, we compare the learning outcomes, as measured by a posttest and a delayed posttest, of two groups of students who were randomly assigned to an epigrammatic simulation or a standard lecture.

The use of computers to play simulations in the classroom represents several important tradeoffs that must be carefully weighed. Using a computer can present an alternative space that traditional in-class simulations cannot. Where noncomputer simulations may ask students to imagine they are in the United Nation Security Council, litigating before the Supreme Court, or negotiating a deal in a Congressional subcommittee, a computer-based game can depict that scene with varying degrees of reality. This is not to say that in every situation computer-based simulations are superior. Computer simulations have multiple drawbacks. Considerations of cost, setup time, and the steep learning curves associated with learning how to program a simulation can be high barriers for many. Additionally, some learning objectives cannot be achieved playing a simulation against a computer. For instance, Asal and Blake (2006) point out that because computer-based simulations preclude face-to-face interaction they do not develop students' interpersonal skills. Alternatively, simple epigrammatic computer simulations can set the stage for very interesting postgame lectures of the main teaching points in ways that a traditional class lecture cannot. Brief games can be cheap, easy to setup, and they might not take much in the way of programming expertise.[2]

The Simulation

We used Olson's 1993 article on the incentive structure of anarchy, authoritarianism, and democracy vis-à-vis economic development as the basis of the simulation on account of its straightforward logic. Olson uses a very clear narrative to describe how a few simple choices bring forth significantly different development outcomes.

Q2 To create the simulation we used Java script with a PHP interface.[3] Java script, a derivation of Java, is a web-browser-based programming language that is simple to use and can produce a very polished looking program. We encourage readers to play with the simulation, which is located at http://www.digitalworld-construction.com/RovingBandit/RovingBandit.html. In order to minimize setup time the game was intentionally designed to be simple and intuitive. In the following section, we provide an overview of the basic rules and a brief description of
Q3 how to use the simulation.

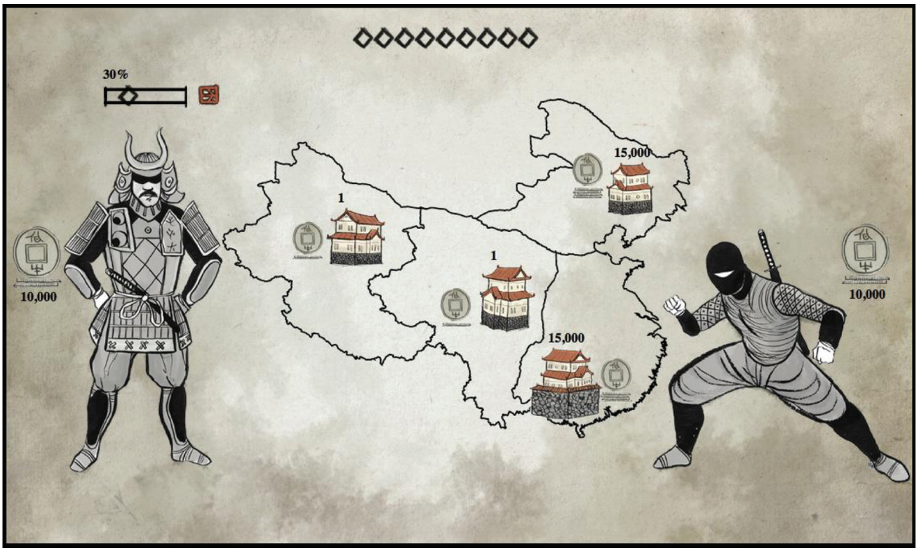

Figure 1. Roving bandit videogame interface. (Figure provided in color online.)

Playing the Game

Each student plays the game individually against the computer, and he or she can take the role of a roving bandit, a sedentary warlord/autocrat, or a democratically elected leader. What role a student chooses to play is determined by the strategy he or she employs. The object of the simulation is to make more money than the computer, which always plays as a roving bandit. The game is designed to simulate four core ideas of Olson's work: the perils of anarchic violence, why roving bandits become stationary bandits, the optimal taxation levels for democrats and authoritarians, and the incentive structure of authoritarians with short time horizons. Students have 10 turns to outmaneuver the computer. The game keeps track of how much money the player and the villages make. By clicking on the coin next to a village or by clicking on the structure, the player chooses to pillage or defend a village, respectively. If the player chooses to defend a village he or she must choose the optimum level of tribute the villagers must pay. Those who choose to extract as much as they can from villagers follow the autocrat's strategy while those who extract a moderate level follow the democrat's strategy.

Since the game is fairly simple, we recommend that the students be given only a minimum of instruction and be left to play by themselves. Once it is apparent that most students are playing the game, we suggest that instructors invite students to share their scores with the class. Students with the highest scores should be asked to volunteer their strategies and instructors should highlight the relationship between the strategy and the work of Olson. Each time a new strategy is deduced students should be given the opportunity to play the game implementing the new tactic.

Testing the Efficacy of the Simulation

We opted to use a randomized experimental design to strengthen the anecdotal claim that simulations improve student learning. Up to now, most claims in support of the efficacy of simulations were anecdotal or the product of quasi-experimental studies (Baranowski 2006; Frederking 2005). To our knowledge, this is the first use of a true randomized experimental design in our field to test the pedagogical efficacy of simulations. Randomized experiments, under the right conditions, can do a lot to strengthen our claims that simulations do work. In what follows, we present a model for the use of randomized experiments to evaluate the potential benefits of using simulations in the classroom.

Study participants were recruited from an introductory political science course on comparative politics. The class fulfills a common curriculum requirement and attracts students from a variety of majors. Arguably, students in the study represented well the general population of any small liberal arts school. In the seventh week of class, participants were asked to attend an extra class session to makeup for a class lost due to the professor's attendance at a conference. Those who attended were offered participation points. The class session was held on a Friday afternoon instead of the regular Tuesday/Thursday morning class schedule and only lasted 60 minutes instead of the regular 75-minute class. Additionally, the class was moved to a computer lab classroom. Students were asked to prepare for class by reading Mancur Olson's 1993 piece "Dictatorship, Democracy, and Development." Students were told that due to classroom size they had to attend one of two sessions. Participants were randomly assigned to a 2:30 class, which had the simulation treatment, and to a 3:30 class, which had a traditional lecture.

The class is made up of 15 freshman, 16 sophomores, 9 juniors, and 4 seniors. Six students were absent the day the experiment took place. Of the students who were absent, four were in the treatment group and two were in the control group. Twenty-one were assigned to the treatment and 23 to the control.

From the beginning of the treatment group lecture, students started playing with the simulation. During the first iteration of the game, participants were told nothing and only were asked to give the simulation a try. Once most students had played the game once, they were asked if they had made more money than the opposing bandit. Only a handful of participants were unable to figure out how to play the game without instruction; however, as they found out there were points to be made, their attention was seized. The professor wrote the scores of the top earners on the board and asked students to play another round. Participants almost immediately jumped at the opportunity and were quickly immersed in the competitive nature of the game.

Once more, the top scores were posted on the board and students were asked to reflect on the best strategies to follow. A lively debate emerged. One participant suggested that the worst possible strategy was to play as a roving bandit; he noticed that the level of production of a village dramatically dropped if it was pillaged. His comments sparked a debate about the incentive structure of anarchy. Students who made the connection between the reading assignment and the simulation were eager to participate and explain why anarchic violence kills individuals' willingness to produce. Another student suggested that in order to make more points players must protect a village and set reasonable taxes. Yet again, a debate developed around the optimal taxation level for growth. Some students suggested that high taxes created more points while others countered that the combined score of the player and the village was lower if taxes were high. For a second time, the lessons from Olson's work were deduced; democracies, which naturally care about citizen well-being, create more society-wide incentives to produce, while autocrats only care to lower taxes when an additional unit in tax represents two units less in income.

Finally, students were given one more chance to play the simulation. Now armed with a better understanding of the pitfalls of anarchy and the benefits of a moderate taxation level, most students successfully generated consistently high scores. The few students who outperformed their classmates realized that in the last round of play, they could set the taxation level to 100% and receive a sizable boost in points. Here, once more the wisdom of Olson's paper was invoked. As a class we addressed the incentive structure of an autocrat with a short time horizon and discussed issues of dynastic succession and regime instability.

The control group lecture followed the traditional model of information processing developed up to that point in the semester. Students were asked questions to assess comprehension and were engaged in the class and overall seemed to find the material interesting. Tangible real-world examples were used to illustrate the main teaching points. Overall, the class did not deviate from previous lectures and the same teaching points that were made in the experimental lecture were covered diligently with the control group.

Immediately after both classes, participants answered a six-item posttest quiz that looked to measure how well students had understood the key points of Olson's paper (see "Appendix" for exact question wording). Of these posttest items, questions two through five were intentionally modeled by the videogame. That is, each of the learning points encapsulated by these questions reflects directly on a winning strategy. Then, three weeks later, during regular class time, participants were asked to retake the exact same posttest.

Next, the posttest and the delayed posttest were stripped of identifying information. An identification number replaced students' names. Additionally, two independent students, not enrolled in the class, also graded each quiz. Then, the averaged scores of all three coders were used to run the analysis.

Analysis

To analyze the effect that the experimental treatment had on student performance, we ran two simple Ordinary Least Squares models, one for the immediate and one for the delayed posttest. Each independent quiz item was run independently as the dependent variable on a dichotomous measure of the experimental treatment. We report the average score for the treatment and control groups. Since the exposure to treatment variable is dichotomous (0 control, 1 treatment), we report the y-intercept as the average score for the control group, and we report the y-intercept plus the regression coefficient for the treatment variable as the average score for the experimental group.

The results for the immediate posttest suggest that students who interacted with the videogame did as well as their counterparts in the traditional lecture (see Table 1).

Table 1. Immediate posttest

	Q1	Q2	Q3	Q4	Q5	Q6
Q4 Treatment	7.57	8.18	8.54	7.58	7.55	6.58
Control	7.47	7.99	8.79	7.15	8.24	6.46
N	38					

$^{*}p$ value < .05.

Table 2. Delayed posttest

	Q1	Q2	Q3	Q4	Q5	Q6
Treatment	6.84	7.23*	8.28*	7.03*	8.03*	6.37
Control	6.18	6.03	6.95	6.35	6.55	5.96
N	36					

*p value $< .05$.

Since both groups had read the paper and had discussed the key concepts in class, it is not surprising for the null hypothesis to hold. In other words, both the traditional model of information processing (the normal lecture) and experiential model of learning (the epigrammatic simulation) are equally as proficient at conveying the teaching points as measured by the posttest. The more surprising findings occurred three weeks later when students' comprehension was measured again. It turns out that, in the four items modeled by the videogame, participants in the experimental group performed significantly better than their counterparts in the control group (see Table 2). On average students who used the simulation were better at explaining how anarchic violence stops development, identifying the incentive structure for roving bandits to become sedentary, saying why democratically elected leaders do not elevate taxes to the revenue maximizing level, and identifying how short time horizons distort authoritarian's incentive structure. In the questions not modeled by the game (questions one and six), both groups did equally well. Because students who used the simulation only outperformed their counterparts in the traditional lecture group in the four items specifically modeled by the simulation and did as equally well in the two items not modeled, we make the argument that the improvements are the product of the simulation and not the product of chance differences between the groups. Taken as a whole, we find that students who played with the simulation retained more of the information and were better able to recall it weeks after the game was played.

Discussion

The significant boost in the delayed posttest scores is suggestive of an effect product of the simulation; however, it does not say much about the mechanisms by which students' performance was improved. We speculate that one possible explanation is related to how an epigrammatic simulation enhances the subsequent class lecture. It is possible that giving participants the opportunity to reflect on why different strategies produced different outcomes and then making them replay the game with the optimal theorized strategy in mind magnified their retention. In line with Kahn and Perez (2009) who borrow from Lantis (1998), we agree that an important part of what students' learn takes place after the active learning portion of the class is done. It seems that the key is in the quality of the discussion that transpires during the debriefing or structured reflection portion of the class session. We speculate that when students have the opportunity to reflect on what worked and what did not and then are prompted to try again, the teaching objectives are assimilated in a way that is easily recalled later.

Perhaps, the important difference between the control group and the experimental group is not just the epigrammatic simulation by itself, but the simulation in tandem with the debriefing. In our study, we found that as we asked students to give the simulation one last try, after the debriefing took place, several students experienced moments of realization when the game theory logic of Olson's argument made something close to intuitive sense. Although we did not plan to systematically measure differences in demeanor between groups, we noticed that in the experimental group students were verbalizing "ahas" and physically nodding their head. In contrast, during the control group lecture, few if any "oh, I got it" moments occurred.

The experiential model of learning as discussed by Dorn (1989) is an improvement over the traditional lecture model because students learn by interacting with an application, then they try to understand the outcomes of their actions, subsequently they attempt to elucidate the general principles at work, and finally they apply these principles to a similar instance. We speculate that in a typical classroom, such moments only come about when students take the initiative to ask for clarification, at which point the professor can make clear the issue and thus reinforce the teaching objective. The difference is that in the traditional lecture model of teaching it takes student initiative to seek clarification while in an experiential model this dynamic is built into the class structure.

Appendix

1. How are the conditions that bring about a strong democracy related to those that bring about economic growth?
2. From the perspective of Olson, why is anarchic violence so bad?
3. What are the benefits to the bandit to become stationary?
4. Even if the incumbent democrat has the same incentive to push the tax rate to the revenue maximizing level, why does he or she not?
5. How does the behavior of individuals living under autocracy change when the autocrat has a short time horizon?
6. How does Olson explain how democracies came to be?

Notes

1. See Dorn (1989) for a detailed discussion of experiential models of learning.
2. As a suggestion to readers interested in creating their own computer simulation but lack the time or the skills necessary, we recommend that they leverage their institution's resources. The programming abilities necessary to create short computer simulations, as the one discussed here, are within the capabilities of an average junior majoring in computer science. With the help of a willing colleague in a programming-related field, an intermediate programming class, for example, the production of the simulation can be undertaken as a class project.
3. Copies of the program are available upon request.

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