



USING WEB SIMULATIONS OF EXTENSIVE-FORM GAMES IN UNDERGRADUATE COURSES

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INTRODUCTION

Simulations and web-based tools are becoming increasingly common techniques for teaching in undergraduate courses. This study examines one approach to building such tools. By combining the parallel structures of extensive-form games, experiential simulations, and the simple language behind the World Wide Web, it is possible to combine content, pedagogy, and presentation into an effective approach to learning. The online simulation of an extensive-form game is a form of active learning understood as activities that require the student to participate in using a body of knowledge to accomplish some practical task. To test the effectiveness of simulations, we surveyed students in a course that used a simulation of the legislative process in the United States Congress in an introductory American government course and compared student reported participation in and preparation for the simulation to both self-reported and direct measures of student performance. Results show that students perceive improvement in performance, but this is contradicted by the direct measures, which show no evidence that simulations are effective means of improving student performance on assignments. While several reasons for this may be present, this study concludes that simulations, and active learning in general, more likely improve students' affective orientation toward the course material, especially their confidence in their ability to use the material, than their achievement of specific traditional learning objectives.

WEB-BASED SIMULATION OF EXTENSIVE-FORM GAMES

Political situations in which players interact by choosing strategies in order to maximize utility are commonly modeled as games. Such situations include many commonly taught in undergraduate classes. Key to understanding concepts of strategic deterrence, cabinet selection, election strategies, or legislative processes is the extent to which actors interact strategically or in which institutional structures shape that interaction. Games are usually modeled in one of two forms: a strategic form in which strategy combinations are mapped onto outcomes in a matrix, and an extensive form which charts a path through a series of strategy choices by the players to a unique outcome dependent on the path followed. The extensive form is particularly valuable in the classroom, as it illustrates certain lessons that are best learned by examining the full process of interaction. The ways in which players can use backward induction to predict the behavior of other actors and choose their strategies accordingly or in which institutions enable or prevent certain strategies either outright or by influencing the outcomes

that result from those strategies, for example, cannot be taught effectively by looking at outcomes alone. The same can be said for understanding the limits to the rational choice paradigm in general, such as problems of actor identity or of endogenous or unstable preferences. These problems might be transparent in a strategic form game but become readily apparent when one must analyze behavior at specific nodes in a game.

Extensive form games are modeled as a series of nodes, representing points at which actors must make a choice, and branches representing strategies that can be chosen at that node and which lead to other nodes at which other actors may make a choice. Nodes are divided among the actors corresponding to their place in the sequence of interaction; they can also be assigned to chance with an associated probability distribution among the branches from that node. Each series of nodes and branches leads to an end node associated with a particular outcome of the game, which actors can evaluate in relation to a defined preference function over the set of possible outcomes. The full set of nodes and branches is referred to as a *game tree*. Numerous complications, such as imperfect information can be integrated into an extensive form game (Morrow 1994).

A simple example of a strategic political interaction that is effectively modeled as an extensive form game is Mutually Assured Destruction. In such a game, one superpower is given the opportunity to launch an attack, and the other must respond to an attack if it comes. (One might assume for the sake of simplicity that if the first does not attack, the game is restarted with the roles reversed, since the decision of the responder is identical to that of the initiator.) If the first superpower chooses not to attack, the game ends with the status quo maintained. If they do attack, the second superpower may choose to respond in kind or not. There are thus three outcomes: no attack, victory, and Mutual Destruction. The utility of each outcome superpower is the gain from destruction of one's opponent (V) minus the loss from one's own destruction (presumably infinite).

The virtue of the extensive form game can be seen in Figure 1. Students can see that there is no possibility of arriving at the outcome of victory for either superpower. In the event of attack the other superpower will respond in kind, since the utility to be gained from counterattack, while still exceptionally low as long as V is any finite value, is still greater than negative infinity. In the event of attack, the responding superpower *will* inevitably counterattack. This is not clear from the strategic form game without more significant knowledge of equilibrium solutions in game theory. By grafting additional games onto this starting point, moreover, the extensive form can also be used to illustrate the destabilizing effects of anti-ballistic missile systems, by showing how they reduce the cost of counterattack to the attacker to, in the immortal words of Kubrick's General Turgidson, getting one's hair mussed, but that this in turn increases the threat of preemptive strike before the system can be deployed.

One approach to teaching students either the interactions in a particular extensive form game or how to analyze such situations generally is to use simulations. Simulations are representations of a real-life situation that require a learner solve a complex problem (Morrison, Ross, and Kemp 2004). In simulations, learners are typically exposed to branching stories that prepare them for common situations that may be encountered in practice (Aldrich 2005). Gredler (1996) identifies two types of simulations: experiential simulations and symbolic simulations. In symbolic simulations, the participants are not part of the process, but instead control variables in populations of events in order to understand relationships or principles. But in experiential simulations, participants take control of decision making in given situations, taking on roles in order to perform complex tasks in which different paths can be followed. A simple simulation of a customer service situation is illustrated in Figure 2.

Gredler distinguishes between games and simulations as learning techniques. Participants are competitive in games; participants in simulations are taking on a role. Games are often played in a linear fashion, while simulations are nonlinear (often referred as branching), where participants' choices lead to different outcomes. The last difference is the

mechanisms employed in the games and simulations. In games, there are rules to follow in order to win, and in simulations, there are variables that change over time and reflect authentic processes. From this it is clear that the term *game* as it is used in game theoretical social science is closer to Gredler's use of *simulation* than her use of *game*. The emphasis on maximizing utility for an actor as defined exogenously, on branched structure, and on working through processes are clearly parallel to the basic principles of the extensive form game. This suggests that simulations can be used to teach political situations that can be modeled as extensive form games. The actors of the game define the roles to be played by the students, while the nodes and branches of the game tree form the basis for the branched structure of the simulation.¹

A means of presentation is necessary for this pedagogical tool, however. One means of doing so is, of course, to simply model the game in one's lecture notes and play through the game in class with the students choosing strategies as a group. While this can be useful, it is often unexciting, its outcomes can appear to be arbitrary rather than determined in advance (the only evidence of cause being the instructor's—unseen—notes), and it offers students little room to explore their own ideas in relation to the situation and compare them to the concepts underlying the simulation. It is also limited to use during class time. An alternative, however, is presentation on a web site. The constant availability of a web page allows the simulation to be used outside of class as well as in an appropriately equipped classroom (requiring only a computer and projector). The ability to integrate graphics and other stylistic features makes the process more exciting in both environments, and the need to have previously established structures enhances the sense that outcomes are directly related to strategies. Since students can play through the simulation in many environments, they can explore the situation and choices in many different ways, using a variety of strategies to see the varying consequences of different choices given the underlying concepts.

The ease of design for basic web pages is an added asset. While most contemporary organization web sites use advanced scripting that requires formal training, and software such as Adobe Captivate is available to produce sophisticated simulations especially of software procedures, neither is necessary for simply classroom simulations. Writing a basic web page and linking it to others requires no more skill than ordinary word processing. The language of simple web pages, Hypertext Markup Language (HTML), consists at its most basic of text to be displayed and simple tags that define how it is to be displayed. This can be learned very easily in a matter of a few hours at most, and the web is full of guides and references to basic HTML page design. In addition, many word processors will save documents as HTML, and commercial web design software such as Adobe Dreamweaver and Microsoft FrontPage is widely available on most campuses (FrontPage is often installed along with the ubiquitous Microsoft Office suite, though it has been eliminated in Office 2007). Creating a web based simulation is within the skills of most faculty members who are comfortable with basic computing.

One of the most significant advantages, however, is that the structure of web pages can easily parallel that of both extensive-form games and experiential simulations. The relationships among pages are defined by links from one page to others. These structures can take many forms. In a linear design, pages are linked in a simple series, with one page linked forward to only one other page and backward to one previous page; readers are meant to start at the first

¹ One might note as well that the term *simulation* also has a meaning very different from *game* in social science, where the former generally refers to computer-based models of an iterative social interaction. This paper will henceforth use the term *game* as it is used in social science to refer to a model of strategic interaction that relies on mathematical game theory, and *simulation* as it is used in instructional technology to refer to the pedagogical technique of role-based choice in the context of a branching process, except as otherwise noted. This choice of terminology reflects only the interests of this paper with social scientific games and pedagogical simulation and not a conclusion about the overall utility of either distinction.

page and end at the last. This structure might commonly be used to present a simple lecture, with each concept in the lecture presented as an individual page. Webbed designs have multiple links to and from each page with many paths that can be followed among the pages; users may start at a central location in some designs or at multiple locations in others. An online, cross-referenced encyclopedia (such as the Wikipedia) is a good example of a webbed design.

Most relevant to the use of extensive-form game simulations is the hierarchical design (see Figure 3). Such designs typically begin with a single page, from which one may choose to follow several different links to other pages. Pages continue to branch from the secondary pages, forming a hierarchy of pages from the beginning page to ending ones. In a strictly hierarchical system, there is only one path to each page; in practice there may be more than one path depending on the degree of overlap among secondary pages but there will rarely be many such paths. The typical university web site is an example, beginning at a home page, taking the user to a secondary set of pages for academics, admissions, student services, athletics, alumni, and other information, and ending at the office or resource that the user is trying to find. Most individual professors' web sites are also hierarchical, with secondary pages for research, teaching, and personal information that branch to specific courses or research papers.

This last structure of pages and links is identical to those of the nodes and branches of extensive-form games and of the situations and decision of experiential simulations. The three parallel forms thus constitute a unified structure for the substantive content, pedagogy, and presentation of a wide range of political situation that might be taught in political science courses (Table 1). Varying the presentation of the game from simple presentation of situations, possible actions, and consequences to formal specifications of information sets and utility functions can make such simulations effective for teaching both substance and method as well as making this tool an appropriate method for classes at many different levels. Every political situation that can be modeled as an extensive-form game can be taught using a simulation and presented with a web site.

EFFECTIVE SIMULATIONS AND ACTIVE LEARNING

Researchers and practitioners have long asserted that learning by doing is far more effective than learning by telling. Learning through simulation and modeling is seen as a vital and powerful method for humans to gain experience (Brown 2006). The learner learns by "manipulating the model" in simulations (Romiszowski 1984) such that the consequences of the course of action resulting from the participants' choices reinforces learning (Gredler 1996). Multimedia simulations of software or human interaction are thus sometimes referred to as performance-based instruction, which "focuses on performance which is characterized by exercises that simulate work and contrasts with 'traditional' instruction, which focuses on the transmission of content" (Brethower 2000, 491). Simulations allow the learner to build skills while safely engaging in a 'real world' activity. Where task-reinforcement is designed as not to reinforce inappropriate strategies, domain-specific knowledge is integrated as a "systematic strategy for addressing a multifaceted situation," and cognitive strategies, which can differ widely in each participant, are taken into account when dealing with the complexity of problem solving. Gredler (1996) argues that simulations can be effective means of promoting learning.

Simulations should thus be understood as an active learning technique. To say this, however, is to say much less than one might think, as the literature on active learning gives little firm guidance in what active learning truly is. Definitions of active learning are often less than helpful. One commonly cited definition holds that active learning "instructional activities involving students in doing things and thinking about what they are doing" (Bonwell and Eison 1991).

Prince (2004) defines active learning as “any instructional method that engages students in the learning process.” Active learning is contrasted with passive learning, which suffers from an equally vague definition. Dolan, Mallott, and Emery (2002) define passive learning as “being disengaged during formal, curriculum-based interactive activities.”

These definitions pose fundamental problems for the idea of active learning, and are probably a major source of the hostility toward it in faculty offices. As Prince acknowledges, these definitions include virtually all learning activity that goes beyond simply sitting in a classroom expecting to learn by one’s mere presence and perhaps by remembering and repeating a few key phrases—“learning by osmosis” as it has been put. Few serious educators would believe that the student who is sitting in the classroom, listening to a lecture and hoping to string together the words on an exam a few weeks hence but doing little else is, in fact, learning. The distinction between active and passive—usually equated with traditional—learning in this sense maps nicely on to a distinction between learning and non-learning. The arguments for the effectiveness of active learning techniques would thus be arguments against a very weak straw man.

If this were all that the active learning literature could offer then it would be worthy of the most dismissive criticism of many faculty members. But the arguments in favor of active learning rely for their force less on formal definitions than on paradigmatic examples found as active learning is operationalized. Here one finds significant differences between active and traditional learning. Bonwell and Eison preface their definition by stating that “students must do more than just listen: They must read, write, discuss, or be engaged in solving problems. Most important, to be actively involved, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation.” They suggest that simply modifying traditional lectures to allow students time to consolidate notes and integrating short writing assignments with class discussion are active processes. Prince gives as his key examples of active learning processes that involve collaboration, cooperation, and problem-based learning. In fact, it is not uncommon for research on active learning to dispense with definitions altogether than use only examples, such as the “mixture of lectures, in-class writing assignments, structured debates, role plays, guided discussions, and out-of-class group research projects” used by Alex-Assensoh (2000). Again, Dolan, Mallott, and Emery form a useful contrast; at-risk students who exhibited passive learning behavior were “reluctant to actively participate in dissections, small-group discussions and problem-based learning.” Definitions aside, it is these practices that are being tested in studies of active learning, and that should be taken as constituting the approach.

The common trait in these activities is direct student engagement through practice. Whether students must collaborate, cooperate, or problem-solve; write, debate, or role-play, students who are engaging in active learning are taking the knowledge that they have found in the classroom and using it practically to answer a question, come to an agreement, or accomplish a task. This does in fact pose a significant difference between active and traditional learning that is not trivial. Traditional learning aims at the presentation of knowledge so that students understand its intellectual structure, and places full responsibility on the student to take such actions as are necessary to achieve that understanding. Active learning, on the other hand, can be defined as activities that require the student to participate in using a body of knowledge to accomplish some practical task. The first and last elements—required activity on the part of the participants and accomplishing a practical task—seem to be the common thread in the active learning movement.

However, this definition also reshapes the relationship between active and traditional learning. For the most part, the tone of the active learning movement is that active learning is to be preferred to passive learning. But if active learning involves the use of some body of knowledge to accomplish a task, that body of knowledge must already be present for active learning to be successful. A good example is a workshop in which the authors recently participated. The participants were assigned the task of reading a summary of one of

Oklahoma's ecoregions and explaining it to the class. This is a nearly paradigmatic example of active learning. It was also a fundamental failure: the students merely read back the highlights of the descriptions in ways that made clear that they did not understand the fundamental relationships that make up an ecoregion. Without an understanding of the concept of an ecoregion the participants could not actively learn. Traditional learning—reading a text and listening effectively to a well-structured lecture—is the source of the knowledge that active learning uses, without which active learning is unlikely to be effective.

True active learning builds on traditional learning. It does not dispense with it. This explains why simulations can be successful, and also the preconditions needed for that success. Simulations present the opportunity to put knowledge into practice in a controlled environment. Participants have the opportunity to use their knowledge to solve problems effectively, thereby gaining a deeper understanding of the underlying knowledge. But for a simulation to be successful, there must be a background of knowledge that the student is putting to use. Otherwise the simulation is pointless, as the student has no knowledge to more fully appreciate. Successful simulations thus require a foundation of traditionally taught knowledge both as a means of structuring the simulation and as a basis for student participation in it.

SIMULATION DESIGN AND USE

Not any simulation will take advantage of the active learning potential of this approach. There are several major design considerations in creating an effective simulation that are relevant to the types of simulations that might be developed by a faculty member who is not a specialist in web design. In designing the simulation, the chief advice is to make the simulation appropriate to the audience. In general, advice that is appropriate for developing other class activities applies equally well to these simulations. The easiest place to run afoul of this need is in the specification of the extensive-form game used in the simulation. In general, a simulation is not likely to be effective if it relies on a level of formal specification that is beyond the background of the students, for example, the use of a game that can only be solved effectively by identifying Nash equilibria in an introductory American government course.

However, it is also important, Gredler argues, that choices and outcomes be directly related to the underlying concepts that students are expected to use in the simulation. Outcomes that appear arbitrary are unlikely to allow the students to use course material to solve problems of practice; success will seem to depend on intuition or guesswork. This is as important in “wrong” responses as in those that are effective uses of the material. It may be fun to punish a wrong answer with nuclear war, and humor may be an effective way of communicating an outcome especially to non-majors, but if the outcome is not a consequence of the game it will serve only to tell the student that their answer was wrong and not to allow the student to understand the underlying concepts through practice.

One practical suggestion is to limit the scope of the game. Each node in the game is a decision that a student will need to make, and more importantly, a web page that needs to be created. Increasing the number of decisions to be made and options to be considered proliferates the workload in creating the web site quite literally exponentially. Simplification is the key. Assuming that all strategy combinations lead to the same number of nodes, the number of pages to be created is equal to $s^d + 1$, where s is the number of strategies available at each node and d is the number of decision levels in the game. Having three decision levels and two strategies at each level involves a manageable nine pages, but adding one more strategy at each level raises the number of pages created to a demanding 28. Beyond the obvious approach of limiting the number of moves and strategies available at each move, one effective strategy for keeping the number of pages to be created reasonable is to allow some strategies

at early decision levels to lead directly to end nodes rather than new choices, truncating the simulation when that path is followed. A simpler game will often make the point as effectively (and can in many cases do so more effectively, as the message is less likely to get lost in the minutiae) with much less work.

The use of the simulation can be enhanced by effective measures before, during and after the simulation is played. It is important that the students be prepared for the simulation with an effective understanding of the underlying body of knowledge on which the simulation is based. If active learning can only complement, not replace, traditional learning (whether in the form of lecture or reading), then a traditional presentation of that knowledge is a prerequisite for using simulations effectively. This is especially the case when the simulation is designed to help the students integrate several different concepts. In more independent contexts this can be accomplished by a linear web presentation of the material followed by a simulation; this could be a particularly helpful technique in online courses. Even when using the simulation in a traditional classroom, the authors' experience suggests that a review of underlying concepts before beginning the actual simulation is helpful.

When playing through the simulation, it is important to stress two factors. The students should give reasons supporting their decisions where possible. This reinforces the way in which the simulation links reasoning and the underlying knowledge base in the moment of decision that practice presents. Students may frequently guess or default to an answer that they assume is correct because they remember the conclusion of a concept but not the supporting reasoning. The essence of active learning is not the choosing of the correct answer but the use of the students' reasoning capability to reach that answer; thus a correct answer based memorizing that "Don't Attack is the Result of MAD" is no more useful in a simulation than in traditional learning.

It is also important that the students be repeatedly and consistently reminded that the game is a simplification of reality and not a mirror-like reflection of it. Given the both the practical and pedagogical need for simplification, realism is at most a minor objective of simulations. But the authors' experience with the simulation described below suggests that many students may take the steps included the only ones in the process, the strategies described as the only formally available ones rather than a limited selection, and the outcomes as following by mechanical rules rather than causal forces or the behavior of other actors. A universally repeated set of strategies for every node that varies only in detail reinforces this notion.

Finally, the use of a simulation should be followed by a debriefing of the students to clarify and reinforce the lessons learned. Students should be able to explain why the outcomes occurred given their decisions; this is the central aim of the simulation itself. This can be done in several ways. When students play through the simulation independently, a single summary page at the end of the simulation that the students go to from any end node is a minimum; describing the reason for the specific outcome of a path on each end node page is more substantial. A page of review questions that students must ask themselves is less likely to be effective unless there is some form of follow-up, for example, requiring the students to turn in the answers or discussing them in class. In-class use of simulations provide the opportunity for more general discussion; time for such discussion should be reserved.

TESTING EFFECTIVENESS: THE CONGRESS SIMULATION

An example of a simulation of the sort described above is the Cameron University Congress Simulation. This simulation has been used in both online and traditional introductory American government classes since Fall 2006, all taught by the author. It uses a web site of 24 separate pages to teach students about the relationships among the institutional structure of the process, the strategies that are likely to be successful, and the substance of laws passed by Congress.

The core insights behind it are that the structure of multiple veto points in the process makes negotiation, cooperation, and compromise necessary for legislative success, and that this in turn most commonly results in incremental rather than revolutionary change through Congressional action.

The simulation is based on the American federal legislative process expressed as an extensive-form game. The game consists of a simplified legislative process consisting of three decision levels: the Senate Committee on Environment and Public Works, the Senate floor, and the Conference Committee. Within this game, students are placed in the role of a Senator from Missouri that wishes to pass a bill appropriating \$75 million for flood control projects. At each decision node, the actor has three of the following four strategies available: stand on principle, negotiate, take the path of least resistance, and play “political hardball.” A response from some actor follows, in each case treated formally as a chance act (i.e., one not controlled by a conscious player) with $p = 1$, which then moves the game to the next decision node for the student or an end node.

The student must guide the bill through the three steps in the simplified legislative process such that the responses from other actors will maximize the amount of money appropriated for flood control and minimize wasteful spending on other projects. The specific situation is described in each node, and each general strategy is given detail appropriate to the step in the simulated process. As in the case of the real-world Congress, most paths lead to the bill failing; the three successful paths all involve negotiating in at least two of the three steps including the Conference Committee. The payoffs of the successful outcomes vary and are measured by money appropriated; unsuccessful outcomes involve either the death of the bill in Congress or a presidential veto, and have equal payoffs of no appropriation. The structure of the simulation can be seen in ; the relationships among strategies, outcomes, and payoffs in Table 2; and a sample web page representing a decision node in Figure 5. The entire simulation is available online at <http://www.cameron.edu/~jajohnson/courses/1113/congress-sim/index.html>.²

The simulation is generally used in two ways. In both the online and traditional classes, students are instructed to play through the simulation individually outside of class after completing the assigned reading on Congress from an introductory textbook and, in traditional classes, attending three lectures on Congress including one on the legislative process. The individual exercise concludes with review questions to which online students are required to submit answers. In the traditional classroom, the students also work through the simulation as a group led by the instructor. This class exercise begins with a review of the principle of multiple veto points and its consequences. The class works through the simulation at least once, discussing the merits of the different strategies at each node before choosing, selecting a strategy to be pursued, and reviewing the consequences of all other strategies advocated by the students before moving to the node associated with the selected strategy. The exercise concludes with a discussion of why certain strategies were successful and which were not.

The simulation aims to develop more than just knowledge of the legislative process. Students in the course are evaluated on the basis of two relevant assignments of nearly identical structure: an out-of-class paper and an in-class essay exam. Both assignments test the reasoning skills that the simulation aims to develop. On both assignments the students are given a reading or other resource regarding some political event in American politics (a brief paragraph for the exams and a set of documents or multimedia files for the essays) and asked

² The simulation as described above is the current version of the simulation. Note that the simulation as it is now has changed slightly from that used during the semester that data was collected for this project, primarily in response to preliminary data used in this study. The major difference is the reduction in strategies per node from five (including all four described above and a resign option) to the three described above. This should enhance effectiveness somewhat, making the data analysis below a conservative estimate of the effectiveness of such simulations.

to explain a specific concept relevant to the resource and then use that concept to answer a question about the resource. For example, on one paper the students are asked to review campaign statements from a Democrat and a Republican, explain what classical liberalism is, and determine whether each candidate is a classical liberal. This ability to apply course knowledge to draw a conclusion about political practice is precisely the kind of knowledge that simulations are meant to develop.

To evaluate the effectiveness of this simulation, a survey was administered to students in the Spring 2007 American government traditional classroom course to determine their level of preparation for, participation in, and self-reported measures of improved understanding from the simulation. The survey asked six questions, four of which measured the independent variables of participation and preparation. The first two concerned the students' preparation for the simulation through readings and lectures, respectively. The next two measured participation in the Congress simulation individually and in class. For each of the first four questions, specific actions were listed that the students were asked to select as indicative of their preparation or participation, with each option indicating a higher level of preparation or participation. The final two questions asked students to evaluate their ability to make effective predictions about the legislative process and the degree to which they felt that the simulation had improved their understanding of the legislative process as measures of the dependent variables of improved knowledge and improved reasoning. To facilitate analysis and mitigate problems with the survey data discussed below, these variables were collapsed to binary dummy variables.

To this data was added the students' exam and essay scores as direct measures of improvement. Students in the course completed three exams and three essays; one of each was completed before the simulation. The second essay question, assigned to all students, required the students to assess the probability of passage for a particular bill given the strategy that supporters were using. Four measures of performance were generated from this raw data. To measure gains in substantive knowledge of the legislative process, scores on the second essay were divided by average scores for all assignments and for essays to determine the relative improvement on the directly related essay. To measure gains in overall reasoning ability during the course, a linear estimate trend for essays and for all assignments was calculated.³

The above arguments about the nature of simulations generate two general hypotheses about the effects on the Congress Simulation:

- If the simulation is effective, students who participated more fully in the simulation should perform better on direct and self-reported measures of their understanding of the legislative process and of their ability to use course knowledge to reason through political situations than those who did not.
- If active learning is successful when it builds on traditional learning, students who prepare before participating should perform better on direct and self-reported measures of their understanding of the legislative process and of their ability to use course knowledge to reason through political situations than those who did not.

Specific hypotheses tested are as follows:

H₁: For all students, mean direct measures of performance will be greater among those students who reported effective participation.

H₂: For all students, the percentage of students who participated effectively in the simulation reporting gains in self-reported performance measures will be greater than that of the students who did not participate effectively.

H₃: For students who participated effectively in the simulation, mean direct measures of performance will be among those who reported effective preparation.

³ All data analysis was conducted with SPSS v. 10.0.7 (student version). Discussion of the weaknesses of this data follows below. Specific questions and protocols for data analysis are included in the appendix.

H₄: For students who participated in the simulation, the percentage of students who prepared effectively for the simulation reporting gains in self-reported performance measures will be greater than that of the students who did not prepare effectively.

The null hypothesis in each case is that there is no relationship between the measures. H₁ and H₃ were tested using multivariate ordinary least-squares regression and a two-tailed Student's *t* test; H₂ and H₄ were tested using a χ^2 test.

RESULTS AND DISCUSSION

Sixty students completed the survey, though seven provided sufficiently incomplete data that their results were excluded. Characteristics of the sample with respect to the independent variables are summarized in Table 3.

Results of multivariate regression for participation and preparation (Table 4) are exceptionally disappointing. No direct measures of student performance were appreciably affected by participation in the simulation. R^2 values range from barely perceptible (.044) to nearly non-existent (.003), while remaining statistically insignificant, p ranging from at best .190 to an almost improbably large .921. Direct measures of performance were, with one exception, equally unaffected by preparation among students who participated in class, R^2 ranging from .005 to .043, and p ranging from .554 to .775. The exception was the trend in essay performance, with a small but respectable R^2 of .146 significant at the .05 level ($p = .032$). However, the standardized coefficient of $-.346$ is opposite the hypothesized direction.

Treating variables individually and looking only for differences in means produced no more useful results (Table 5). Only two findings produced statistically significant results, but these findings were contradictory. While mean trend in overall assignment grades for those with participating in the simulation in class was slightly higher than for those who did not ($p = .080$), mean trend in essay scores declined for participants who prepared by attending the lecture ($p = .043$). Overall, these tests provide little support for rejecting the null hypothesis for either H₁ or H₃.

In general, the trend of negative findings was also the case for self reported measures (Table 6). Students' assessment of their abilities to understand and to make predictions about the legislative process generally bore no statistically significant ($p < .01$) relationship to either individual participation in the simulation or, for participants in class, to their preparation efforts. However, there was one quite important exception to this trend: students perceived that classroom participation in the simulation improved their mastery of the legislative process by both measures. While 78.6% of students who did not participate in class felt that they could accurately predict outcomes in the process at least some of the time, 94.9% of participants did ($p = .073$). Improvements in general understanding of the legislative process were reported by 71.8% of in-class participants but only 42.9% of non-participants ($p = .053$). While the data thus does not support rejection of the null hypothesis in the case of H₄, the null hypothesis can be rejected in the case of H₂.

Overall, then, this study provides contradictory evidence for the idea that simulations improve student performance but none for the idea that prior preparation improves the effectiveness of simulations. The ambiguities in the former require explanation. There are several possibilities. Two weaknesses in this study could explain the contradiction. The survey instrument was not designed with the intent of collecting statistically analyzable data. The initial aim of the survey was to collect basic information relevant to the use and value of the simulation from the students' perspective solely for use in classroom use. As such, the question wording and structure is ambiguous and not adequate for more than simple binary analysis. Some responses logically entail others whether the student indicated so or not. Poor question wording caused noteworthy problems of logically inconsistent responses. Four students, for example,

reported that the Congress simulation improved their understanding while reporting at the same time that they did not participate in the simulation in any form. The direct measures of student achievement should also be more specific and detailed protocols produced to enhance the reliability and validity of these measures. The unique structural characteristics of this simulation make communication worthwhile and, together with increasing emphasis on active learning techniques in campus administrative processes, suggest the value of assessing what evidence of effectiveness is readily available. But clearly much more effective data is possible. Collecting it is a priority for further assessment of this simulation.

A second problem with the study is structural. The design considerations described above were investigated after the initial creation of the simulation. This simulation was not designed with these considerations fully at hand. Several weaknesses result. The simulation is appropriate to the audience, and outcomes are clearly related to the concepts: strategies that are not based on negotiation, cooperation, and compromise generally lead to outcomes in which an individual or small group blocks the student's legislation, reflecting the central premise of a system of multiple veto points. The simulation is complex in terms of the number of nodes and strategies (hence the number of pages created); however that complexity is not apparent to the student. However preparation, giving reasons for one's actions, feedback on individual actions, and debriefing take place outside of the simulation itself. This is a very significant limitation on the value of the simulation when used individually. Finally, the simulation is played through only once in class, which limits the extent to which the students can gain practical experience with the concepts. Improvement in these regards may produce clearer results of effectiveness.

But the contradictory findings of this study may also reflect underlying problems with simulations in themselves. It is not unreasonable to conclude from the results that simulations are not effective learning tools. The only evidence supporting their effectiveness is the students' own perception of improvement; all other tests were either statistically insignificant or contrary to the hypothesis. Since simulation is a paradigmatic active learning technique, this would bring into question the effectiveness of active learning in general. The results of this study cannot show conclusively that active learning is of limited value, especially given that a reasonable body of evidence supports the effectiveness of active learning. But one cannot deny that active learning did in this case struggle with a test that one could have expected it to pass, a conclusion that has been found in other cases as well (Wingfield and Black 2005).

There may be a reason for this, however, that does not eliminate the value of active learning in general or simulations in particular. Comparative studies of learning media have shown in many cases that differences in the medium of presentation do not translate into differences in achievement, especially with regard to grades on assignments (Clark and Mayer 2003). But other effects have been noted. Good (2004) found that the use of online simulations of laboratory procedures in a biology laboratory course improved students' efficiency in completing the assignments but not their grades. As in this study, Sottile and Brozik (2004) found that teacher education students reported better understanding of human development concepts after a traditionally presented role-playing simulation, though they did not test that understanding directly. These studies suggest that the value of such techniques may not be found in cognitive achievement of learning objectives but rather with affective dispositions toward using the material learned. This conclusion would not only be consistent with but also would explain the contradictory findings of the study: self-reporting reflects not conceptual mastery but students' self-confidence in their use the material, which would not be reflected in direct measures of achievement. Active learning, and especially simulations, would be valuable tools for increasing the students' comfort level with the material. This is a worthy end in itself.

CONCLUSION

Such a conclusion would still call into question the often unthinking, manta-like devotion to “student-centered active learning environments” that seems to be increasing common in university mission statements, faculty evaluation procedures, and faculty position announcements. Active learning is ultimately praised in many circles because it is seen as a more effective tool for teaching achieving measurable assessment objectives. The findings of this study, while certainly of a preliminary nature and in need of further refinement and investigation, cannot express confidence in such views. Based on the evidence in this study, the commitment to active learning may be rooted as much in ideology as in demonstrable results.

That commitment may further reflect a divergence in the goals of the educational process between the advocates of active and traditional learning. The former likely maintain a strong, and in some cases primary, commitment to the shaping of students’ identities. The latter likely value the acquisition and use of information, practical skills, and intellectual competence as the sole goals toward which education are oriented. Unlike the competing claims regarding effectiveness, this is a quintessentially philosophical question to which no amount of observational or formal inquiry will provide an answer. Realistically both positions are likely to be overstatements of the reasonable positions that most instructors hold: students should not only have knowledge and be able to use it, but they should feel confident in their ability to do so. Seen in that light, this study suggests that simulations are valuable tools in the undergraduate political science classroom.

APPENDIX: SURVEY AND DATA PROTOCOLS

The study population consisted of students in three sections of Cameron University's introductory American Federal Government course during the Spring 2007 term. Total enrollment in the three sections was 135; however, based on grade data, between 80 and 85 were actively involved in the course at the time of the simulation. Participation in the simulation was required through normal attendance in class; individual participation was voluntary but encouraged. Participation in the survey was voluntary. Students received extra credit equivalent to 4.5% of their course grade for participation, and were informed that if they did not wish to participate they could simply provide their student ID number in the first question and then not answer the remaining questions (21 did so). Surveys were not anonymous so that responses could be matched with assignment grades and so that participation credit could be awarded, but data was stripped of identifying information once data match was complete. Participants were informed that data would not be reviewed in an identifiable way other than to match survey responses and assignment grades. The survey was administered on the Blackboard online course management system, which was already in use in the course.

Participants received the following instructions in the online survey form in addition to similar instructions in class:

This survey is designed to help me evaluate the usefulness of the Congress simulation. Because this is a survey that is about helping me make the course work better, your honest answers are important and will not be held against you in any way. Your answers will be compared to your grades on the essays to help me determine if simulations like the Congress Simulation help improve your ability to analyze political events.

This survey will not be used for any other purpose, nor will any personally identifiable information be used or stored outside of Blackboard. Your name is included in this solely to match this data up with other data from the course and will be deleted before data is analyzed or stored in any other form.

Please answer each question below to the best of your knowledge. You should select more than one answer if more than one answer applies. For example, if you read the chapter of the textbook and took notes, select answers 1 and 2 to question 1.

The survey consisted of one question to allow Blackboard processing of extra credit for participation and six questions assessing preparation for, participation in, and perceptions of the Congress simulation.

Question 1: Please Enter your Student ID Number.

Question 2: Did you read the section of the textbook that described the process of how a bill becomes a law? (1) I took notes on the textbook. (2) I read the section textbook. (3) I skimmed over the textbook. (4) I did not read the textbook at all. (5) I don't know or decline to answer.

Question 3: Did you attend the lecture in which we discussed the legislative process? (1) I took notes on the lecture. (2) I attended the lecture. (3) I received lecture notes from someone else or printed out the lecture notes from Blackboard. (4) I did not attend the lecture. (5) I don't know or decline to answer.

Question 4: Did you play through the Congress Simulation on your own? (1) I played through the Congress Simulation on my own more than once. (2) I played through the Congress Simulation on my own once. (3) I succeed in passing the bill at least once. (4)

I did not play through the Congress Simulation on my own. (5) I don't know or decline to answer.

Question 5: Did you participate in the Congress Simulation in class? (1) I felt that I understood the simulation well when participating in it. (2) I took notes during the in-class simulation. (3) I participated in the simulation in class. (4) I did not participate in the simulation in class. (5) I don't know or decline to answer.

Question 6: How well do you feel about your ability to predict whether a bill will be successful in the legislative process based on how its supporters are trying to get the bill through the process? (1) I feel that I could make an accurate prediction most of the time. (2) I feel that I could make an accurate prediction some of the time. (3) I feel that I could seldom make an accurate prediction. (4) I do not feel that I can make any predictions. (5) I don't know or decline to answer.

Question 7: Do you feel that the Congress Simulation improved your understanding of what it takes to get a bill through the legislative process successfully, compared to the textbook and lecture alone? (1) I feel that the Congress Simulation greatly improved my understanding. (2) I feel that the Congress Simulation improved my understanding somewhat. (3) I feel that the Congress Simulation did not improve my understanding. (4) I feel that the Congress Simulation left me with a worse understanding than the textbook and lecture alone. (5) I don't know or decline to answer.

Students were also provided with an opportunity for open ended responses, which were not analyzed in this study.

The inconsistency in answer choices and orders required separate protocols for collapsing each variable. Two main principles were used to guide the creation of protocols: that the key distinction was between active effort and passivity rather than between formal presence or absence, and that protocols should reflect that some answers logically entail others whether the student indicated so or not. Answers were coded as follows:

Table A-1: Coding of Dummy Variables

	Questions			
	2, 6, 7	3	4	5
Yes (1)	1, 2	1	1, 3	1, 2, 3
No (0)	3, 4	2, 3, 4	2, 4	4

TABLES

Table 1: Parallel Structures of Games, Simulations, and Web Sites

	Purpose	Representation		
		First Point	Path	Next Point
Extensive-form Game	Content	Choice	Strategy	Outcome
Experiential Simulation	Learning Structure	Situation	Decision Made	Consequence
Hierarchical Web Site	Presentation Structure	Page	Hyperlink	Next Page

Table 2: Strategies, Outcomes, and Payoffs in Congress Simulation

Committee	Strategies		Outcome	Payoff
	Floor	Conference		
Negotiate	Negotiate	Negotiate	Passed	\$42 million
Negotiate	Least Resistance	Negotiate	Passed	\$35 million
Hardball	Negotiate	Negotiate	Passed	\$15 million
Hardball	Negotiate	Least Resistance	Vetoed	\$0
Hardball	Least Resistance	Hardball	Vetoed	\$0
Hardball	Least Resistance	Negotiate	Vetoed	\$0
Hardball	Least Resistance	Least Resistance	Vetoed	\$0
Negotiate	Negotiate	Principle	Died in Conference	\$0
Negotiate	Negotiate	Least Resistance	Died in Conference	\$0
Negotiate	Least Resistance	Principle	Died in Conference	\$0
Negotiate	Least Resistance	Hardball	Died in Conference	\$0
Hardball	Negotiate	Principle	Died in Conference	\$0
Negotiate	Hardball		Died on Floor	\$0
Hardball	Principle		Died on Floor	\$0
Principle			Died in Committee	\$0

Table 3: Characteristics of Sample

	Participation		Preparation	
	In Class	Independent	Textbook	Lecture
Yes	39 (73.6%)	17 (32.1%)	29 (54.7%)	40 (75.5)
No	14 (26.4%)	36 (67.9%)	24 (45.3)	13 (24.5)

Table 4: Regression Analysis of Direct Measures of Student Performance

	Overall Ratio	Essay Ratio	Overall Trend	Essay Trend
Participation (n = 53)				
Independent (β, p)	-.014, .921	-.038, .793	.074, .599	-.087, .542
In-class (β, p)	-.077, .589	.044, .760	.186, .190	.132, .353
R^2	.006	.003	.044	.022
Preparation (n = 39)				
Textbook (β, p)	.134, .421	.196, .240	.009, .959	.202, .201
Lecture (β, p)	.099, .554	.047, .775	-.073, .666	-.346, .032
R^2	.031	.043	.005	.146

Table 5: Student's t-tests of Direct Measures of Student Performance

	Overall Ratio	Essay Ratio	Overall Trend	Essay Trend
Participation (n = 53)				
Independent ($\Delta\mu, p$)	-.005, .879	-.007, .844	.032, .484	-.070, .504
In-class ($\Delta\mu, p$)	-.017, .560	.009, .775	.068, .080	.130, .178
Preparation (n = 39)				
Textbook ($\Delta\mu, p$)	.028, .379	.041, .221	> .001, .995	.181, .282
Lecture ($\Delta\mu, p$)	.028, .496	.018, .755	-.031, .664 ^a	-.460, .043 ^a

^a Equal variance test used: $F = 4.327, 20.420$; $df = 37, p = .044, > .001$ respectively.

Table 6: Chi-Square Tests of Self-reported Measures of Student Performance

		Predictive Ability			Increased Understanding		
		No	Yes	<i>p</i>	No	Yes	<i>p</i>
Participation (n = 53)							
Individual	No	1 (4%)	24 (96%)	0.669	8 (32%)	17 (68%)	0.482
	Yes	1 (7.1%)	13 (92.9%)		3 (21.4%)	11 (78.6%)	
In-class	No	3 (21.4%)	11 (78.6%)	0.073	8 (57.1%)	6 (42.9%)	0.053
	Yes	2 (5.1%)	37 (94.9%)		11 (28.2%)	28 (71.8%)	
Preparation (n = 39)							
Textbook	No	0 (0%)	18 (100%)	0.179	6 (33.3%)	12 (66.7%)	0.510
	Yes	2 (9.5%)	19 (90.5%)		5 (23.8%)	16 (76.2%)	
Lecture	No	0 (0%)	7 (53.8%)	0.497	7 (53.8%)	6 (46.2%)	0.119
	Yes	2 (5%)	30 (75%)		12 (30%)	28 (70%)	
		1 (4%)	24 (96%)		8 (32%)	17 (68%)	

FIGURES

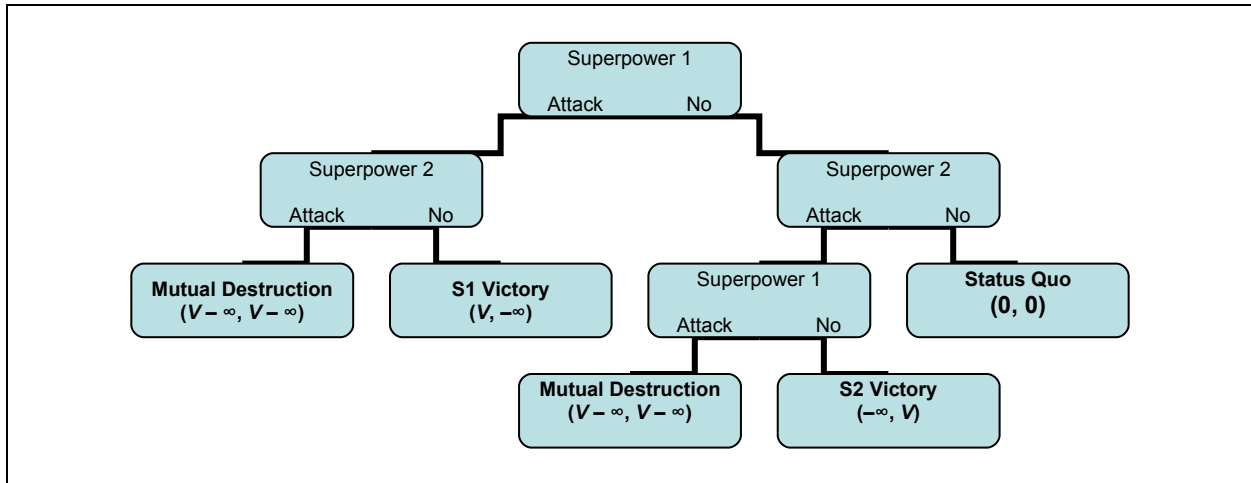


Figure 1: Mutually Assured Destruction Game in Extensive Form (End nodes in bold.)

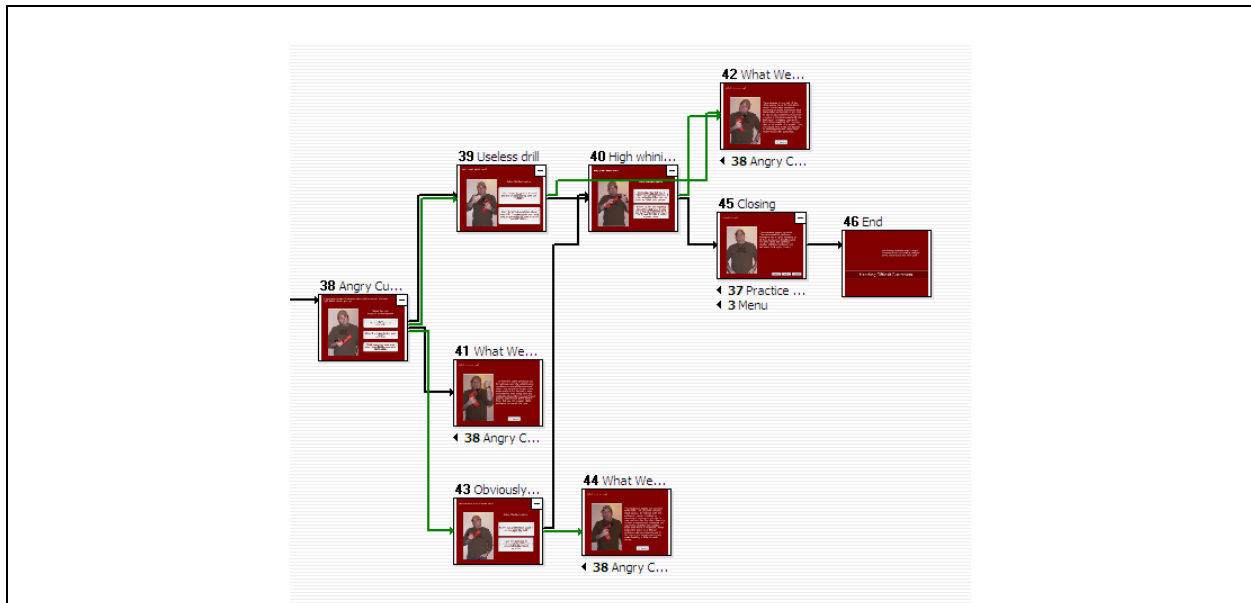


Figure 2: Branching Structure of a Customer-Service Simulation Viewed in Adobe Captivate (Moulder 2007)

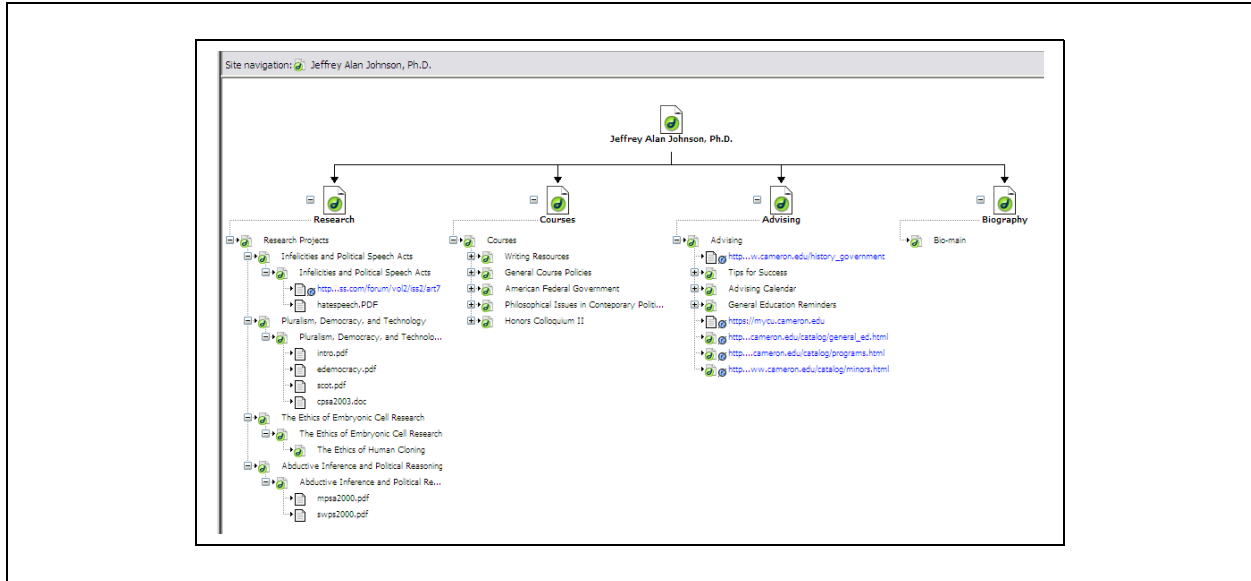


Figure 3: Hierarchically Organized Web Site Viewed in Macromedia Dreamweaver

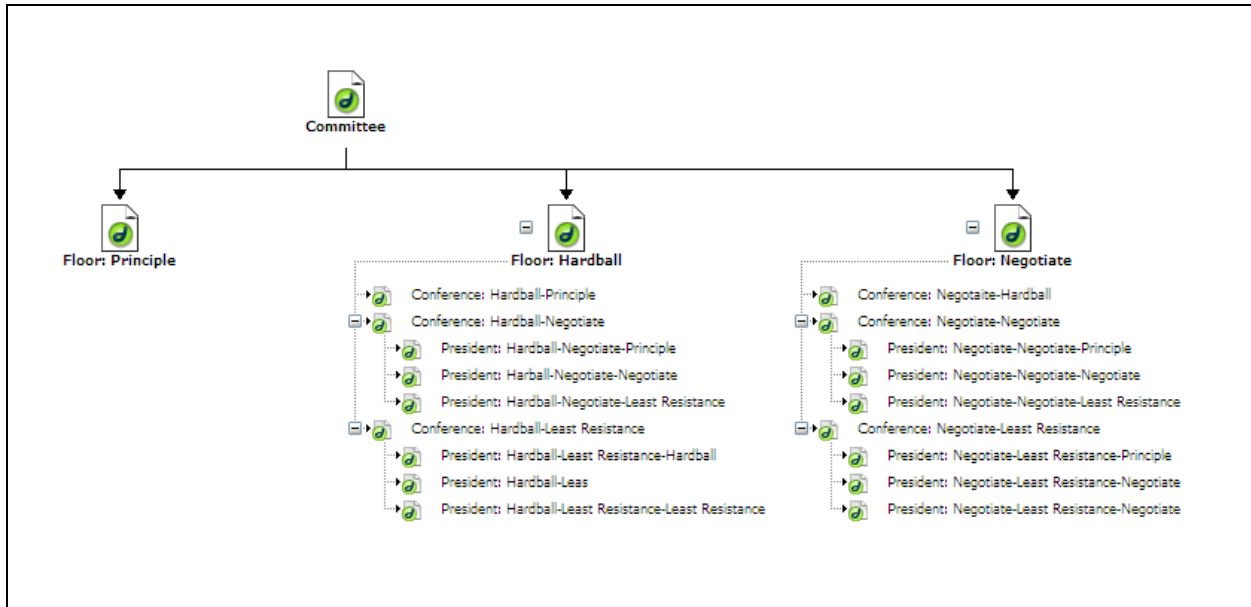



Figure 4: Structure of Congress Simulation Viewed in Macromedia Dreamweaver



Congress Simulation
Cameron University

Phase 3: The Conference Committee

Strategy and outcome of previous node

Available Strategies with links to next nodes


On the Senate Floor:
You negotiated, recognizing a weak position and taking what you could get: a small appropriation in a bill that was sure to pass. The Surface Transportation Act is on its way to the other end of the Capitol.

Outcome: S. 102, the Surface Transportation Act of 2005, includes an appropriation of \$40m for levees in Missouri. It passed in the Senate and is now before a conference committee.

In the Conference Committee
The House version of the Surface Transportation Act, H.R. 154, does not include your provision, and the House members of the conference committee don't seem inclined to include it. Conference committees usually aren't successful unless both the House and the Senate members agree on something. The House bill, however, includes a provision that would appropriate \$75m for obviously unnecessary highway repairs in the Speaker's district.

How will you get the House to include your provision in the conference report?
Click on the hyperlink to make your move.

- [Stand on Principle](#): You know that the Speaker needs to rebuild votes among construction workers and not bridges in central Kansas. Persuade the House members to seeing the light.
- [Negotiate](#): No one in the Senate is buying the Speaker's claim that this is "wise public investment." Unless he offers something in return, he's not getting anywhere. Offer \$15m for the highways in exchange for your levees.
- [Least Resistance](#): You scratch my back and I'll scratch yours. Include both provisions.



Progress indicator showing strategies followed

Current Situation

Figure 5: Sample Decision Node in Congress Simulation

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