CLASS SIZE AND GAME DESIGN

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ABSTRACT

This paper reviews five games that have been used in small classes (30 or fewer students) and in large classes (more than 50 students). The types of games and the characteristics of their use in different size classes provide insight for game developers. Analysis suggests that larger class size seems to increase the difficulty of managing games at a non-linear rate. Developers of games designed for large classes must spend extra effort to design control processes that will facilitate management of the game or simulation.

INTRODUCTION

Games can be designed to address either specific or general learning goals. Regardless of the intent of the exercise, the structure of the simulation must be able to support the number of participants. A simulation that works with groups of 20 students can fail miserably if the group size exceeds a certain critical value. At such a point, the internal workings of the simulation bog down and the exercise fails to provide adequate learning results. This paper describes five games and analyzes their effectiveness in large classes compared to small classes. Characteristics that resulted in either the success or failure of the exercise are identified.

GENERAL CONSIDERATIONS FOR LARGE SCALE GAMES

Decreases in funding for both public and private colleges and universities have forced many institutions to increase class sizes. Such pressure forces faculty to adapt experiential exercises to class sizes much larger than originally intended or designed. With proper facilities and support, it is possible to deliver lectures and administer examinations to very large groups of students, but simulations and games that are designed for a specific number of participants may not tolerate a similar scaling process. The ability to identify those experiential exercises that can be scaled and the methods used to accomplish such scaling can facilitate the development of exercises that can be used successfully with a large number of participants.

The five games used in this study are Its Puzzling (Cassidy & Brozik, 2006), Fish Banks (Meadows, 2001), The Market Game (Brozik & Zapalska, 1998), Exchange Rate Game (Brozik & Zapalska, 2002), and IndoAm Enterprises (Brozik, Zapalska, and Cassidy, 2005; Cassidy, Brozik, and Brozik, 2005). The authors have conducted these exercises a number of times with groups of from 10 to 30 participants, depending on the game. The original design parameters of these games are shown in Table 1.

During the summer of 2007, the opportunity arose to

TABLE 1
Summary Information on Five Games Originally Designed for Small Classes

	Computer Required	Number of Players	Number of Teams	Number of Administrators
It's Puzzling	No	10-30	3-6	1
Fish Banks, Ltd	Yes	10-30	3-6	2
The Market Game	No	12-30	5-8	1
Exchange Rate Game	No	12-30	4-10	1
PanPacific Enterprises	No	12-30	4-10	2

attempt these experiential exercises with groups of 50 and 100 students in an MBA program in India. Some of the games and administrative procedures were modified in anticipation of the increased number of participants, but no effort was made to change the underlying educational experience. When possible, the number of administrators was increased to backstop the lead administrator. The participants were not aware that the exercise was originally designed for a smaller group.

ADMINISTERING LARGE SCALE GAMES

IT'S PUZZLING

Purpose: "Its Puzzling" is a game used to teach communications, competition, and cooperation. Teams attempt to assemble a simple children's puzzle while constrained by rules that limit behavior and force players to adapt to these constraints. These adaptations illustrate behaviors and perspectives on various aspects of intra-and inter-group dynamics.

Objectives: To force player adaptive behaviors, the game requires teams to comply with specified constraints, but players have the latitude to innovate within and around the rules. Creative players and teams may come up with innovations that thwart the constraints. At the discretion of administrator, rules may be added during play that were not specified at the beginning of the game.

Previous Small Scale Uses of Game: In more than 10 previous administrations of this game, group sizes varied between 10-30 players, organized into 3-6 groups. It is advisable when running this game for the first time to have 2-3 administrators to enforce rules, observe behaviors, and make detailed notes for the debriefing. With some experience, a single person can run the game with 4-6 groups and 20-30 students. Typical problems requiring administrator attention include players breaking rules and what might be described as mob confusion. Such behaviors distract the administrator from taking notes during each round of play.

Use of the Game in Large Classes: In two administrations of the game in classes of more than 50 students, it was found that two administrators were insufficient to run the game. In these classes, the number of students simply overwhelmed the administrators' ability to control the game. It seems that a linear increase in the number of students requires more than a linear increase in the amount of administrator time needed for control. This seems logical given the complexity added by each additional student. Using the logic of managerial span of control (Ouchi & Dowling, 1974), the number of administrators should be proportionate to the number of player-to-player relationships in a game. If there are N students participating in a game, there will be [N*(N-1)]/2 relationships to observe and manage. Therefore, if one administrator could manage a game with 20 students, or about 380 relationships, it would take about four administrators to manage a game of 40 students with 1560 relationships. These two administrations of the game support traditional span of control theory; larger groups require a more than linear increase in the number of administrators.

FISH BANKS

Purpose: Fish Banks is useful in illustrating a problem in business sometimes called "the tragedy of the commons". It makes students aware of the insidious nature of resource depletion issues in industries dependent on renewable resources and the lack of ownership of those resources. The game is also useful for reinforcing long term thinking, performance measurement, and environmental scanning in managerial decision making.

Objectives: The students are assigned to teams representing fishing fleets and told to maximize their long term profitability. This can only be done if fishing is conducted in a sustainable manner, harvesting only as many fish each year as can be regenerated by the fish population. The problem with the competitive nature of most industries is that long term thinking devolves into short term focus on present period profits. In most cases, student performance mimics the fishing industry disasters of the last century.

Previous Small Scale Uses of Game: The authors have run this game more than 10 times in undergraduate and graduate classes. The calculations to support the game are computed by the game's software on a PC, and the game has a reasonably "friendly" interface. The administrator and the data entry can become a bottleneck when there are a large number of teams. In small scale use with 3-6 teams, data entry proceeds smoothly and there is no difficulty conducting the game.

Use of the Game in Large Classes: When the game was run with a class of 50 students organized in 8-10 teams, the large number of teams caused a long delay between team submissions and results. This delay was entirely due to the time needed to enter data into the computer. The administrators had to develop specific procedures to make the data entry process more manageable. These procedures do not reduce the large amount of time needed for data entry but do make it less distracting. There were three specific "lessons learned" that should be considered when a "data entry intensive" game on a large scale.

1. When planning the game, one administrator should be assigned solely to the task of data entry. This administrator will not interact with the teams. Teams will be prohibited from interacting with the data entry administrator.

2. Teams will be put on a schedule requiring them to submit their periodic plan by a deadline. A 10-15 minute schedule should provide sufficient time for planning, auctions, and trades. Teams should be encouraged to submit fishing plans when complete. The failure of a team to submit its plan by the deadline results in the team's fleet staying in harbor for another period.

3. If groups get noisy, rowdy, or otherwise difficult to manage, the administrators can resort to whispering instructions to the entire group. This will force the teams into silence to be able to hear instructions. Teams that do

not hear the whispered instructions will be unable to comply with the rules, and their fleets will remain in port until they comply with the rules.

THE MARKET GAME

Purpose: The Market Game is designed to introduce students to the characteristics of market structures and the nature of information flow within markets. It can be used at all levels, and variants can be created to examine specific facets of market activity.

Objectives: Students are formed into "families", and each family is given a list of items it needs and items it has to trade. The basic version of the game resembles a simple barter market, and the players must identify the relative value of their holdings as well as possible sources of the items they need. The common theme through the game and its variants is that it is necessary to develop a communications network so all participants can identify the relevant supply/demand characteristics of the market.

Previous Small Scale Uses of Game: The Market Game and its variants have been played over one hundred times spanning twenty years. It has been used in introductory economics courses, graduate finance courses, and educational communications with equal success. Class sizes have varied from 8-40, but most commonly there are 20-30 players divided into six teams. The Market Game is designed to require minimal intervention by the administrator. The lists given to the teams define the structure of the market, and participants have to discover the state of supply/demand for the various items, establish market prices, and conduct trades. The administrator at times can give teams or individuals hints or make comments about specific behaviors, but the main role of the administrator is to observe the behaviors that become the basis of the debriefing.

Use of the Game in Large Classes: There was no difficulty expanding The Market Game to a class size of 50 participants. Teams were set at five members which resulted in ten teams. This required the preparation of additional lists of items for the expanded number of teams. Previously developed spreadsheets that generate the item lists were easily adapted to the number of new teams. During the exercise, there was an increased level of activity and commotion. (In fact, there was so much noise that instructors from other classes came to the room to see what was happening.) Since there was no need for administrator intervention, the players developed their own techniques to identify market parameters. It should be noted that the administrator involved had significant previous experience with the game; there were no span of control problems in scaling the game up for a larger number of players.

THE EXCHANGE RATE GAME

Purpose: The Exchange Rate Game creates an environment where teams compete to make profits by trading foreign currency. Students are expected to learn about the dynamics of the foreign exchange markets and identify those characteristics that make certain market makers more successful than others.

Objectives: Players are divided into teams that function as separate foreign currency trading companies. Each company is given a stock of a domestic and foreign currency and asked to devise a strategy for making profits by creating a market in the foreign currency. Each team submits a bid/ask spread for the amount of foreign currency it is willing to buy/sell, and rolls of the dice determine the period exchange rate and the quantity of currency exchanged from previously specified probability distributions. The team that most quickly devises a strategy to become the market maker in the foreign currency generates the most profits and wins the game.

Previous Small Scale Uses of Game: The Exchange Rate Game has been conducted more than twenty times in upper division finance and economics classes, including classes dealing with international trade. Class sizes are usually between 20-30 students. A required step in the game is that after each round the administrator collects the bid/ask spreads from all the teams, posts these results, rolls the dice, and allocates the sales and purchases to the winning teams. After each round, the teams review their previous performance and the performance of their peers and submit a next round of quotes which is similarly processed. The game comes to a natural end when one team discovers that it can make most of the profits by submitting quotes for large amounts of currency with a very small spread. This usually takes about four rounds.

Use of the Game in Large Classes: There was no problem adapting the game for the additional number of players. It was only necessary to generate sufficient descriptive material for all teams. The play of the game was the same as with smaller groups, but difficulties began at the end of the first round when it was necessary for the administrator to gather and display the data, roll the dice, and allocate the sales and purchases to the winning teams. More time was needed to collect and display the data, and it seemed that the time was more than proportional to the number of teams playing the game. There were approximately 50% more teams than in the small scale applications, but it took almost twice as long to get the data collected and processed. It is possible that this problem could have been lessened by using a computer-assisted method of displaying the data, but the nature of the interaction between the groups and the final allocation process would not be affected. The game can be conducted in a large class, but it takes proportionately longer to complete it than in a smaller class. This again illustrates that administrator interaction with the players is a key span of control factor.

PANPACIFIC ENTERPRISES/INDOAMERICAN ENTERPRISES

Purpose: PanPacific Enterprises is a simulation used to teach unstructured problem solving in the context of a business optimization task. The simulation is intended for groups of students who have received some training in

linear programming and operations management. IndoAmerican Enterprises is an extension of PanPac to accommodate a very large number of participants.

Objectives: The objective of the simulation is for the students to discover the obstacles designed into the simulation that will prevent successful task accomplishment and find ways around those obstacles. The simulation is designed so that every group has contradictory objectives and will be attempting to communicate its goals using terminology and measurement units that are meaningless to the other groups. The successful groups will discover that communications barriers and competitive behaviors interfere with group performance and redefine group goals into common organizational goals.

Previous Small Scale Uses of Simulation: This simulation has been run more than 10 times in upper-level undergraduate and graduate classes; these classes were usually 15-30 students in size. In most administrations of this simulation, the student groups discover the communications barriers, but lacking experience involving dysfunctional organizations and contradictory instructions, students become frustrated and fail to solve the problem. This outcome is expected because the simulation was designed to be unsolvable. Groups often experience frustration at the failure of the task focus of the simulation until they are told during the debriefing that the purpose was to develop group dynamics and efficient group processes. One reoccurring observation is that some students will feel that they have little or no impact on group dynamics. These students withdraw from the simulation leaving others to the debate over a consensus solution; estimates of the size of this group range from 10-33% of the class in smaller sized groups.

Use of the Simulation in Large Classes: IndoAmerican Enterprises is a version of PanPacific Enterprises intentionally scaled for a class of about 100 students. The original simulation already contained sufficient complexity for the linear programming problem, and more complexity would have made the problem intractable. The nature of the changes was to create more functional groups in order to accommodate added students and keep the complexity level the same. Ten additional groups were created with identical objectives but with names similar to the ten existing teams. This resulted in 20 teams, two complete sets of 10 teams. To prevent the identical teams from discovering each other too quickly, the first set of 10 teams was assigned to work in one room, and the other set of 10 teams was assigned to work in an adjacent room. The two groups of teams worked independently for the first two hours and worked together in a large lecture hall for the last two hours. The IndoAmerican Enterprises exercise requires no computer data input by the administrators. The focus is in getting the various groups to recognize their mutually incompatible goals and develop a mutually acceptable final plan. The administrators act as facilitators to the communications process, and there is no predetermined or preconceived final result. The sheer size of the class required that the administrators be in constant contact with the students and be suggesting ways for them to overcome their obstacles. It must be noted that the number of students who "withdrew" during the simulation was much larger than in previous administrations of PanPac. At one point a core group of about 20-30 students dominated the discussion, and the remaining players withdrew from the decision making process. Only direct intervention by the administrators got this larger group involved as a second decision making body, a "shadow government" that devised a separate solution to the problem. This created the situation in which an autocratic and a democratic process were taking place at the same time in the same room. There were no span of control issues with this game since it was designed so that administrators played a strictly advisory role.

GENERAL OBSERVATIONS

The common factor that enabled a game to be scalable was the degree of administrator intervention required. Those games that were designed to require little or no direct administrator action, "The Market Game" and "IndoAmerican Enterprises", easily accommodated the increased number of players. This does not mean that the small version of the game could simply be applied to the larger group, but with only small adaptation, the games were successful. "It's Puzzling" required a moderate amount of administrator action, and its success required a heightened level of administrator activity. The two games that required high levels of administrator activity, "Fish Banks" and "The Exchange Game", suffered notable degradation. This does not mean that they did not provide a meaningful learning experience for the players, but the quality of that experience was somewhat degraded due to the inability of the

TABLE 2
Summary Information for the Five Games as Adapted for Large Classes

	Number of Players	Number of Teams	Number of Administrators	Difficulty of Use in Large Classes*	Suitable for Large Classes
Its Puzzling	53	10	2-3	3	Yes
Fish Banks Ltd	53	8	2-3	4	Yes
The Market Game	51	12	1-2	1	Yes
Exchange Rate Game	50	10	2-3	3	Yes
IndoAmerican Enterprises	102	20	3-5	2	Yes

*** 1=slightly more difficult, 5=much more difficult**

administrators to interact in a timely manner. Table 2 presents recommendations for the design parameters of these five games when used in large classes.

It appears that even though some of the games were more problematic all can be used successfully in large classes. Success will depend upon the administrator's ability to design information flow techniques that will facilitate rapid information processing. The bottlenecks that were observed were due to the inability of the administrators to keep up with the pace of the game due to demands on the administrators' time that resulted from game characteristics. It should be possible to take simulations that work in small classes and adapt them for large classes, but the transition will require that the game designer pay specific attention to the amount of administrator interaction required in the game.

SPECIFIC OBSERVATIONS

The opportunity to conduct these games on a large scale occurred during the summer, in two courses that are part of a joint US-Indian MBA program located in Bangalore, India. All course instructors and administrators were from the US. All the students were MBA students and natives of India. While most factors affecting the games described above would be the same regardless of location and culture, some of the above observations might be influenced by culture. Distinct differences that were noted in general student behavior, potentially affecting exercise results, are listed below.

Respect for authority: Indian students are extremely respectful of authority figures such as teachers.

Competitiveness: The Indian students were much more competitive than their counterparts in the US. This was manifested in each of the experiential exercises and the entire academic process in both classes. In virtually all cases, outcome performance seemed to take precedence over process performance. "Fish Banks" was an especially competitive game with each student team trying to maximize its short term profit at the expense of long term industry survival. In "Fish Banks", the one student who correctly observed that competitive behavior would result in the destruction of the industry and long term bankruptcy intentionally failed to tell the rest of the group because "I wanted to win." While all students who played "Its Puzzling" violate some of the constraints, rule breaking seemed much more widespread and excessive with the Indian students. In fact, there were not enough administrators to prevent rule breaking, and the rule breaking was so extensive that the students failed to grasp the learning objectives taught by the constraints. After debriefing the students and stressing the importance of the constraints, the game was re-run with similar results. Behavior exhibited during "The Market Game" and "IndoAmerican Enterprises" was more competitive than usually seen in US students, but the games were able to accommodate this characteristic.

Rule breaking: When playing "It's Puzzling", the students had recommendations about rule breaking. As a group, they emphasized authoritative enforcement of rules and scoffed at control systems based on incentives, voluntary restraint, or industry self regulation. They recommended additional administrators to prevent rule breaking. Conscripting 20 out of 50 students to help administer the game helped initially, but soon the administrators noted that the students were allowing friends to break rules while enforcing the rules on others. Administrators are ultimately responsible for the proper conduct of a simulation, and relying on players to police themselves is inappropriate.

There may have been other cultural factors that affected the outcome of the games which the administrators did not observe. While these factors might have changed the play of the game, they did no affect the ultimate learning outcome. The major results in all games were similar whether the game was conducted in the US or in India. Any such unseen factors apparently did not have span of control implications.

CONCLUSIONS

Games have been shown to be effective and innovative methods of teaching both simple and complex concepts. The use of games expands the palette of educational tools that educators can use to develop skills, knowledge, abilities, and attitudes in their students. The status of games and simulations has already been established in education, but the changing nature of education requires the continuing assessment of the efficacy of any teaching technique. As the structure of the educational environment changes, it is important to validate that any particular educational technique can be effective.

Education is expensive, though not as expensive as the lack of education. Funding is tight and probably will continue to be so for the foreseeable future for all colleges and universities. Both traditional and innovative educational techniques need to be appraised in the context of a system that results in more students being in each class. There are some traditional techniques like lectures and common examinations that have been shown to adapt to larger class sizes, but these teaching methods place limits on the entire educational experience. Games add the extra dimension to the learning experience of personal participation that cannot be achieved by sitting in a desk and taking notes. This extra dimension is not free, however. An effective experiential exercise requires a well conceived design and dedicated individuals to assure that the design comes to fruition.

This paper examined whether five established games were scalable beyond their original design parameters. The ability to use games in the large classes of the future will depend on the ability of the exercises and their administrators. Though the games used in this study addressed many different educational objectives, there was a single common factor that was critical to the ability to scale the exercise to large or small class sizes, the degree of administrator involvement. Exercises that required administrative actions for recording or facilitating actions bogged down as the number of players increased. Those

exercises that relied on the players to define their own frameworks and move within were able to scale up to a greater number of players. It seems that the critical resource is the administrator of the simulation. If the administrator must dedicate all of his/her time to the actual processing of the intermediate data, there is simply no time available to oversee the greater learning objectives of the simulation. A person only has so many hands, and once they are full, there is no room for additional responsibilities. A scalable simulation will assure that the administrator has enough hands and enough time to deal with the educational objective of the simulation.

The world of larger class sizes need not be an end to using games and simulations. The value of experiential exercises has already been proven and cannot be denied. What is necessary, however, is the ability to take proven exercises and translate them into experiences for even larger classes. In order to do so successfully, care will have to be taken so that the design of the simulation does not require extensive participation by the administrator. The administrator must be able to "go with the flow" of the exercise, and the details of handling critical information must be streamlined and made invisible to the players. This is a crucial design parameter for either creating new or adapting old experiential exercises. In some exercises, it might be possible to use technological means to ease the administrative burden and broaden the span of control, but it is ultimately the design of the exercise that allows the administrator to supervise more students.

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