

THE THINKING STEPS MODEL IN GAME THEORY: A QUALITATIVE APPROACH IN FOLLOWING THE RULES

Douglas L. Micklich
Illinois State University
dlmickl@ilstu.edu

ABSTRACT

Game theory is a mathematical system for analyzing and predicting how humans behave in strategic situations. Much research has been conducted in this area and numerous mathematical models have been suggested to explain each of these games. The purpose of this paper is to take the “thinking steps model”, a behavioral approach, and show the application in non-mathematical terms in a non-cooperative game situation using the vertical checkers game, “Connect Four”. It is hoped that through this method we can develop a better understanding on how people think in strategic situations

Keywords: Game Theory, Thinking Steps Model, Experiential, Learning

INTRODUCTION

Game theory is a mathematical system for analyzing and predicting how humans behave in strategic situations. Standard equilibrium analysis assumes all players: 1) form beliefs based on analysis of what others might do (strategic thinking); 2) choose a best response given those beliefs (optimizing); 3) adjust best responses and beliefs until they are mutually consistent (equilibrium) (Camerer, 2001). Much research has been conducted in this area and numerous mathematical models have been suggested to explain each of these “games”. These models can be, and often are very sophisticated in nature (Nage, 1999; Capra et.al., 1999)(Van Huyck, et.al., 1997). The question is how these become understandable, absent of the math, and get down to the basic concepts of the game.

Illustrating concepts in an experiential learning exercise has been used as a very effective learning tool. This form of learning also allows for the immediate feedback so that corrective action to enhance the learning process. For it was Van Damme (1999) who stated; “without having a broad set of facts on which to theorize, there is a certain danger of spending too much time on models that are mathematically elegant, yet have little connection to actual behavior. While the primary goal of behavioral game theory models is to make accurate predictions where equilibrium concepts do not, it can also circumvent two central problems in game theory: refinement and selections. Because we replace the stochastic better – response, all possible paths are part of the statistical equation. (Camerer, 1999)

The model used in this paper is a qualitative interpretation of the thinking model. The thinking model is designed to predict behavior in one-shot games and also to provide initial conditions for models of learning (Camerer, 2001). The approach taken here is to try and draw a better connection between the content of the theory and the participants’ behavior.

In the thinking model, players who do one step of thinking do in fact think strategically. This is in the sense that they are trying for the most advantageous position on the way to securing a win. The series of one-shot games will tend to contribute to the principle/rule of “looking ahead and reasoning back”, where prior moves are observable, this is the reasoning back. The part associated with looking ahead asks the strategic question, “If my rival anticipates what I am going to do, what should I do”. This is an example of a recursive “embedded sentence” or “circular reasoning” that can strain both thought processes and memory. By applying this principle/rule we try to eliminate this tendency and to move forward. This process can contribute to the ability of producing inferences and recalling past mistakes brought about by incomplete strategic thinking or missing a step, or “not thinking” at a decision point.

The key challenge in thinking steps models is pinning down the frequencies of players using different numbers of thinking steps (time when they may not be thinking). This follows in part that we assume the players to be rational decision-makers when in fact we know that there are times when they are not.

Since the thinking steps model is a cognitive model, it gives an account of some treatment effects and shows how cognitive measures, like response times and information acquisition can be correlated with choices (Camerer, 2001). Response times in this context would be the amount of time between your rivals move and your response to that move. It can be inferred that the longer the response time, the greater amount of thinking is going on when contemplating the move and shorter times associated with less or no thinking. The inference here is that either no thought was given to the move and hence it was made under some impulse or a response rule was automatically invoked that required no thinking.

Also in the area of information acquisition, players put into their memory what has worked vs. what hasn’t from their moves or “games”. From this one could predict, based on patterns, what the next move would be. This information

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

acquisition is crucial to resolving the question of whether the players are close to equilibrium. Here too, one team may come to the same conclusion as another with the only differences being the number of “steps” or amount of discussion taking place before each move is made (Camerer, 2001)

Information acquisition is also related to the amount of “reasoning back” being done when examining previous moves as well as the amount of learning that has transpired to the forward looking aspect. Strategic thinking is invoked in part by belief prompting. Belief prompting is defined as the explicit beliefs about what others will do that moves them closer to equilibrium. It can also be interpreted as increasing all players’ thinking by one step (Camerer, 2001).

The types of game being used to illustrate the rules of strategy are those classified as “non-cooperative games”. Non-cooperative games are characterized by the fact that players cannot, ahead of time, enter into binding, enforceable agreements with each other. That is, they cannot predetermine the games’ outcome (Bierman and Fernandez, 1993), they cannot collude. Non-cooperative game theory is also characterized by three key modeling principles: *strategic thinking* (looking forward and reasoning back); *best response* (dominant vs. dominated strategy); and, *mutual consistency* (equilibrium) (Camerer, 2000).

The thinking model is characterized by the number of steps or iterated thinking that the players do, and their decision rules (Stahl, et. al., 1995). This model is designed to predict behavior in one-shot games and also provide initial conditions for models of learning (Camerer, 2001). In this instance consider the vertical checkers game “Connect Four”, where the object is to get four checkers of one color in a row either vertically, horizontally, or diagonally as a series of one-shot games. The total game can be then thought of as being a series of inter-related one-shot games.

In the thinking model some players, using zero steps, do not reason strategically at all. This would include those who do not envision their strategy before undertaking a course of action, and those who do not contemplate move before making it. One of the positive aspects of this model lies in the learning that can take place as one moves towards equilibrium. The challenge which presents itself is to see how well we can account for the fine details of how one arrives at a particular solution, to be able to synthesize and analyze the process. The basis for this line of thought is a model initially developed by Camerer and Ho (1998, 1999) called the experience-weighted attraction (EWA) which was later refined into the Functional Experience-Weighted Attraction Learning (fEWA) (Camerer, 2001). Learning in EWA is characterized by changes in (unobserved) attractions based on experience. These changes can occur due to several reasons: an increasing unattractiveness of a particular course of action; forgetting; or, that old strategies are “retired” in the sense that they have not worked when

applied in similar situations in the past, the severity of the impact increasing the “remembering” aspect and decreasing the “forgetting”.

EWA is a hybrid of two widely-studied models, reinforcement and belief learning. In reinforcement learning, only payoffs from chosen strategies are used to update attractiveness and guide learning (Camerer, 2001). Reinforcing can come from two areas reinforcing strategies near their choice. These would be termed as those strategies being weakly dominant, as opposed to those further away (weakly dominated strategies), their behavior will take on the appearance of learning. Imitating a player who is similar and successful can also be seen as a way of heuristically inferring high foregone payoffs for an observed choice and moving in the direction of those higher payoffs (Camerer, 2001). This type of strategy is also known as a “Follow the Leader” strategy where move are “aped or copied” as close as one can in trying to keep an advantage for getting too large.

Imitation in the model can be seen in Table 4 - Round 3 when the rival moves were “shadowed” and Table 9 – Round 9 where the strategy was “mirrored”. It should be noted that that it is more likely for an imitation strategy to occur in the beginning of the game as opposed to the middle or end game positions. Defense type strategies such as “blocking” are more evident during middle game situations than end-game where more of an offensive strategy is warranted.

In belief learning, players do not learn about which strategies work best; they learn about what others are likely to do, then use those updated beliefs to change their attraction and hence what strategies to choose (Fudenberg and Levine, 1998). That is, analogous to simultaneously anticipating your rivals responses and seeing through your rivals strategy. Instead of linear thinking that would normally result, circular reasoning will result. The trick is then becomes in squaring this circle (Dixit and Nalebuf, 1991). The direction that one moves in when squaring is in the direction of observed best response (Selton and Stochen, 1986). To do this, learning must be present to recognize what has worked best and leads to goal attainment and equilibrium.

As the game progresses, learning occurs as it (the game) moves towards equilibrium and as such it can be seen that some strategies are more suited for early on in the game, while others are more suited for the middle game and others for the end-game. This can be seen in the “continental divide” game (Van Huych, Cook and Battalio, 1977)

APPLICATION OF THE THINKING MODEL

The rules of strategy in relation to game theory specify four distinct rules. These rules being: 1) to look head and to reason back. To be able to anticipate where your initial decision(s) will ultimately lead and to use this information

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

to calculate your best move; 2) if you have a dominant strategy, use it. Dominance is defined as dominance of one of your strategies over all other strategies, not of your opponent; 3) eliminate any dominated strategies from consideration and go on doing so successively. If during this process any dominant strategies should emerge, they should be chosen successively, and 4) having exhausted avenues of looking for dominant and dominated strategies, look for an equilibrium to the game. We are drawn to this for several reasons. First, being the need to avoid circular reasoning; this gets you nowhere. Secondly, players' interests are strictly opposed, that is they are against one another. Thirdly, pragmatism is present in that prediction of outcomes and prescription for behavior emerge from the way of thinking. Lastly, there is the need to avoid a misinterpretation of the notion of equilibrium. There is not an automatic prescription that is best for all the players of the game (Dixit and Nalebuff, 1991).

Knowledge of these rules can, in most cases, help a strategy maker to develop and implement successful courses of action based on what is observed directly and what can be inferred. In devising strategy, people are predisposed to either think strategically or not and to further use that knowledge in devising future courses of action. Knowledge itself may not be sufficient in devising and executing strategy, but it is necessary.

Strategic Thinking: Looking ahead and reasoning back

The first rule of looking ahead and reasoning back infers that a person making a choice at an earlier period must look ahead, not just to their own future choices, but to those of others (Dixit and Nalebuff, 1991). The art/skill of looking ahead and reasoning back takes the skill of "backward reasoning". Backward reasoning enables one to predict the outcome of games with alternating moves. These types of games are called games of sequential moves is defined as one in which all players make their decisions in sequenced, one after another (Bierman and Fernandez, 1993). The general point is that for the principle to apply, it is essential that earlier moves be observable to those who choose late and that the strategy must be irreversible (Dixit and Nalebuff, 1991). That is in the context of the game, once a checker is dropped, it cannot be withdrawn and re-dropped in another spot. If every player at every decision knows the actions taken previously by every other player, then the game is one of perfect information. This is opposed to simultaneous move games where the players may have to make their decisions at the same time (Bierman and Fernandez, 1993).

Sequential moves occur from the outset as one team drops the first checker. Where this checker is dropped can be perceived as being either an advantage or disadvantage, which of course, is in part dependent on the perceivers' games' perspectives. First mover advantages in this case can influence the direction of play at the outset of the game. Subsequent moves can be used to force play in a certain direction most advantageous to one team over the other. As

play continues, each team is able to see and make a record of the moves as the game unfolds. Strategy itself will then unfold with each successive move. As the game progresses strategies are implemented which are either predetermined or as the game progresses.

Best Responses: Dominant vs. Dominated Strategies

Dominant strategy:

Strategies which are predetermined usually fall into the category called "Dominant Strategies". Dominant strategies are one that for a player is one that is always strictly better than every other strategy for that player regardless of the strategies chosen by the other player. There is also the existence of a weakly dominated strategy. This type of strategy is always equal to or better than every other alternative strategy for that player regardless of the strategies chosen by the other player (Bierman and Fernandez, 1993). In this case the player can be indifferent to every other strategy (one no better than the other) available to them at that point.

When play first starts, each player will try to use their dominant strategy in trying to gain an advantage. When this happens each player has an unambiguous "best strategy" regardless of what he or she believes the other player will do and choose that strategy. This collection of dominant strategies, when they exist, is called dominant strategy equilibrium (Bierman and Fernandez, 1993). This will continue until such time when one of them is forced to change their strategy in response to the other.

Dominated Strategies:

The third rule of strategy is to eliminate any dominated strategies from consideration. If during the process any dominant strategies should emerge, then that strategy should be chosen. Dominated strategies are described as those that perform successively worse than any other strategy (Dixit and Nalebuff, 1991). It is one that is strictly worse than some other strategy regardless of the strategies chosen by the other player (Bierman and Fernandez, 1993). Just as with dominant strategies there is the existence of a weakly dominated strategy. This strategy is one that is always equal to or worse than some other strategy for that player regardless of the strategies chosen by the other player (Bierman and Fernandez, 1993). Choosing this type of strategy would be choosing the "lesser of two evils" or one in which you would "cut your losses".

Because of the options available to each player at each move or decision point, you would find in most cases a behavioral strategy being implemented where a player can choose among a series of alternative courses of action at each decision point. Where this would not be applicable is when one player has those in a row and the opposing team faces elimination on the next move. In this case a pure strategy would be implemented by one team to prevent the other from placing the fourth checker, thereby winning the game. A pure strategy exists where each player is told what

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

action to take at each decision point or information set in the game. Where this would not be applicable is where a player has more than one clearly viable option and if conditions, while created such that one player created two opportunities to win. Additionally the other team could not have been watching the board carefully. The opposing team would execute their dominant strategy thereby winning the game.

Mutual Consistency: Looking for an equilibrium

This condition occurs when you have attained or try to attain a tying position; you play to neither win or to lose. In such cases these strategies become sub-optimized as one teams' outcome is not optimized at the expense of the other. In some cases both teams would need to agree that this is the end that is deserved, else one team would execute its weakly dominant strategy to change the rules to the game. We employ these types of strategies for the following reasons: to avoid circular reasoning.

METHODOLOGY

The game being used to illustrate the rules of strategy and competition is the vertical checker game, Connect Four. The objective of the game is to get four checkers of one color in a row either vertically, horizontally, or diagonally. The board's dimensions are seven columns by six rows.

The game is played in a round-robin format with each team playing every other team. The game commences by each team deciding who is to first. Play continues by each side alternating dropping checkers until one side wins or a time is realized. After completing each game, each team is required to complete a form (Exhibit 1) in which they are asked a series of questions for the following areas: first mover strategies; strategy used in the beginning, middle and end games; if strategy changed, at what point did it occur; envisioning strategy; the ability to take back a move; and what did you learn during the game.

The main thing we are looking for are any patterns that exist in the data that would give some indication of: a dominant vs. dominant strategy; change in strategy; and any evidence of learning that may have taken place. The existence of a dominant strategy can be seen with the following teams: Executive Management (middle); Business Level (defense); Management Info Systems (diagonals) and; Human Resources (middle). More fragmented strategies were present with Marketing, Finance, Accounting, and little or no strategy with the Board of Directors and Operations.

Tables 2-10 show that the strategies which were enacted by the teams in the beginning, middle and end games and what did they learn from that game. Looking at the time of strategy enacted for beginning to end we see a few instances where the same strategy was carried through the game and numerous times when the same strategy was used from game to game.

It was found that changes in strategy were more apt to occur in later stages of the game (toward the middle and end

games) versus the beginning. This would indicate that some learning had occurred and the elimination of dominated strategies whenever you see strategy changing. The application of the first rule of strategy can be seen, for example in Table 6 – Round 1 whenever Finance learns that it is “better to take more time to think ahead” and in Table 8-Round 1. Instances such as these also show that these teams as thinking strategically because they have gone from zero steps, Table 1-Rounds 2, 4, 6, 9 and Table 7-Rounds 7 and 9 and Table 8-Round 5 to at least one-step thinking in Table 3- Rounds 1, 6, 9; or in Table 4-Rounds 6, 7 and 8, for example. Response time as a factor in the thinking steps model can be see in Table 6-Round 1 and Table 8 – Round 1.

In putting memory as part of the thinking model, we can look to Table 3-Round 4; Table 5-Round 4; and Table 7 – Round 2. We can also see another side to the ability to increasing the number of steps in this model when we see such remarks as seen in Table 4 –Round 6: “that screwing around causes you to lose”; Table 5 – Round 10: “Making the first move gives a big advantage to the group”; Table 7 – Round 2: “Strategy from 1st game didn't work for 2nd game”; Table 7 –Round 6: “It get more serious as the rounds go on”.

In conclusion, there is more to just the quantitative aspects of game theory, assuming that one is always a rational decision-maker, and although it can be difficult to show the behavioral side, this is one way in which we can see and observe “how people think” when it comes time to devising and considering strategic options

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Developments in Business Simulation and Experiential Learning, Volume 34, 2007

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Exhibit 1

MQM 385 Organizational Strategy
Connect -4 Tournament
Spring 2006

Winner: _____

Your
Team: _____ vs _____

For each round please complete the following:

1. Who made the first move? Did you see this as being an advantage?
2. Describe in detail the type of strategy you used to start the game?
3. Describe in detail the type of strategy you used in the middle of the game?
4. Describe in detail the type of strategy you used toward the end of the game?
Were you playing to win or to tie?
5. At any point during the game, did you find yourself changing your strategy? If so, in what way did it change?
6. During the game were you able to envision your strategy and try to get your rival to move in that direction?
7. At any point in the game, did you wish you could take a specific move back? If so, at what point in the game would you want to take it back?
8. During the game would you describe your overall strategy as one of passiveness, moderate aggression, or very aggressive?

Table 1
First
Mover
Advantage

| | First Move | Advantage | Record | | | |
|----------------------------|---------------|-----------|--------|--------|------|--------------|
| | | | Wins | Losses | Ties | Undetermined |
| Board of Directors | 4 | 0 | 2 | 5 | 0 | 1 |
| Executive Management | 4 | 3 | 5 | 2 | 1 | 0 |
| Business Level | 4 | 3 | 4 | 4 | 0 | 0 |
| Marketing | 3 | 3 | 3 | 5 | 0 | 0 |
| Finance | 2 | 0 | 2 | 4 | 1 | 1 |
| Operations | 7 | 0 | 4 | 4 | 0 | 0 |
| Accounting | 3 | 1 | 3 | 3 | 1 | 1 |
| Management Info Systems | 2 | 3 | 4 | 1 | 1 | 2 |
| Human Resources | 4 | 4 | 5 | 3 | 0 | 0 |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 2
Game Point
Strategies
Board of Directors

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|-------------------------------------|------------------------------------|---|---|
| 1 | Surround their chips with our chips | Make lines of chips | Playing to win - blocked their lines of chips | |
| 2 | We really didn't have one | We were always trying to stop them | Playing to tie and keep them from winning | Be more Aggressive |
| 3 | Mounting | Look only at our stuff | We were concentrating on ourselves | Pay attention to the other teams' moves |
| 4 | No strategy | We tried to block them | We just did not want to lose again | Red blends in with the board - easy to ignore |
| 5 | Bye | Bye | Bye | Bye |
| 6 | No particular strategy | We were pretty close to winning | Playing to win | We lost both ways |
| 7 | Nope | Mounting | Don't lose | We suck |
| 8 | | | | |
| 9 | We really didn't have one | | We were playing to tie | It didn't work |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 3
Game Point Strategies
Executive Management

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|--|---|---|--|
| 1 | Start in the middle; hope to bottom row them. Had 2 in rows on bottom but thwarted | We were defensive; try not to set them up for a win; match their strategy | Playing for tie; we have to defend ourselves; hoping to avoid 2 different columns | Strategy worked well |
| 2 | Put one in the middle - We won quick | <i>No entry</i> | Win | To do that everytime, if possible |
| 3 | Minimize their strategic rows; draw a diagram of the board on paper to prevent them from hearing/seeing our planning | Stack diagonally | Prevent them from getting more than 2 in a row | First move is the key to success |
| 4 | Middle first, like everytime | We tried to build as many diagonals as possible | They had us on the left side. But didn't realize it | To go first everytime Be proactive and defensive, sometime the other person gets lucky, there's nothing you can do sometimes, you have to lose. |
| 5 | Defense | Defense | Aggressive; playing to tie | |
| 6 | | | | |
| 7 | We attacked middle of board, 1st row | We were offensive | Same as offensive - win | That we're a winner |
| 8 | | | | |
| 9 | Try for diagonals, plotting our moves on paper | Try to stop their runs of 2 or more | Go for the tie; we were both waiting for the same spot to be filled | Take an early lead |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 4
Game Point Strategies
Executive Management

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|---|---------------------------------------|---|--|
| 1 | Block them, shadow | Try to take the lead role | Play to win; but we lost | It helps to go first because we can try to keep control |
| 2 | Defense at first, switch to offense after halfway | Transition from defense to offense | Offensive | We learned that you can take control of the game halfway through |
| 3 | Shadowed their moves | Spread out the chips | We win...allowed them to make a mistake | Be more aggressive |
| 4 | | | | |
| 5 | Spread out the chips | Take over board but watch their moves | We led the moves - We won | Being more aggressive works |
| 6 | Develop multiple rows and diagonals | Same | Same, win | That screwing around cause you to lose |
| 7 | Defensive | Defensive | Aggressive | Not to change from passive to very aggressive |
| 8 | Start from middle and expand | Defensive | To tie | Control the board |
| 9 | Aggressive | Try to take the lead | Blocking | Nada |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 5
Game Point Strategies
Marketing

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|---|---|--|--|
| 1 | Went in middle | More aggressive at first, but went to a defensive stance | Playing to win | More than 1 way to get 4 in a row |
| 2 | Response | Attack | Attack and keep earned advantage | Respond quick and be aggressive |
| 3 | Try to block form 3 | Was over quick, no middle game | Literally over in two seconds | |
| 4 | We were reacting and trying not to lose the same way we did last time | We tried to find a position where they would have no other option but to begin reacting to us | We were trying to find ways to catch them | Not to lose |
| 5 | Aggressive | Defensive | Playing to tie | A lot |
| 6 | | | | |
| 7 | | | | |
| 8 | None really | | Becoming Reactive Blocking and trying to map steps to keep them from winning | Better to be the team that make the first move |
| 9 | Blocking | Trying to take the lead | | To pay attention and think ahead |
| 10 | Response. We tried to take the lead, but had no opportunity | Same as above | We were trying to count the steps and respond to their strategy. We had no choice. | Making the first move gives a big advantage to the group |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 6
Game Point Strategies
Finance

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|---|---|---|--|
| 1 | We wanted to build the board so we could win in more than one direction | To block their moves while at the same time make a strong board for ourselves to win with | Started to play a more defensive strategy over aggressive. Basically hold them off and hope they screw up | That it is better to take more time to think ahead |
| 2 | Setting up ours as a them | Blocking them and creating a place where we could win | We were playing more offensive than the other team. We tried to maintain our advantage with having two winning drops set up. We were playing to win | Make more calculated decisions |
| 3 | See their strategy and combat it defensively | | | |
| 4 | | Developing the board in our favor aggressively | To win | |
| 5 | | | | |
| 6 | We decided to build upward compared to building wide | They are being aggressive and we are being defensive in order to survive | Just trying to keep them from winning. If we see a chance to win then we will take it. | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 7
Game Point
Strategies
Operations

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|-------------------------------------|---|--|---|
| 1 | Luck | Same | We were playing to win | |
| 2 | Experience from previous game | Same | Keep them from getting 4; playing to win | Strategy from 1st game didn't work for 2nd game |
| 3 | Get them to play defensive | Same as beginning | Same as middle and beginning | It's hard to do |
| 4 | Same as the first game | Block them | Played to win | To have a good time and not stress out about this |
| 5 | Tried to look about at our moves | Same | We were playing to win. But ended up losing | It's just a game |
| 6 | Place ourselves to win | Get accounting to put them where we wanted | Play to win | It is getting more serious as the rounds go on |
| 7 | There wasn't a strategy at first | There wasn't much of a strategy here either | We were playing to win, but we lost | We have to start playing to win |
| 8 | | | | |
| 9 | No, just winged it at the beginning | We tried to beat them diagonally throughout | Playing to win. We filled up toward the top in order to get a diagonal win | Marketing was easy to manipulate. |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 8
Game Point Strategies
Management Info Systems

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|---|--|--|---|
| 1 | To keep options open for the end and middle game | To attack and the and block their moves and to try to get 2 or 3 pieces aligned | We were playing to win because we think of ties as losses. We were trying to end the game quickly | To take our time and think about our moves before we make them |
| 2 | | | | |
| 3 | To try to control the middle of the board. This lets us branch out to the left or right | Try to stop their strategy while continuing to develop ours. Start taking control of the corners | We had to merely try to get a tie. Did this by calculating up to 5 moves in advance | We need to think defensively and offensively at the same time |
| 4 | Control the middle of the board | Spread out our pieces | We went from offensive to defensive quickly | We are not very good at Connect 4 |
| 5 | We wanted to set ourselves up for future wins | Made sure to stop the other team from winning but still looking for our future wins | | To always think of what your opponent will do |
| 6 | We took the offensive from the start of this game. We wanted them to block our pieces so they could not get any pieces in alignment | We had to play some defense but we still were trying to complete diagonals and upper level lines | We played to win. Our opponent was just following what we did but eventually could not block all of our moves. | That playing aggressively and thinking your moves through will lead us to a win |
| 7 | | | | |
| 8 | Try to get diagonals going | Try to block their use of the lower board (bottom rows) | We were playing to win because we think of ties as losses. We were trying to end the game quickly | It worked |
| 9 | Offensive | Defensive, need to be aware of where they could possible win | Defensive, playing to win | Plan ahead |
| 10 | Offensive | To continue on the offensive | Offensive | There is strategy to Connect 4 |

Developments in Business Simulation and Experiential Learning, Volume 34, 2007

Table 9
Game Point Strategies
Accounting

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|--|---|--|-------------------------------|
| 1 | | | | |
| 2 | Block | Looked to block - find chance to win | We were on defense | Take your time and look ahead |
| 3 | One person makes moves with 2 others thinking | Was no middle | Blocking | Look before you leap |
| 4 | We started on the defense, then tried looking a step ahead | We tried looking a step ahead to trap the opponent | We were on the defense and looking ahead | |
| 5 | We had no strategy | We were trying to find ways to win from 2 or 3 different angles | The other team made a move too quick - didn't see we had a chance to win | Don't move too fast |
| 6 | Chris went and we helped | Same | Same | Pay attention and look ahead |
| 7 | | | | |
| 8 | | | | |
| 9 | Mirror them | Same | Aggressive trying to make 4 - win | Pays to be aggressive |
| 10 | We prefer to use the diagonals to our advantage | Stayed on the offensive. Forces them to think twice, then make a mistake. | Playing to win | How to strategize. |

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Table 10
Game Point Strategies
Human Resources

| Round | Beginning Game | Middle Game | End Game | Learning |
|-------|---|---|---|---|
| 1 | To put chips close to where they put chips so that they couldn't get 4 in a row | There was no middle of the game, we lost after they put down 4 chips | We wanted to win but they outsmarted us right away | We need to play with our strategy and feed off of their strategy to try and beat them before their next move. |
| 2 | There was no middle, since we beat the other team in 4 moves | We were playing to win, Executive Mgt did this to us the first game and we used it on marketing | No | To use Exec. Mgt's Strategy |
| 3 | 1st, get 3 in a row. Then have 2 options | Tease the other side, then block them | Win | This strategy worked |
| 4 | We put the chip in the middle so we could have more room for other chips | There really wasn't a middle of the game, it was a quick game | We were playing to win, but we didn't see their connected 4, so we lost | Look for straight across rather than always looking for diagonal connections |
| 5 | We put the chips in the middle of the board | There was no middle, we won right away | We were playing to win, we got 4 straight in a row | You can win by starting out in the middle and putting 4 in a row |
| 6 | Started putting pieces in | Forcing them into losing | To win - We forced them into putting a piece in so we would win | |
| 7 | We really didn't have one | Stopping them from getting 3 | No end game | We didn't have a strategy |
| 8 | We started in the middle | We wanted to go the diagonal's and block their shots | We were playing to win but it did not work as we planned. | We need to look at the whole board before we made out moves |
| 9 | | | | |
| 10 | | | | |

Table 11
Ability to take back a
move

| | Yes | No | No Response |
|--------------------|-----|----|-------------|
| Board of Directors | 5 | 2 | |
| Executive Mgt. | 1 | 4 | 1 |
| Business Level | 1 | 6 | |
| Marketing | 2 | 5 | |
| Finance | 2 | 2 | 1 |
| Operations | 2 | 5 | |
| M.I.S. | 1 | 7 | |
| Accounting | 2 | 5 | |
| H.R | 5 | 4 | |

Table 12
Change and Alteration

| | At What point? | Alter Strategy? | | |
|--------------------|----------------------|-----------------|----|-----------|
| | | Yes | No | No Answer |
| Board of Directors | At the end | 4 | 1 | 2 |
| Executive Mgt. | Late in the game | 0 | 2 | 5 |
| Business Level | End of the game | 2 | 1 | 5 |
| Marketing | At the beginning | 2 | 3 | 3 |
| Finance | Middle | 2 | 1 | 1 |
| Operations | At the end | 0 | 1 | 7 |
| M.I.S. | Last moves | 1 | 2 | 5 |
| Accounting | Maybe the first move | 0 | 5 | 2 |
| H.R | Beginning | 4 | 1 | 3 |