A Conceptual Framework of Cognitive Game
Theory to Motivate Student Learning

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This paper considers the application of game theory to motivate student learning. The advantage of game theory is that ultimate–payoffs are made explicit and constitute the basis for student motivation of an extrinsic and intrinsic nature. This paper reviews game theory and offers an experimental design to assess the direction, intensity and persistence of student learning in Principles of Marketing courses. Preliminary findings from a pilot study between Principles of Marketing control and experimental sections is that (a) interventions to encourage students to switch to the marketing major should take place in the freshman and sophomore years and (b) interventions addressing marketing career paths and income levels help improve the image of the marketing profession.

INTRODUCTION

Learning in its many guises has evolved from the passive didactic into highly participative methods (experiential, service, action) that help students become valuable problem solvers. The emphasis on learning to learn (lifelong learners) across the many and varied careers graduates will experience requires that learning shifts away from the delivery of knowledge and toward the development of knowledge and skills (Bridgestock, 2014). The competitive landscape facing students has also changed dramatically. The 1.13 million foreign students in the U.S. enrolled mostly in college-degree programs represent a 14% increase over 2014, nearly 50% more than in 2010 and 85% more than in 2005 (Jordan, 2015). In addition to increased global competition for jobs, another competitor may be technology, or more specifically, automation. As Levy and Murnane (2013) point out, "In order to prepare young people to do the jobs computers cannot do we must re-focus our education system around one objective: giving students the foundational skills in problem-solving and communication that computers don't have (p.3)."

In spite of possessing the world's most prestigious universities, the most advanced learning software and decorated instructors, the U.S. has its share of educational challenges. The Organization for Economic Co-operation and Development (OECD) ranked the U.S. as 28th out of 76 countries on average mathematics and science scores for 15 year old students. The report claimed 24% of all students in the

U.S. had not acquired basic skills, making it the second-worst high-income country in the world on this measure, after Luxembourg (Coughlan, 2015).

It is therefore somewhat misleading to suggest that student learning is the key to individual, national and global success. In spite of powerful learning techniques and measures, there appears to be something missing. From an educator's perspective, more effective techniques are needed to better motivate our students to pursue lifelong learning for its profound benefits. The principles of Game Theory suggest possible intervention approaches to inspire greater student engagement. The contribution of this paper is two-fold. First, to introduce the notion of applying cognitive game theory within the domain of student learning, and secondly, to present an experimental design to test whether a game theory application can improve student learning.

BACKGROUND

The notion that Game Theory could be instrumental for extrinsically and intrinsically motivating student learning is based on a recent and straightforward observation. A college bound high-school student was presented with an introductory textbook in Accounting (Warren, Reeve and Duchac, 2012) and after having completed the first chapter cheerfully announced "I will be a public accountant, specializing in financial accounting and when I earn my CPA, my starting salary will be $45,000!!" When was the last time you heard this as the result of a student reading the first chapter of *any* principles of marketing textbook? Yes, there are appendices with job titles, perhaps starting salaries, but these potential outcomes are not placed front and center to showcase to the student realistic and tangible benefits from studying marketing. This conceptual piece is designed to examine whether the application of Game Theory is useful to help students increase their motivation to learning.

Game Theory in Marketing

Game theory is the process of modeling strategic interactions between two or more players in a situation containing set rules and outcomes. This is used to anticipate and explain the actions of all players involved in competitive situations and to test and determine the relative optimality of different strategies. From a practical perspective, the most common criticisms of game theory center on its axiomatic approach (Dominici, 2011) and the assumption that the players are rational (Harsanyi, 1982). Chatterjee and Lilien (1986) incorporated irrationality into their design with "bluffs and threats" thereby extending game theory to include incomplete information about payoff functions.

Game theory effects on competitive behavior has generated some interest in terms of analyzing interdependences and competitors' interactions (Branderburger and Nalebuff, 1996). Other research has examined game theory implications of advertising expenditures (Shubik and Leviatan, 1980), new products (Kaiser, 2001) pricing (Rao and Shakun, 1972), and buyer-seller relationships across the entire supply chain (Esmaeili et al., 2009).

The classic game theory modelling exercise is a game (a formal abstraction of the social interaction) with the following five conditions (Vega-Redondo, 2003; Simley and Hell, 2015).

1. Each decision maker (player) has two or more choices or sequences of choices.
2. All possible combinations of decisions result in a clear outcome: win or lose.
3. The scenarios (strategies) have well-defined outcomes with decision makers receiving a "payoff" (the value of the outcome to the participants) that they will gain or lose depending upon the outcome.
4. The decision makers know the rules of the game as well as the payoffs to the other decision makers.
5. The decision makers are rational: when faced with two alternatives, players will choose the option that provides the greatest payoff.

The payoff function for each player is effectively a preference ordering over the set of all possible outcomes. There is an implicit assumption that the "payoff function" drives the decision maker's actions (otherwise there would not be much point in defining a payoff function).

The preceding would suggest that the use of classical game theory to model student behaviors and preferences could produce similarly inconclusive and unwieldy outcomes. Izquierdo's (2008) review of the game theory literature offers various approaches for overcoming the extreme rationality, deductive thinking and precision of classic game theory exercises by using case-based reasoning or cognitive game theory applications (Flache and Macy, 2002; Macy and Flache, 2002) Suggested treatment conditions are outlined in Table 1.

TABLE 1
COMPARISON OF CONDITIONS FOR CASE-BASED
REASONING AND COGNITIVE GAME THEORY

Case-Based Reasoning	Cognitive Game Theory
Payoffs may be interpreted as preferences measured on an ordinal scale.	Players base their decisions on experience of past events versus logical deductions about the future, requiring fewer assumptions about other players and a more accurate model of human behavior.
Each player is assumed to know the range of possible actions available to her, and her own aspiration threshold. Players do not use any information regarding the other players.	Players have feedback on their actions to facilitate learning leading to non-optimal behavior since inferences about other players' behavior cannot be guaranteed to be true.
For each possible state of the world they may perceive, players are assumed to store in memory the last payoff they received for each of the possible actions available to them. They need to be able to rank their preferences.	Players who learn from experience often satisfice rather than optimize (Simon, 1957) seeking a solution to a problem which is 'good enough.' In the simplest models (e.g. reinforcement learning) this link between acquired information and action is direct (e.g. in a stimulus-response fashion).

Adapted from Izquierdo (2008)

Given that the goal of cognitive game theory is to identify learning mechanisms that will lead to patterns of behavior observed in real-world interactions as compared with case-based reasoning that assumes high levels of player knowledge, we propose the use of cognitive game theory as the theoretical framework for this study.

SUGGESTED METHODOLOGY

To test the direction, intensity and persistence of student motivation to learn and develop new skills, we propose a simple quasi-experiment after-only with controls experimental design. The study will be fielded in two sections of Principles of Marketing. This course is ideally suited to test the impact of a student learning intervention since it is typically sequenced first in the marketing curriculum and as such offers a diverse student population with widely varying interest in mastering marketing knowledge and skills. This baseline variability adds power to the detection of significant treatment effects.
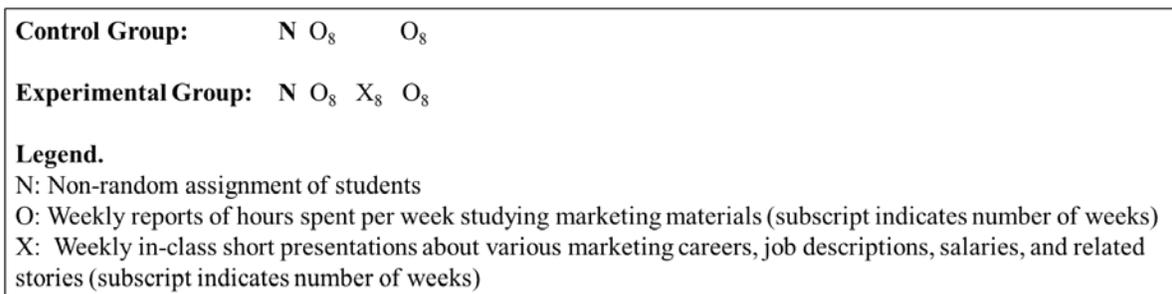
The first section constitutes the control group. Students will be invited to log their course related activities (quality and duration of time spent per type of activity, e.g. studying, reviewing, writing projects, etc.) in a personal diary. Diary information will be parsed into three dimensions of student motivation to learn: "direction" is the student's self-reported effectiveness (e.g., was the time well spent?), "intensity" is an index of how many different types of course-related activities the student engaged (including whether they stay within or venture outside the scope of assigned materials), and

"persistence" is the cumulative time spent on all activities in a given week. These three dimensions of motivation are the three independent variables (IV1, IV2, IV3) that tap the underlying construct of student learning. The dependent variable (DV) for both control and experimental groups will be grades earned (excluding any extra credit) from the mid-point of the course to the end of the course to capture any treatment effect taking place. This latter point is essential in that it will allow the capture of quantity and quality of cumulative hours spend outside the class on marketing materials. A default mean value for both groups will allow for a more robust set of comparisons pre- and post-treatment implementation.

The second section constitutes the experimental group. Similar to the control group, students will be invited to log their course-related activities (quality and duration of time spent per type of activity, e.g. studying, reviewing, writing projects, etc.) in a personal diary. The treatment will start mid-way through the course as a short (<5 minutes) introduction in each class session highlighting various aspects of how a marketing career provides a fulfilling personal experience, substantial salary range, transferrable soft and hard skills, professional status and other valued benefits. Recommended careers to be discussed include: marketing research and analytics, global marketing, brand management, sales, small businesses and marketing, supply chains, and advertising.

The dependent variable (DV) for both control and experimental groups will be grades earned (excluding any extra credit) from the mid-point of the course to the end of the course to reflect the hypothesized treatment effect. Moderating variables may be assessed such as high versus low performing students, age and other factors to be determined. Additional DVs may include the proportion of students switching to the marketing major at the completion of the course. Figure 1 graphically presents the experimental design.

FIGURE 1
STUDY'S QUASI-EXPERIMENTAL DESIGN

Control Group: N O_8 O_8

Experimental Group: N O_8 X_8 O_8

Legend.
N: Non-random assignment of students
O: Weekly reports of hours spent per week studying marketing materials (subscript indicates number of weeks)
X: Weekly in-class short presentations about various marketing careers, job descriptions, salaries, and related stories (subscript indicates number of weeks)

The Model

We start by defining a few terms commonly used in the study of game theory (McNulty, 2015) as applied to student learning assuming that players within the game are rational and will strive to maximize their payoffs in the game.

1. Game: Any set of circumstances that has a result dependent on the actions of two of more decision makers ("players"). In this case, the course (could also be applied to a program, college or university).
2. Players: A strategic decision maker within the context of the game. There are two distinct groups of players, one are the students, and the other are employers.
3. Strategy: A complete plan of action a player will take given the set of circumstances that might arise within the game. In this case, strategy is whether to invest more heavily in learning, enroll in a relevant internship, reassess a particular marketing major (if offered), or to continue 'as is.'
4. Payoff: The payout a player receives from arriving at a particular outcome. The payout can be in any quantifiable form, from dollars to utility. In this case, a viable and productive career.

5. Information Set: The information available at a given point in the game. The term information set is most usually applied when the game has a sequential component. In this case, career information supplied by the instructor.
6. Equilibrium: The point in a game where both players have made their decisions and an outcome is reached. In this case, optimality would suggest waiting until the student's mid-career point, though for our purposes, capturing a suitable dependent variable such as an observable change in student studying behavior.

We propose two options facing students, an outside and an inside option. The outside option is to increase learning as a strategic career benefit, whilst the inside option is to carry on as is. Cunyat (1988) suggests that an inside option payoff amounts to a status quo and their bargaining power is automatically increased. That is, if the offer (information about marketing careers) fails to inspire the student to learn more, then the inside option is the default selection. The challenge is to inform and persuade the student to consider and then accept the outside option that in this case bodes well for a professional career. Furthermore, even though the initial form of information is asymmetric (students do not know all the benefits of being a professional marketer), information symmetry evolves as students gain additional and tangible evidence of professional marketing benefits from their instructor. The payoffs may be presented as follows (See Table 2).

TABLE 2
STRATEGIC PAYOFFS FOR EMPLOYERS AND STUDENTS

		Employers	
		Interested in highly motivated students	Uninterested in highly motivated students
Students	**Outside Option** Motivated to increase learning	(Career, Career)	(Underemployment, Uncertain future)
	Inside Option Unmotivated to increase learning	(Job, Less future)	(No job, no future)

The Nash Equilibrium (Nash, 1950) is an outcome that once achieved means no player can increase payoff by changing decisions unilaterally. It can also be thought of as "no regrets," in the sense that once a decision is made, the player will have no regrets concerning decisions considering the consequences. In this case we discover the intersection of (Motivated to increase learning, Interested in highly skilled students) where both payoffs of 'career, career' is our Nash Equilibrium and the optimal payout.

The takeaways are to seek a strategic fit between highly motivated student learners and employers that value this skill (career, career), otherwise the best the student can hope for is a job with an uncertain future at best.

Hypotheses and Statistical Design
The first hypothesis pertains to the treatment effect of enhanced direction, intensity and persistence when studying course materials.

Hypothesis 1a: Students in the experimental group will be more "directed" (higher self-reported effectiveness on average) interacting with course-related marketing materials as compared to students in the control group.

Hypothesis 1b: Students in the experimental group will demonstrate greater "intensity" (interacting with a more diverse array of course-related materials and more diverse activities overall including activities that go beyond the scope of assigned materials) as compared to students in the control group.

Hypothesis 1c: Students in the experimental group will be more "persistent" (more cumulative hours per week interacting with course-related marketing materials as compared to students in the control group.

The second hypothesis is to test whether the additional time spent outside of class working on marketing materials results in improved grades **over the course of the treatment**.

Hypothesis 2: Students in the experimental group will earn higher grades over the course of the treatment period compared to students in the control group.

A recent study by Elbeck and DeLong (2015) discovered that for extra credit opportunities, higher performing students were more likely to take the opportunity, and therefore our third hypothesis.

Hypothesis 3: In the experimental group only, high performing students will exhibit significantly higher average scores on all three motivational measures as compared to low performing students.

Finally, as a test of this study's overall game theory contribution, the fourth hypothesis will capture the number of students changing their major to marketing.

Hypothesis 4: A larger proportion of students in the experimental group will change their major to marketing as compared to the students in the control group.

The recommended statistical design will likely include a regression analysis to establish the relationship between the DVs and IVs. See the appendix for the questionnaire that can be used to capture student motivation to learn.

INTERIM PILOT STUDY FINDINGS

A pilot study was implemented to test pre and post differences and whether students responded to the outside option to pursue a marketing major.

Students in two sequential sections of a Principles of Marketing course participated in the pilot study. Fifteen students were enrolled in the control group (N=15; 54% female, 2.9 average GPA, 75% upper classmen, 87% business majors), and 21 students in the experimental group (N=21; 81% female, 3.38 average GPA, 80% upper classmen, 90% business majors) participated. In spite of the small samples, every measure of motivation drops from pre to post treatment, for both the control and experimental groups. Relative to each groups' mean score before treatment, the post treatment activity is decreased, sometimes significantly so. This remarkable finding may be explained in terms of resource allocation. All but three students were marketing majors, and given the majority were upperclassmen entrenched in their major of choosing, the significant drop in motivation and time devoted to the course may be due more to competing demands from their major courses than disinterest in the principles of marketing course. Suggesting perhaps a trade off that as a result of the intervention students focused more on their major

courses and therefore chosen career path which is actually quite a positive outcome that is student career focus. The takeaway may be that interventions to encourage major switching should taken place when students are freshmen or sophomores.

To test whether the treatment to present the various marketing career paths and income levels had any effect, students responded to an anonymous survey asking for their before the course interest in switching to a marketing major and their interest at the end of the course. There was a significant improvement in the scores before the course (M=.35, SD=.33) and after the course (M=.66, SD.26); $t(19)$= -6.29, p=.00. This suggests that the treatment to present the various marketing career paths did influence the likelihood of a student switching their major to a marketing major. The takeaway is not so much students suddenly switching to the marketing major, but taking time to think about their careers and indicate a more favorable attitude toward the marketing profession.

CONCLUSION

Exploring how cognitive game theory might contribute to student learning is intriguing, and as a first study in this topic, we offer this conceptual piece as the precursor for a complete quasi-experimental study to establish whether some feature of game theory will facilitate student motivation to engage with course materials and, by extension, enhance learning outcomes within the marketing curriculum. The noteworthy findings from our pilot study is that (a) interventions to encourage students to switch to the marketing major should take place in the freshman and sophomore years (after that, there is far too much vested in a particular major to make switching an attractive option) and (b) interventions addressing marketing career paths and income levels help improve the image of the marketing profession.

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APPENDIX

Questionnaire to Capture Student Motivations to Learn

Principles of Marketing: Student Weekly Time, Activities and Productivity Sheet

Your name. _____

In the table below, for each day, please include:

• How many hours (or fraction of an hour) per day you spent learning about marketing outside the class.

• The types of marketing-related activities you did (reading the book, reading about marketing topics, preparing for a quiz, exam or assignment, explaining marketing to a friend or family member, attending a presentation, etc.)

• Rate your productivity on these marketing-related activities **from 1 to 10**. Were you focused and engaged, was your time well spent? If not at all (e.g., daydreaming, multitasking, going through the motions), then enter **one (1)**. Otherwise, enter an amount up to a **maximum** of **10** to rate how productive and effective you feel you were on these activities.

Please keep this sheet with your marketing textbook and bring to each class. Next week I will give you another sheet. Thank you, Dr. M. Elbeck

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
Time Spent learning about Marketing (hours)							
Marketing-related Activities (list all types)							
Productivity (focus and effectiveness)							