DIGITAL GAMES AND BEYOND: WHAT HAPPENS WHEN PLAYERS COMPETE?[1]

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Because digital games are fun, engaging, and popular, organizations are attempting to integrate them within organizational activities as serious components, with the anticipation that they can improve employees' motivation and performance. But in order to do so and to obtain the intended outcomes, it is necessary to first obtain an understanding of how different digital game designs impact players' behaviors and emotional responses. Hence, in this study, we address one key element of popular game designs: competition. Using extant research on tournaments and intrinsic motivation, we model competitive games as a skill-based tournament and conduct an experimental study to understand player behaviors and emotional responses under different competition conditions. When players compete with players of similar skill levels, they apply more effort as indicated by more games played and longer duration of play. But when players compete with players of lower skill levels, they report higher levels of enjoyment and lower levels of arousal after game-playing. We discuss the implications for organizations seeking to introduce games premised on competition and provide a framework to guide information system researchers to embark on a study of games.

Keywords: Digital games, intrinsic motivation, experimental study, tournament theory

The path to becoming happier, improving your business, and saving the world might be one and the same: understanding how the world's best games work.
—Timothy Ferriss ("Foreword" to McGonigal 2011)

Introduction

Digital games, played by more than half the American population and a billion people globally, are rapidly growing, especially with online social networking websites and mobile devices (Gaudiosi 2011; McGonigal 2011). Because digital games are fun, engaging, and popular, many organizations, including schools, companies, military units, and health-care organizations, are using games to train individuals, engage online customers, and connect a global workforce (Bonnett 2008; Dickey 2005; Stapleton 2004; Totty 2005). Indeed, the

borders between work, play, and learning are becoming so thin that the term *serious games* is coined to refer to games used for purposes other than pure entertainment (Jarvenpaa et al. 2008; Michael and Chen 2005; Susi et al. 2007; Tay 2010).[2] For example, Cisco developed a series of games for networking professionals to learn and apply their networking knowledge in a Tetris-like gaming environment (Tay 2010). Cereal maker Kellogg built an online game called "Race to the Bowl Rally" that has attracted 549,000 players (Richtel 2011). Foldit, a multiplayer online game that is specifically designed to engage non-scientists in challenges and competitions of solving protein structure puzzles, has resulted in significant discoveries (Praetorius 2011). In an era of scarce attention, games are believed to be crucial for building an "engagement economy" that works by motivating participants with intrinsic rewards and *competitive engagements* (McGonigal 2011, p. 243). But to harness the benefits of serious games in organizations, it is necessary to obtain a theoretical understanding on how different game designs affect player behaviors and emotional responses. This task provides an excellent opportunity for information systems researchers to conduct investigations by taking advantage of their expertise on information technology and organizations; however, little research is being conducted (Altinkemer and Shen 2008). To move in this direction, in this study, we use popular online games as a model for game design to study the effects of competition on players' behaviors and responses when playing games.

Among digital games, online games, facilitated by gaming platforms, have become increasingly popular, because players seem to favor the opportunities to challenge and compete with one another (Schiesel 2005; Weibel et al. 2008). Foldit, for instance, allows participants to compete as an individual or as a group. Prior research suggests that games are fun, because they provide fantasies, evoke curiosity, and create challenges for players (Malone 1981). A key part of game design is having dynamic challenges, which are often facilitated through competition among players of different skill levels in online games (Schiesel 2005; Totty 2005). While a few research studies examine the fantasy element in games, competition, as an important source of challenge, has been ignored thus far (Baek et al. 2004; Hsu et al. 2005). If organizations wish to integrate game designs that create challenges, it is necessary to study players engaged in competition and its impact on their game playing behaviors and emotional responses.

To address this, we view online game design as an IT-mediated competition among players of different skill levels that provides differing challenge levels. Using tournament theory and perspectives from psychology, we model competition conditions that will maximally engage players and hypothesize effects on their emotional responses. Through a laboratory experiment, we collected observations on participants who engaged in such an IT-mediated competition and played games over two sessions. Our findings indicate that, as per tournament theory, when players compete with others of equal skill levels, they will expend more effort and be more engaged in game activity than when they compete against a player of unequal skill levels. The effects on emotional responses of players, however, are somewhat different. It is not when players play against a competitor of equal skill level, but against a player of lower-skill, that is, when they are in winning conditions, that they obtain a greater sense of enjoyment from game activity. We discuss the implications of our findings for online game design and the integration of serious games in organizational tasks.

We begin by presenting a brief background on game-related research. We then draw on tournament theory and theories in psychology and marketing to derive our hypotheses. This is followed by descriptions of our laboratory experiment, data analysis, and findings. Finally, we discuss our findings and present a framework for future research, highlighting unique contributions that IS researchers can make to this research inquiry.

Research Background ▬▬▬

Prior Research on Games

In online games, players have the opportunity to match with others of varying skill levels, and their resulting behaviors depend on the skill levels of their competitors. Perhaps because online games are so new, little research has been conducted on how the interplay of player skill levels affects playing behavior. But prior to the advent of online games, scholars researched games and questioned why game playing activities are fun (Malone 1981). One reason is that they challenge the players. By varying the difficulty level of playing, game designs can provide different levels of fun (Fabricatore et al. 2002; Malone 1981; Malone and Lepper 1987). Self-determination theory suggests that activities, such as games, are enjoyable because they satisfy people's intrinsic psychological needs to feel competent, autonomous, and connected to others (Deci and Ryan 1985; Ryan and Deci 2000b).

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[2]For a host of activities, including conferences, initiatives, and partnerships between academia and private game vendors, that tackle challenges and opportunities in the emerging area of serious games, go to http://www.seriousgamesinstitute.co.uk/.

Games are also examined as an *intrinsically motivating* activity that people do "for its own sake" (Malone 1981). Playing games improves intrinsic motivation and promotes a state of heightened enjoyment (Epstein and Harackiewicz 1992; Reeve and Deci 1996). The sense of enjoyment arising after game activity leads to the idea that serious games can be a precursor to organizational activities such as training, collaborative decision making, and global team work (McGonigal 2011; Tauer and Harackiewicz 1999; Venkatesh 1999). Games can also create a state of *flow,* which is described as being so totally involved that people lose their self-consciousness and sense of time (Csikszentmihalyi 1975, 1990). IS researchers are intrigued by games and similar activities because they are engaging and create holistic experiences such as flow, but to-date, not much research is available on games (Agarwal and Karahanna 2000; Finneran and Zhang 2005; Guo and Poole 2009; Trevino and Webster 1992; Webster and Martocchio 1993).

There is some limited recent research on online games, which shows that, among other reasons, the opportunities for achievement, immersive experiences, and interactions with other players, draw players to online games (Bartle 1996; Ryan et al. 2006; Yee 2006). Surveys of players suggest that they show loyalty to games that provide reputation, enjoyment, and social cohesion, and they are more willing to pay for games that have interpersonal features such as in-game chatting and player-to-player interactivity (Baek et al. 2004; Chang et al. 2008; Hsu and Lu 2004; Park et al. 2008). From these limited studies, although competition emerges as a key element in the appeal of games, the effects of different competition conditions on player behavior and emotions have yet to be examined.

Prior Research on Competition

Competition refers to a contest in which two or more parties strive for superiority or victory (Merriam-Webster 2010). Because contests represent strategic situations in which players' payoffs depend on the acts of rival contestants, tournament theory, which uses game theory modeling, is developed for analyzing contests. The first formal tournament-theory model is Tullock's (1980) study of the *rent-seeking* phenomenon that involves individuals or organizations engaging in a lobbying contest to obtain a monopoly privilege. Tullock's work is subsequently extended and applied to many other economic situations, including research and development races (Fullerton and McAfee 1999), sporting contests (Szymanski 2003), and relative performance compensation (Lazear and Rosen 1981). Most tournament theory research deals with situations in which contestants are moti-

vated by rewards with clear economic value, but recent studies (Huberman et al. 2004; Kosfeld and Neckermann 2011) suggest that symbolic rewards such as status or praise alone can drive competition.

Effort in tournament-theory models is interpreted as the resources a contestant expends in completing a given task. Relatively few papers examine asymmetric tournaments that involve contestants of different skill levels. Allard (1988) examined the impact of skill asymmetry on the uniqueness of equilibrium in tournaments. Liu et al. (2007) studied the use of tournaments in sales promotions and found that marketers can generate higher revenue by segmenting contestants into similarly skilled groups. Baik (2004) and Hurley and Shogren (1998) studied impact of skill asymmetry on effort levels in two-player settings. Baik found that players' effort levels are maximized when two players have equal "strength." These recent studies highlighted the importance of skills and grouping of players based on their skill levels.

Research Model and Predictions ■■■

We may classify competition into *direct competition* and *indirect competition* depending on whether players can exert direct influence on another players' performance. Competition is integral to the task in a direct competition (e.g., a chess game) and is an additional element in indirect competition (e.g., online score board and contests on Foldit).[3] As with most research based on tournament theory, we focus on indirect competition, which is convenient to implement and popular in serious games (Schiesel 2005).[4]

Effort

To begin, we model and study the effect of competition in a two-player tournament with indirect competition. The two-player tournament has the advantage of providing essential information about the impact of competition in game play in the simplest setting. We denote t_i (i = 1 or 2) as player i's *effort* and μ_i as player i's *skill* level. By exerting effort t, a player incurs a disutility of $c(t)$. The disutility can be inter-

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[3]The distinction may not be mutually exclusive because some direct-competition games may also offer indirect-competition features, such as a leader board for most wins in a chess game.

[4]Many online games offer indirect competition. For example, game portals such as Yahoo! Games and MSN Gaming Zone, have online score boards for players to show off their achievements.

preted as the player's opportunity cost of time (including physical, mental, or financial cost). We assume that c(0) = 0, c'(t) > 0, and c''(t) > 0. This assumption is that players who choose not to play incur no opportunity cost; players who exert more effort incur more disutility; as players increase effort level, disutility increases faster.

After learning their competitors' skill levels, players make their effort decisions without knowing their competitors' effort decision. Player *i*'s total expected utility U_i is

$$U_i = \frac{\mu_i t_i}{\mu_1 t_1 + \mu_2 t_2} - c(t_i), i = 1,2 \qquad (1)$$

where $\frac{\mu_i t_i}{\mu_1 t_1 + \mu_2 t_2}$ captures player *i*'s winning probability.[5] This

winning probability formulation, also used by a number of other authors (Baik 2004; Hurley and Shogren 1998; Rosen 1986), is an adaptation of Tullock's (1980) original formula, with the addition of the skill factor. In this formulation, a player's probability of winning increases with the player's investment (referring to a combination of skill and effort) and decreases with the competitor's investment. The player with the highest investment has the highest probability of winning but is not guaranteed to win, capturing the uncertainty in game competition (Baik 2004). Finally, the model assumes that each player maximizes total expected utility by choosing the effort level.

Next, we analyze the effort level at equilibrium conditions and the impact of players' skill levels. A pair of effort levels is a Nash equilibrium condition if they are the best response to each other.

Proposition 1: *A player will exert the highest equilibrium effort when the player's skill level equals the competitor's.* (see Appendix A for a proof.)

Figure 1 shows an example of player 1's equilibrium effort level as a function of player 2's skill level. It is seen that player 1's effort at equilibrium is highest if two players have identical skill levels.

Intuitively, when a player plays against a higher-skilled competitor, additional effort makes little difference on the probability of winning. As a result, the player will exert a low level of effort. Similarly, when facing a competitor of lower skill, additional effort also makes little difference because the skill advantage allows the player to win with little effort.

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[5]Note that each player gets a normalized utility of 1 from winning the competition.

Hence, when two players challenge one another in a game competition, our model predicts that each will expend maximum effort when they are matched with competitors of equivalent skills. To empirically test the predictions of the model, we state our first hypothesis:

Hypothesis 1: *A player will expend more effort when competing with an equally skilled competitor than when competing with an unequally skilled competitor.*

While tournament theory is helpful in understanding how players *approach* game competition, it is of limited use in explaining how players are *affected by* competition and respond emotionally. Players' emotional responses to competition can carry over to the evaluation of and attitude to the objects (Deng and Poole 2010), and therefore hold important organizational implications for game designs. Next we draw upon other theoretical perspectives to examine player's emotional responses to competition in terms of enjoyment and arousal.

Enjoyment

Games and sports are considered to be most germane to intrinsic motivation because people play them to enjoy and have fun (Deci and Ryan 1985; Malone 1981). It is for these reasons that researchers examine games as an intrinsically motivating activity, looking for ways to integrate games into classrooms, board rooms, and managerial activities in hope of enhancing people's enjoyment of learning and work activities (Epstein and Harackiewicz 1992; Reeve and Deci 1996; Stanne et al. 1999; Tauer and Harackiewicz 1999). Prior empirical findings show that employees with high intrinsic motivation tend to spend more time on their organizational tasks, have a more positive mood and less anxiety in the workplace, and that students with high intrinsic motivation take more pleasure in their learning tasks (Deci and Ryan 1985). For these reasons, conditions that can help employees develop intrinsic motivation should be identified.

Different descriptions of intrinsic motivation have been adopted, but they all seem to include three relatively invariant qualities: interest, enjoyment, and involvement in the activity (Deci and Ryan 1985). Intrinsic motivation is operationalized in several ways, but there are two most commonly used forms (Ryan et al. 2006). One is to have a free choice phase, or a free time period after the intrinsically motivating activity. If a person continues to engage in the activity in the absence of any rewards or instructions, it indicates a high level of intrinsic motivation for the activity. Another approach is to obtain self-reports of enjoyment or interest of the target activity. Be-
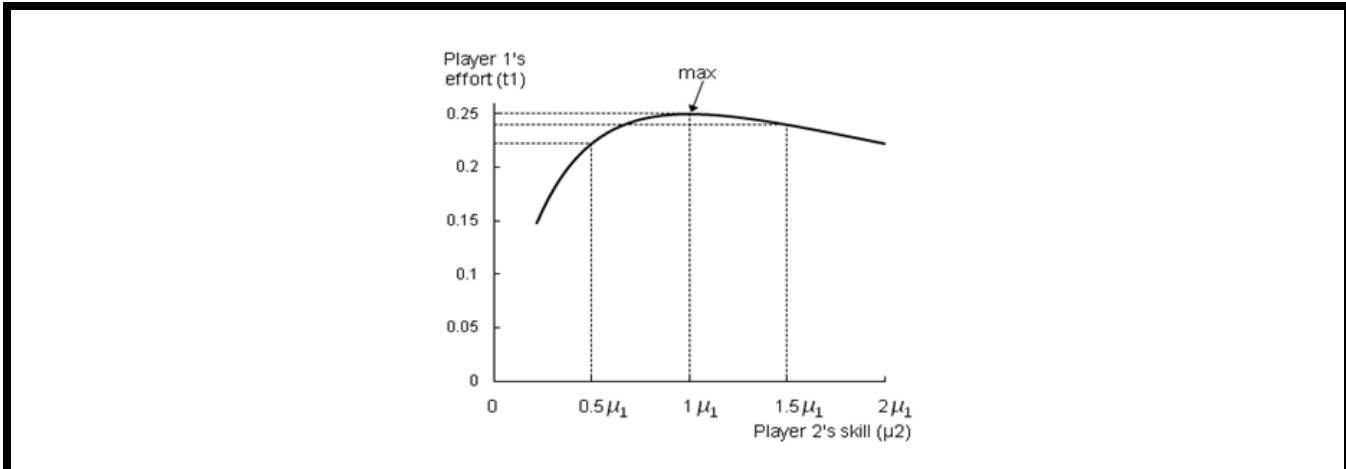
Figure 1. Player 1's Equilibrium Effort Level

cause of this operationalization, the terms task enjoyment and intrinsic motivation are sometimes used interchangeably. In this research, we operationalize intrinsic motivation as enjoyment and use the terms enjoyment and intrinsic motivation interchangeably. It shall be noted that our notion of intrinsic motivation is different from flow, although researchers often measure flow in intrinsically motivating activities (Agarwal and Karahanna 2000; Finneran and Zhang 2005; Guo and Poole 2009; Trevino and Webster 1992; Webster and Martocchio 1993).

Competition is one of the basic elements of intrinsically motivating activities (Csikszentmihalyi 1975; Deci and Ryan 1985). The research on intrinsic motivation offers several perspectives on the impact of game-based competition (Deci et al. 1985; Malone 1981). Cognitive evaluation theory, part of the self-determination theory, provides two concurrent views on the effects of competition (Deci 1975; Deci and Ryan 1985; Reeve and Deci 1996). First, external incentives such as monetary prizes may undermine the enjoyment of players because they will pressure players to behave in certain ways and cause the players to perceive competition as controlling (Reeve and Deci 1996). On the other hand, competition can satisfy players' innate need for competence by providing opportunities for facing optimal challenges and obtaining competence evaluation. Thus, competition can result in players feeling enjoyment. While most games are intrinsically motivating, the potency of each game in providing enjoyment may vary depending on the characteristics of challenges and competition provided by the game (Ryan and Deci 2000a). So there is significant practical value in examining the optimal game-designs with competition and its impact on players' enjoyment.

From the perspective of competence evaluation, a game design that pairs a player with a competitor of equal skill level can provide an optimal amount of competence evaluation information. When players face competitors of equal skill levels, the outcome is more uncertain than facing competitors of unequal skill levels, resulting in higher diagnostic value (Sedikides and Strube 1997; Trope 1986). Therefore players will enjoy a competition with equally skilled players for its optimal competence evaluation value. People also engage in intrinsically motivating activities to seek optimal challenges (Deci and Ryan 1985). Research on flow shows that an optimally challenging condition occurs when challenge and skill are balanced (Engeser and Rheinberg 2008; Luna et al. 2002; Nah et al. 2010). In the context of competition, this means that when players are matched with players of equal skill levels, they are optimally challenged and therefore are most likely to experience high levels of enjoyment. Based on the above, we advance the following hypothesis:

Hypothesis 2. *A player will experience higher enjoyment when competing with an equally skilled competitor than with unequally skilled competitor.*

Arousal

Arousal denotes an individual's emotional response to stimuli, such as an event, a movie, or a game, that can range from drowsiness to frantic excitement (Broach et al. 1995; Holbrook et al. 1984; Pham 1992). It is used as a barometer of consumer reactions in evaluating the impact of stimuli, such as advertisements, promotional events, and entertainment activities (Mehrabian and Russell 1974; Russell et al. 1989;

Wahlers and Etzel 1990). Arousal is relatively unaddressed in IS research, but it is starting to get some attention because the emotional responses of consumers can potentially be influenced by the design of IT-based systems such as websites, games, and virtual worlds (Deng and Poole 2010). There are many descriptions and operationalizations of arousal that depend on the context and goal of the stimuli being evaluated (Bagozzi et al. 1999; Deng and Poole 2010; LaTour et al. 1990). Early descriptions and measurements of arousal are at the physiological level, determined by a person's blood pressure and heart rate (Berlyne 1971; LaTour et al. 1990). Later descriptions emphasize the psychological dimensions of arousal obtained via optimal experiences, such as playing games and solving puzzles, and suggest the use of a person's self-report as measurement (Bagozzi et al. 1999; Deci and Ryan 1985; Kellaris and Mantel 1996).

In the game playing context, competition is a stimuli that can create emotional responses of arousal (Sherry 2004; Vorderer et al. 2003). Feeling a sense of arousal differs from being in state of flow, but some parallels exist. From flow theory, we know that a person experiences flow and heightened arousal of sensory and cognitive stimulation when their skill levels are balanced with the challenge (Agarwal and Karahanna 2000; Trevino and Webster 1992). Similarly, when players are equally matched in skill levels, they are optimally challenged and also likely to reach high arousal levels. When players are matched with competitors of unequal skill levels, they are under-stimulated, either because there is not enough challenge or because the challenge is overwhelming and players are ready to give up. Hence, we hypothesize:

Hypothesis 3*: A player will exhibit higher arousal when competing with an equally skilled competitor than with an unequally skilled competitor.*

Research Method and Results ▬▬

Overview

We employed a mixed two-factor experimental design (Keppel and Wickens 1982) with an open source game, Frozen Bubble (see a sample screen in Appendix B). In this game, players aimed and shot at colored bubbles to knock them off before they reached the bottom of the screen. The game had four levels: the starting bubble arrangements were different at each level and more complex at higher levels. The game performance was measured by the highest level reached, with ties decided by the time taken to play the game. Participants were allowed multiple attempts at the game and compared by best performance.

Each participant was matched with an *equally skilled competitor* (ESC) in one experimental session and an *unequally skilled competitor* (UESC) in another. We randomized the order of treatment conditions so that half of the participants were matched with an ESC first; the other half were matched with an UESC first. An unequally skilled competitor can be a *lower-skilled competitor* (LSC) or a *higher-skilled competitor* (HSC) and each pairing had an equal chance. We reiterated our treatment conditions with the help of on-screen messages, prior to and during the competition. For example, before the competition a player matched with an LSC was told, "Your competitor's skill level is much lower than yours based on the best performance in the practice session"; during the competition the player was told several times, "You are leading your competitor." (We varied the wording of the messages to give a more realistic feeling of game competition).

Participants

For partial fulfillment of their research-exposure requirements, 80 business undergraduate students from a large southeastern university volunteered to participate in the experiment. We offered no prizes because studies show that external rewards may confound the results by influencing intrinsic motivation (Benabou and Tirole 2003; Deci et al. 1999). Each participant completed two 1-hour sessions, within a week, at a laboratory featuring individual cubicles and headphones that avoided interference among participants. We altered the game title to prevent participants from finding and practicing the game between two visits. To minimize distractions, we asked participants to stay at their cubicle and surf the Internet if they finished early.

Experimental Procedures

We conducted two pilot studies to test the instruments, the game software, and experimental procedures. The pilot studies showed support for our hypotheses. Based on the feedback from the pilot studies, we adjusted our experimental procedures and software. For example, we added instructions for participants to remain seated after they finished playing and reduced the number of levels to accommodate more game attempts.

When participants volunteered for the study, they completed a background questionnaire (Appendix C). During the first visit, they were asked to read the instructions (Appendix D1) and complete a 10-minute practice session (with no com-

petitor). Next, they read instructions about the competition (Appendix D2) and then completed a questionnaire (Appendix D3), which we used to ascertain their understanding of their treatment conditions and experimental procedures. During the game competition, they could, at any time, quit playing by clicking on the finish button. The computer recorded the number of game attempts and playing time. Throughout the competition, participants were unaware of whether their competitors had stopped playing or the competitor's final performance. After the competition, participants completed a questionnaire on enjoyment and arousal. The procedure for the second experimental session was similar to the first, but did not have a practice session. After both sessions ended, we debriefed participants.

Measures

Effort: We measured actual effort expended during the game competition in two ways: the number of game attempts and the total playing time. *Number of game attempts* was the total number of times each participant attempted the game under a given treatment condition. *Playing time* was the time each participant spent under the treatment condition, from the time the player started playing until the player clicked the finish button.

Enjoyment: The measure of enjoyment (see Appendix E) was obtained from prior research on intrinsic motivation (Epstein and Harackiewicz 1992; Tauer and Harackiewicz 1999). These items (e.g., "this computer game is very enjoyable") gauged participants' emotional responses to the computer game after the game competition. Respondents answered on a seven-point scale anchored from *strongly disagree* (1) to *strongly agree* (7).

Arousal: The measure of arousal (see Appendix E) was adapted from an instrument developed by (Broach et al. 1995) for measuring arousal from a television program. It included items such as "the computer game makes you feel excited." Respondents answered on a seven-point scale anchored from *strongly disagree* (1) to *strongly agree* (7).

Controls: The treatment order was used as a control variable.

Data Analysis and Results

From the 80 participants who volunteered for the experiment, we obtained usable data on 70, among which 34 received ESC and LSC treatments and 36 received ESC and HSC treatments. Recall that we used a questionnaire (see Appendix

D3) to test participants' understanding of the treatment. This manipulation check led us to drop eight participants who did not correctly state the treatment they were assigned to, that is whether they were playing against a person of an equal, higher, or lower skill level. Data from two other participants were dropped because technical problems interrupted their games. Among the 70 participants, 34 percent were females and 66 percent were males. They averaged 3.15 hours daily computer usage and 2.66 hours weekly game playing. No significant differences were found in gender ($p = 0.329$), computer usage ($p = 0.344$), or gaming experience ($p = 0.129$) across treatment conditions, suggesting a successful random assignment.

We conducted factor analysis and validity checks on the measurement scales. We dropped one item that did not load properly on the measure for enjoyment ("I think playing this computer game is a waste of time") and used the remaining two items. The remaining two items loaded together and so did the five items for arousal with acceptable factor loadings greater than 0.8, and principal components showed them as distinct factors. The Cronbach's alpha for enjoyment was 0.81 and 0.94, for arousal. We computed the square roots of the average variance extracted (AVE) for enjoyment and arousal and they were greater than the correlations between the constructs. Thus our measurement scales satisfied tests of convergent and discriminant validity and had an acceptable level of reliability (Fornell and Larcker 1981).

We conducted repeated measures ANOVA with SPSS to test the treatment effects on effort (number of game attempts and playing time), enjoyment, and arousal. As shown in panel 1 of Table 1, as hypothesized, the main treatment effect is statistically significant, both on number of game attempts and on playing time. Players expended significantly more effort under the ESC treatment than under the UESC treatment as indicated by more game attempts ($p = .003$) and longer playing time ($p = .009$). Hence we find empirical support for Hypothesis 1: *a player will expend more effort when matched with an equally skilled competitor.*

When examining the results on emotional responses of enjoyment and arousal, panel 1 shows no significant difference in enjoyment or arousal between the ESC and UESC treatments. So Hypothesis 2, stating that *a player will experience higher enjoyment when matched with an equally skilled competitor,* and Hypothesis 3, stating that *a player will experience higher arousal when playing with an equally skilled competitor*, were not supported.

We conducted follow-up tests by splitting our samples into two groups: those who received ESC and LSC treatments

Table 1. Experimental Results				
	Marginal Estimated Mean (Standard Deviation)		**Repeated Measures ANOVA†**	
			F value	*p-value (1-tailed)*
Panel 1: Equally skilled competitor (ESC) vs. unequally skilled competitor (UESC) (*n* =70)				
Dependent variables	ESC	UESC	Hypothesis: ESC > UESC	
Number of game attempts	5.47 (0.4)	4.50(0.3)	7.916	.003***
Playing time (in seconds)	908.93 (56.8)	770.60(50.2)	7.196	.009***
Enjoyment	9.33(0.3)	9.37 (0.3)	0.220	.441
Arousal	23.74 (0.8)	23.44 (0.8)	0.210	.324
Panel 2: Equally skilled competitor (ESC) vs. lower-skilled competitor (LSC) (*n* = 34)				
Dependent variables	ESC (tying)	LSC (winning)		
Number of game attempts	5.71(0.5)	4.52(0.5)	5.313	.014**
Playing time (in seconds)	926.19 (82.8)	752.18 (76.0)	5.055	.016**
Enjoyment	8.82(0.5)	9.29 (0.5)	1.716	.10*
Arousal	24.87 (1.0)	23.69 (1.1)	2.400	.066*
Panel 3: Equally skilled competitor (ESC) vs. higher-skilled competitor (HSC) (*n* =36)				
Dependent variables	ESC (tying)	HSC (losing)		
Number of game attempts	5.30 (0.5)	4.52 (0.4)	2.668	.056*
Playing time (in seconds)	901.48 (78.3)	796.91 (65.3)	2.187	.074*
Enjoyment	9.78 (0.4)	9.44(0.5)	0.647	.214
Arousal	22.67 (1.2)	23.23 (1.1)	0.288	.30

†The effects of treatment order were non-significant in all tests.

 ***$p < .01$; **$p < .05$; *$p < .10$

(panel 2) and those who received ESC and HSC treatments (panel 3). We find that, once again, similar to our hypothesized effects, players expended significantly more effort when matched with equally skilled players than with higher-skilled ones (panel 2) in terms of the number of game attempts ($p = .014$) and playing time ($p = .016$). Similarly, players expended significantly more effort when matched with equally skilled players than with lower-skilled ones (panel 3) in terms of the number of game attempts ($p = .056$) and playing time ($p = .074$). Therefore our hypothesis that players expend maximal effort when matched with equally skilled players holds in both subgroups.

Results were mixed in terms of emotional responses. Negating our hypothesized effects, players showed higher levels of enjoyment when matched with a lower-skilled (winning) than with an equally skilled (tying) competitor, as shown in panel 2. The respective means were 9.29 and 8.82 ($p = .1$). Players had a slightly higher but nonsignificant mean score on enjoyment when matched with equally skilled players (tying) than when matched with higher-skilled players

(losing), as shown in panel 3. On the measure of arousal we find that players showed higher levels of arousal when competing with equally skilled players (tying) than with lower-skilled players (winning), as shown in panel 2. The respective means were 24.87 and 23.69 ($p =.066$). Players had a slightly lower but non-significant mean score on arousal when matched against equally skilled than against higher-skilled competitors (panel 3).

Discussion

As an initial step toward understanding the impact of serious games on player behaviors and emotional responses, we focused on competition as a game design element, because it evokes a sense of challenge (Malone 1981). Our results indicate that in competitive games, if players are equally skilled, they expend more effort by playing more games and for longer duration than if players are matched with competitors of higher or lower skill levels. But when players are

in competitive play with players of lower skill levels and are winning, they report higher feelings of enjoyment and lower level of arousal. We must, however, add that our findings suggest that there are many nuances in players' emotional reactions to competition that necessitate more investigations.

There are several possible reasons for the findings that a player achieves higher enjoyment when paired with a competitor of lower skill level. First, the positive interim performance feedback ("you are leading your competitor") may have affected their sense of enjoyment. Tauer and Harackiewicz (1999) argue that positive outcome feedback can enhance players' intrinsic motivation by increasing their perceived competence. We withheld feedback on the final outcome until after the experiment, but players may be affected by interim performance feedback. Second, it is also likely that the positive interim feedback was perceived as an encouragement that enhanced players' perceived competence (McAuley and Tammen 1989; Reeve and Deci 1996; Tauer and Harackiewicz 1999), which in turn increased their sense of enjoyment. In developing our expectations, we drew parallels with the balance condition when flow is highest. We argued that this will also lead to a high level of enjoyment. But recent research (Csikszentmihalyi 1997; Nah et al. 2011) makes a distinction between flow and enjoyment, describing enjoyment as an outcome of flow because "it is only after we get out of flow… that we might indulge in feeling happy" (Csikszentmihalyi 1997). Hence, it is possible that players experienced flow when matched with an equally skilled player but their enjoyment, which reflected both flow and performance feedback, was not the highest. Our expectation that higher levels of arousal will occur when players are matched with equally skilled players was not supported, but additional analysis shows that there was some partial support: players indeed reported higher levels of arousal when matched with equally skilled players than with lower skilled players. Taken together, the emotional responses of enjoyment and arousal are not similar to the outcomes of effort seen in competitive game designs, and performance feedback, among other factors, must be investigated further.

Implications for Practice

Our findings highlight that although there have been many calls to integrate games in organizational activities there are many challenges in designing these games and appropriate designs will depend on the intended benefits (Jarvenpaa et al. 2008; Raybourn and Bos 2005). For organizations that primarily use games as a way to engage employees in game activity, a design where players are equally skilled is beneficial because it can lead to optimal challenges for employees.

But for organizations that primarily use games to create enjoyment for employees in target activities, it will potentially be more beneficial to use a design where a player is matched with a lower-skilled player and has winning outcomes. The same design may not be desirable, however, if the primary goal is to create high levels of arousal among employees.

This study results offer some practical choices and strategies for organizations that want to use serious games in work and for organizations that sell online games to consumers. We find that players respond to competition even if there are only symbolic rewards, suggesting that competition is a cost effective way to motivate employees and online players. Moreover, when games are played on IT platforms, we have the potential to track players' skill levels and to design games to engage players in appropriate levels of competition (Stuart 2011). To keep the players engaged in the game, they can be paired with competitors who exhibit similar skill levels. When game playing activity is new to a participant, it is important to ensure that participants have enjoyment so that they will return to play and, as such, players can be paired with an opponent of lower skill level, so that they enjoy and develop an intrinsic interest toward the game.

Theoretical Contributions

Our research contributes to the tournament theory research in several ways. First, our study is among the first to develop an empirical test in an actual competitive gaming context and show that tournament theory can be tested in "real effort" experiments. Existing experimental tests of tournament theory ask participants to choose an abstract "effort number" instead of expending real effort in competition (Harbring and Irlenbusch 2003; Orrison et al. 2004). Our study adds to a small, but growing, body of empirical evidence that people respond to tournaments even if there are only symbolic rewards such as status and honorable mention (Huberman et al. 2004; Kosfeld and Neckermann 2011). Our results suggest that tournament theory may be a suitable theoretical framework for studying the "engagement economy" envisioned by McGonigal (2011). Yet another contribution to tournament theory is our results showing that high effort levels are not necessarily correlated with high levels of enjoyment or arousal, an issue hitherto not addressed in current tournament theory research which focuses primarily on effort. Emotional responses of participants hold important implications for future task choices and entry into tournaments. It is important for tournament theory researchers to take a more holistic approach by examining not only effort but also factors that impact future entry (e.g., emotional responses), especially when participation is voluntary.

Our findings extend our knowledge on intrinsic motivation. Games are often cited as examples of intrinsically motivating activities, but not much is known on the effects of skill-based competition. This study shows that competition can be examined as a strategic game of skills and demonstrates the value of differentiating competition conditions on relative skill levels. The finding that players experience different levels of enjoyment and arousal when facing competitors of different relative skill levels may potentially explain the inconsistent findings regarding the impact of competition on intrinsic motivation (Deci and Ryan 1985; Reeve and Deci 1996). The intrinsic motivation research typically evaluates player effort in a free-choice period after the competition (Tauer and Harackiewicz 1999) and our findings suggest that this can be expanded by taking into cognizance player effort levels *during* competition. This approach can give more insights into factors that create and sustain intrinsic motivation because effort during competition is not necessarily aligned with post-competition emotional responses.

Our study also illustrates the benefits of combining theoretical perspectives and research method paradigms (quantitative modeling and empirical laboratory testing), as several IS researchers have urged (Mingers 2001). By simultaneously examining how players approach different competition conditions and how they are emotionally affected by them, we reveal that player effort and emotional responses to game competition may follow different patterns, which in turn informs both tournament theory and intrinsic motivation theories, as explained. By combining different theoretical paradigms, we are able to understand the commonalities that exist between them. For example, the prediction based on tournament theory shows that effort is maximized in the equilibrium condition when players are equally matched in skill. As per flow theory, this would be seen as an optimal experience condition where a player's challenge and skill are balanced (Csikszentmihalyi and LeFevre 1989). Thus, two seemingly disparate theories, tournament theory and flow theory, can address similar game conditions and results. This blending of theories and paradigms provides a more comprehensive picture of how people respond to game competition and optimal game designs.

Limitations

We study a two-player indirect competition to keep our theoretical and empirical analysis within bounds, but future research should relax this assumption. Investigations are needed as to whether our findings can be generalized to other genres of games (e.g., strategy games) and games of other purposes (e.g., educational games). Our study is restricted to student participants, who may be less representative, although reports indicate that these future employees and consumers form a large segment of the gaming population. The manipulation check questions on treatments were given prior to game competition, which may have cued participants, but we did not find evidence of this effect. As a way of administering competitive game conditions, we informed the players that they were leading or trailing their competitors, which may be seen as encouragement or discouragement. Alternative feedback formats, such as showing real-time score boards and letting players decide whether they are winning or losing, might yield different results. Our study considers emotional responses of enjoyment and arousal, but there are other outcomes and indicators of intrinsic motivation and these have to be addressed.

Implications for Future Research

IS researchers have many opportunities to extend and chart new research directions on using serious games in organizations. To highlight some of these opportunities and the connections to existing IS research, we propose a research framework (Figure 2) for studying games.

This framework maps games based on the nature of social interactions. Social interdependence theory (Johnson and Johnson 1989; Stanne et al. 1999) delineates that an environment is *individualistic* when individual actions have no effect on others, *competitive* when individual actions obstruct the actions of others, or *collaborative* when individual actions promote the goals of others. Correspondingly, we may classify game designs as (I) individualistic (e.g., stand-alone games in which a single player faces individualistic challenges such as defeating monsters), (II) cooperative (e.g., simulation games in which teams face common challenges), (III) competitive (e.g., casual online games as described in this study where two or more players compete to be the best), and (IV) cooperative–competitive (e.g., multiplayer games in which players compete with each other as a group).[6] Please note that, as Figure 2 shows, individualistic goals (I) may be present in each of the three more complex environments, (II), (III), and (IV). Because of different social interactions in each environment, information technology plays different roles in the four environments: IT provides the human–computer interface in (I), facilitates coordination, trust, and

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[6]*Virtual Peace* is an example of a cooperative game that challenges a team of players to successfully rescue people affected by a hurricane. *Foldit* has both a competitive element, where individual members compete as soloists, and a cooperative–competitive element, where members can join groups and compete as a group.
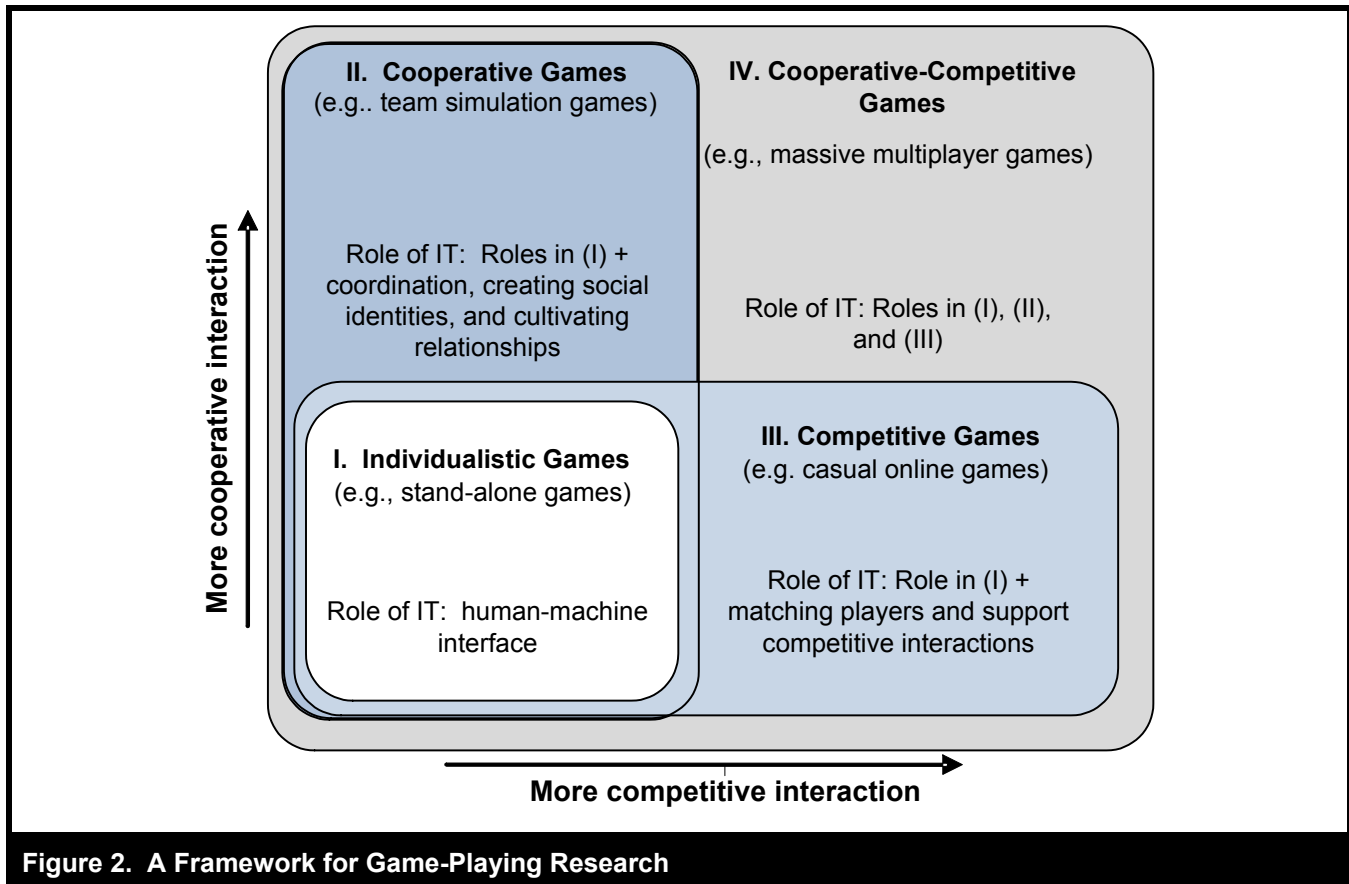
Figure 2. A Framework for Game-Playing Research

social identities in (II), provides skilled-based matching and facilitates competitive interactions in (III) , and perform all of the aforementioned functions in (IV).

Thus far, most existing game research focuses on individualistic game designs (I); very little research has considered cooperative (II), competitive (III), or cooperative–competitive (IV) game designs. Different theoretical perspectives are needed for studying each type of game interactions. For individualistic games, perspectives on flow, cognitive absorption, and intrinsic motivation provide excellent anchors to study the appropriate designs and impact of games in managerial and skill development applications (Agarwal and Karahanna 2000; Csikszentmihalyi and LeFevre 1989; Malone 1981). Research on cooperative and cooperative– competitive games, because of its emphasis on trust and team work, can benefit tremendously from existing research on virtual teams (Adya et al. 2008; Davidson and Tay 2003; Jarvenpaa et al. 1998; Rutkowski et al. 2007), small group theory (McGrath 1991), and social network theory (Brass 1995; Lin 1999). Research on competitive or cooperative– competitive games can draw upon tournament theory (Lazear and Rosen 1981; Rosen 1986) and theory of rivalry (Kilduff et al. 2010).

Future research can address a number of issues for competitive and cooperative-competitive game designs. For example, with the facilities offered by information technology, researchers can investigate how different types of information on competitors (e.g., age, gender, location, avatar) and different modes of communication during play (e.g., emails, voice, video, and text-based chatting) affect player engagement, emotional responses, and other outcomes. One can also determine whether adding cooperative elements makes competitive games more engaging and pleasurable than competitive or cooperative environments alone. As illustrated above, a plethora of research questions can be asked regarding the most effective game designs (from I to IV) and the best information technology features for a particular game application and managerial goal.

Concluding Remarks

The world of interactive digital games, as a growing segment of the IT industry, not only provides the most engaging interactions between humans and computers, but also serves as a novel and captivating conduit for humans to interact

competitively or cooperatively. Serious games as a way to engage and motivate employees has caught the attention of researchers (Greitzer et al. 2007; Raybourn and Bos 2005; Stapleton 2004). Some academic institutions are even starting to educate students on designing serious games (see http://seriousgames.msu.edu/). But research on interactive digital games is at a nascent stage and IS researchers, with their multidisciplinary background, have an excellent opportunity to conduct pioneering research to examine the impact of these games on organizational activities and theorize on the role of the IT artifact. We hope that our study findings and the proposed research framework will jump-start IS research on digital games.

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