The Effects of Game Dynamics on User Engagement in Gamified Systems

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Abstract
The use of game design elements to foster user engagement in non-game contexts, such as marketing, education, training, and healthcare, is rapidly gaining interest. Despite the growing attention given to gamification, little research has been conducted to theorize and empirically assess how and why game design elements influence user engagement. The resulting lack of an empirically validated theoretical foundation has kept the picture unclear of how gamification causes behavioral change in a way that increases user engagement. To help overcome the lack of theoretical support, this study develops a research model that predicts an individual’s engagement by drawing on two theories—basic psychological needs theory and mechanic-dynamics-aesthetics theory. Findings from an empirical study with 275 subjects confirm the expectations of this research that game dynamics lead to increased needs satisfaction, which promotes enjoyment and, ultimately, user engagement with the system.

1. Introduction
Along with the proliferation of diverse social media platforms and mobile applications, many business organizations are struggling to engage users because online markets have become increasingly competitive [47]. An increased number of online applications and companies are chasing a much slower-growing user base, thus heating up competition for user attention. As a relatively new paradigm to engage people, gamification has been adopted as a strategy to influence and motivate people to participate in education, training, marketing, networking, and health related activities [7, 24, 44]. Gamification, in this context, refers to the use of game elements, such as design techniques, thinking, and mechanics, to enhance non-game contexts to solve problems and engage users [11, 43]. It has been predicted that gamification will become a multibillion-dollar industry by 2015 [32]. Nike+, for instance, has adopted game elements in a way that users are rewarded when they reach a milestone. Users can also track their statistics, set goals, join challenges, play with an online “alter ego,” and connect with others in the community. The result has been a large and active fan base of 28 million users [8].

Researchers argue that gamification has the potential to positively impact performance, productivity, and user engagement [24, 43]. However, it has also been pointed out that gamified applications may fail to drive participation and sustain user engagement, unless they address the goals users really care about [8]. That is, while elements such as points, badges, and levels may motivate initial user engagement, the effects of game elements can be short-lived [24]. Foursquare, for instance, which is one of the original “gamified” applications, recently announced it would remove the gamified aspects from its original application and transfer them into a new one, Swarm.

Despite the growing attention to gamification, few studies have theoretically explained how and why adopting game elements influences user engagement, and there is still little empirical evidence about its real impact [24]. To fill this gap, this study aims to develop a theoretical framework that predicts user engagement in gamified systems with the following guided question:

How do game design elements work to engage users in gamified systems?
Toward this end, we draw on the basic psychological needs theory (BPNT) proposed by Ryan and Deci [38, 39], which is rooted in socio-psychology and describes why people engage more in a certain activity when they feel enjoyment. We also employ the mechanics-dynamics-aesthetics theory (MDAT) developed as a game design theory [21], which explains why game elements make people feel enjoyment. Integrating the two theories, we develop and test a research model that predicts an individual’s engagement in a gamified system. In so doing, this study provides meaningful implications for both academia and industry. For academia, it contributes toward a richer understanding of the impact of game dynamics on user engagement in gamified systems. For industry, by explaining the antecedents and motivation of user engagement in gamified systems, the study can assist in designing appropriate game mechanisms and techniques to enhance user engagement.

2. Theoretical Development

We employ two theories to investigate the impact of game design elements on user engagement: BPNT to theorize what factors determine an individual’s engagement and MDAT to theorize how game elements increase users’ intrinsic motivation. These two theories complement each other. While the former focuses on individuals’ psychological aspects, the latter focuses on the impact of game design elements on human psychology.

2.1. Basic psychological needs theory

BPNT is a sub-theory of self-determination theory (SDT), which is a widely studied macro-theory of human motivation [13, 38, 39]. SDT argues that people engage more in an activity when they are intrinsically motivated [12, 16, 17]. Intrinsic motivation refers to motivation that comes from inside an individual (e.g., enjoyment) rather than from any external rewards (e.g., money payment) [38]. BPNT further explains what factors make people feel that a certain activity is enjoyable. According to BPNT, conditions supporting individuals’ experience of autonomy, competence, and relatedness stimulate their intrinsic motivation, which in turn increases their levels of engagement in activities. Since the main purpose of gamification is to foster volitional and high-quality forms of motivation, BPNT is relevant for understanding user’s engagement in gamified systems. BPNT argues that individuals’ intrinsic motivation for a particular activity can be predicated by autonomy, competence, and relatedness. Autonomy refers to a sense of volition or willingness when doing a task; competence refers to feelings of effectance; and relatedness is experienced when a person feels connected to others [13, 14, 38, 39]. Figure 1 depicts the linkages between the concepts derived from BPNT. While the gray boxes represent the concepts developed at the theoretical level, the white boxes represent concepts at the operational level, which are used as research variables in this study.

2.2. Mechanics-dynamics-aesthetics theory

MDAT proposed by Hunicke et al. [21] describes how game design elements induce particular reactions from players. MDAT consists of three components: game mechanics, game dynamics, and game aesthetics. Game mechanics refer to the tools, techniques, and widgets that are the building blocks of a game. Game dynamics refer to the run-time behavior of a game and its interaction with players. Game aesthetics refer to players’ emotional responses when they interact with a game. Depending on the game dynamics, different emotional responses from individual users can be expected, such as rising tension, excitement, frustration, or relaxation. Whereas MDAT has been developed to theorize about actual games, we adopt the same theory in the context of gamified systems, as gamified systems employ game elements in a non-game context.

MDAT explains that game mechanics—PLB (points, levels, and badges), virtual goods, and leaderboards, all of which are designed at the level of algorithms—cause gameplay dynamics [21]. Game aesthetics come from game dynamics that stimulates users to leave their marks, compete with others, purchase game items, change levels, and create unique characters. Given that the purpose of gamification is to make non-game activities fun and enjoyable, we infer that enjoyment is pertinent to game aesthetics in gamified systems. Figure 2 represents the linkage between game mechanics, dynamics, and aesthetics at theoretical and operational levels.
2.3. Integration of BPNT and MDAT

BPNT explicates the influence of basic needs satisfaction on intrinsic motivation (enjoyment) and its positive functioning. On the other hand, MDAT suggests that the impact of game elements cause individual behavioral change by creating game dynamics, which in turn induce particular psychological responses from game players. As discussed in previous studies, users’ typical psychological responses to game dynamics are strongly associated with needs satisfaction [14, 15, 16, 39], so we link the path between game dynamics and needs satisfaction. Given that game aesthetics refers to enjoyment in a gamified system, drawing on the tenet of BPNT—enjoyment increases users’ engagement—we link game aesthetics with user engagement. Figure 3 outlines how we integrate the two theories.

3. Research Model and Hypotheses

Figure 4 represents the integrative theoretical model that we develop in this study. Because the purpose of this study is to examine how game dynamics influence needs satisfaction, intrinsic motivation, and engagement, we do not include an investigation about the relationship between game mechanics and game dynamics in this model, which is self-explanatory. In this model, we use rewards, status, and achievement as first-order reflective constructs because the three dynamics are highly co-related and they usually function together [7]. Accordingly, we create a second-order construct, getting PLB (points, levels, and badges).

3.1. User engagement in a gamified system

Users are engaged in a system when “it holds their attention,” indicating that a system has caught, captured, and captivated user interest [22, p. 58]. User engagement positively affects intentions to use a website [48] and may encourage users to revisit websites in the future [27]. Webster and Ahuja [48] posit that engagement gives rise to a positive view of human computer interaction and fosters motivation to interact with software in the future. User engagement is important in human computer interaction not only because it is beneficial for “informing the design and implementation of interfaces, but also for enabling more sophisticated interfaces capable of adapting to users” [35, p. 9].

While previous research regards user engagement as an individual’s overall involvement and satisfaction while doing a certain activity [19], it has more recently been acknowledged that the breadth and complexity of user engagement can be better captured by assessing its sub-dimensions: vigor, dedication, and absorption [41]. These three sub-dimensions represent the physical, emotional, and cognitive aspects of user engagement, respectively [10]. In this study, vigor refers to the extent to which a user is willing to invest his or her effort in doing a certain activity designed by a gamified system, and to be persistent even in the face of difficulties. Dedication refers to users’ sense of significance, enthusiasm, inspiration, pride, and challenge. Absorption refers to the extent to which a user is fully concentrated and deeply engrossed in a particular activity, whereby time passes quickly and he or she do not detach from the activity.
3.2. Enjoyment and user engagement

Enjoyment refers to the extent to which individuals feel a sense of fun when they use an information system [37]. Because intrinsic motivation comes from an individual’s enjoyment in using technologies, prior research argues that if they perceive that any activity involving a form of technology will be enjoyable, they tend to engage in using the technology more extensively than others [33]. Accordingly, assuming that the more users interact with a site, the more valuable and loyal they become, companies gamify their websites or applications in order to make user activities more enjoyable [7]. Since enjoyment is an important intrinsic reward, users are engaged in a system when it holds their attention and they feel that it is enjoyable [22]. Therefore, we formulate the following hypothesis.

H1: Enjoyment will lead to user engagement in a gamified system.

3.3. Needs satisfaction and enjoyment

According to BPNT, people need to feel competent, autonomous, and socially related while doing something if they want to maintain their intrinsic motivation (i.e., enjoyment) toward that activity. That is, when doing an activity satisfies an individual’s basic needs, in terms of competence, autonomy, and relatedness, he or she feels greater enjoyment. Competence involves feelings of effectance [43]. Autonomy refers to a sense of volition or willingness when doing a task [13, 15]. Relatedness is experienced when a person feels connected to others [15]. Applying the general notion of BPNT to the context of using a gamified system, we can infer that if individuals satisfy those basic needs in a gamified system, they will feel greater enjoyment. Based on the above discussion, we propose the following hypotheses.

H2a: Competence will lead to enjoyment in a gamified system.
H2b: Autonomy will lead to enjoyment in a gamified system.
H2c: Relatedness will lead to enjoyment in a gamified system.

3.4. Game dynamics and psychological needs satisfaction

PLB refers to the points, levels, and badges people can obtain as pay-off in a gamified system when they complete pre-designed tasks. While points, levels, and badges incur different dynamics, such as rewards, status, and achievement, these dynamics have commonalities in that individuals get tangible items as a response to their performance. Points, levels, and badges have therefore in many cases been treated as one single mechanism of a gamified system [11].

Rewards refers to obtaining points or receiving any kind of tangible items, which will be at users’ disposal after they follow the pre-designed procedures, and thus
H3a: Getting PLB will lead to the experience of competence in a gamified system.
H3b: Getting PLB will lead to the experience of autonomy in a gamified system.
H3c: Getting PLB will lead to the experience of relatedness in a gamified system.

Self-expression refers to the unique identities that users can create using virtual goods in gamified systems. Using virtual goods is a common way for users to create their own identities, whether they are earned through rewards, received as gifts, or bought directly with real currency. For example, a person’s avatar can often serve as a rich focal point for expression. In addition, people can use their own signatures or symbols to distinguish themselves from others [30]. Self-expression stimulates users’ sense of style and personality, and reveals an affiliation with a group. By having unique personalities that are different from other users, people can exercise greater autonomy. By expressing their emotions and feelings through virtual items (e.g., emoticons), people can interact with the other participants in a more personal way. Hence, we propose the following hypotheses.

H4a: Self-expression will lead to the experience of autonomy in a gamified system.
H4b: Self-expression will lead to the experience of relatedness in a gamified system.

Competitions enable people to challenge each other to achieve the highest score on an activity. The leaderboard is central to displaying the results and celebrating the winners. The fundamental nature of gaming is to compete to achieve a particular goal, regardless of the types of games, such as multiplayer-enabling, one-player games, or other single user experiences. This is because people gain a certain amount of satisfaction from comparing their performance with that of others. Psychology literature suggests that individuals are motivated to achieve greater performance in a competitive environment [38, 39]. In addition, through competition people feel that they interact with others. Accordingly, competition increases the perception of competition and relatedness with others. Based on the above, we propose:
H5a: Competition will lead to the experience of competence in a gamified system.
H5b: Competition will lead to the experience of relatedness in a gamified system.

Altruism refers to the behavior of gift giving in this study. Gift giving is a strong motivator when people seek to foster relationships. In gamification, gifting is an incredibly powerful acquisition and retention mechanic. People receive a gift from someone who pulls them into the system where the game dynamics operate, and then they are incentivized to send gifts to others, creating a large acquisition loop. When people receive a gift, it pulls them back into the application to redeem it, so people feel greater relatedness. Therefore, we suggest the following.
H6: Altruism will lead to the experience of relatedness in a gamified system.

4. Methods

To test our hypotheses, we adopt a survey method, through which we collect empirical data from the users of gamified systems. Given that our model links diverse aspects linking game dynamics, needs satisfaction, intrinsic motivation, and user engagement, we analyze whether the relationships between variables proposed are statistically significant through path analysis using structural equation modeling [2]. Specifically, we choose partial least squares (PLS) because it is appropriate for the early stages of theory development [4]. The methods used to develop the measurement items and for data collection are discussed in more detail below.
4.1 Measurement

This study has either adopted or adapted existing validated scales. All items were measured using seven-point scales that ranged from “strongly disagree” to “strongly agree.” The engagement scale [41] contained 14 items and three sub-scales: vigor (4 items), dedication (5 items), and absorption (5 items). Items of enjoyment were adapted from Kim et al. [26]. In order to assess the basic needs satisfaction, we adapted items from Jang et al. [23] and Sheldon et al. [45] for competence (5 items), autonomy (5 items), and relatedness (6 items), respectively. We developed the items for game dynamics following the standard psychometric scale development procedures [3]. Items on rewards (4 items) were derived from Kankanhalli et al. [25] and Bock et al. [5]. We employed measurements from Sen et al. [42] and Wang et al. [47] to examine status (4 items). Achievement was captured by 4 items based on O’Brien’s study [34]. Items for self-expression (4), competition (4), and altruism (4) were adapted from Ma and Agarwal [30], Lee and Yang [28], and Chen et al. [9] separately.

Similar to previous studies that addressed game design elements and human behavior [29], age, gender, and education levels were used as control.

4.2 Data collection

We collected data from users of two gamified systems: Nike+ runners club and Knowledge-in. Employing game design elements, Nike+ gamified its system so that users are able to upload their regular sports activities (running, walking, and cycling), including data such as distance, pace, and calories burned using a GPS sensor connected to their mobile devices (e.g., iPod and iPhone). Knowledge-in, a gamified knowledge-sharing community maintains about 5 million users in Korea. In both communities, users receive points, levels, and badges, according to their contribution or achievement. Leaderboards are used to facilitate competition among users. The users of both communities are able to use virtual items to express their emotions and interact with others using virtual gifts.

An online survey company was commissioned for the survey data collection, targeting users of the two gamified systems. Two filtering questions, “Are you an active member of the Knowledge-in community?” and “Are you an active member of the Nike+ runners club?” were presented on the first page of the survey website. Respondents who answered “no” for both questions were immediately terminated from the survey. In the next question, the respondents were asked to choose one gamified system in which they were most actively taking part. They were then instructed to answer all subsequent questions while keeping the selected system in mind. An email invitation to participate in the survey was sent to 20,000 people. The survey ended after 300 valid responses were gathered. After removing 25 responses that contained unanswered items, 275 responses were used for the final analysis. Approximately 61% of respondents were male and 39% were female. A large majority of the respondents (65.45%) were between 30 and 49 years old. More than 75% of respondents had obtained either a bachelor’s or graduate degree.

5. Results

In light of previous research, data analysis followed the two-stage analytical procedure [2]. The first stage assessed the measurement model for reliability and validity. The second stage examined the structural model to test the research hypotheses [18].

5.1 Measurement model

Table 1 contains factor loadings, t-statistics, indicator reliability (Cronbach’s alpha). To assess convergent validity, we examined the loadings and the t-statistics of the indicators on their corresponding construct. To do so, we conducted a confirmatory factor analysis (CFA), using the partial least squares technique (Smart PLS). If all the item loadings exceed the recommended 0.7 and reached statistical significance (greater than twice their standard errors), this is viewed as evidence supporting the convergent validity of those indicators. The results show that indicators are effectively measuring the same construct. In addition, Cronbach’s alpha was used to check internal consistency. All reliability measures were 0.8 or higher, well above the recommended level of 0.7, indicating adequate internal consistency.

Table 2 contains the composite reliability (C.R), average variance extracted (AVE), and correlations among constructs. Discriminant validity is assessed by comparing the correlation between the two constructs and the respective AVE. For each construct, the square root of the average variance extracted should exceed the construct’s correlation with every other construct. The results demonstrate that the discriminant validity of the constructs was ensured in our study.

5.2 Structural model

Results for the path coefficients in the structural model are shown in Figure 5. A positive relationship between enjoyment and engagement was supported.
Needs satisfaction dimensions (competence, autonomy, and relatedness) also had positive impacts on enjoyment. However, the positive effect on needs satisfaction of game dynamics (PLB, self-expression, competition, and altruism) was partially supported, in that PLB had a non-significant impact on relatedness. Accordingly, all of the hypotheses we proposed were supported except H3c.

Table 1. Measurement Reliability and Convergent Validity

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6. Discussion and Implications

We set out to examine how game dynamics influence user engagement in a gamified system. Our work suggests that the three basic needs should be satisfied to stimulate users’ intrinsic motivation in a gamified system. Specifically, the results show that competence, autonomy, and relatedness account for about 49% of the variance of enjoyment. This implies that ignoring one aspect of the three basic needs may significantly reduce user’s enjoyment levels. Our work also demonstrates that game dynamics positively influence user engagement through the mediation of needs satisfaction, confirming our research model proposed in this study.

Table 2. Discriminant Validity and Correlation of Constructs

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Note: Square root of AVE for each latent construct is given in diagonals.

Our findings indicate that game dynamics are effective mechanisms for increasing user engagement, but different game dynamics have different impacts on user engagement. The results of our analysis show that (1) getting PLB positively influences competence and autonomy; (2) self-expression positively influences autonomy and relatedness; (3) competition positively influences competence and relatedness; and (4) altruism positively influences relatedness. Our findings imply that none of the game dynamics suggested in this study should be ignored when attempting to make users more engaged in a gamified system. This is because each dimension of game dynamics plays a different role in satisfying the different facets of basic needs. Our work suggests that gamification is not all about receiving PLB, but that other dynamics, such as self-expression, competition, and altruism, also play important roles in stimulating individuals’ intrinsic motivation by influencing needs satisfaction. In sum, our work confirms that game dynamics operate as important mechanisms for increasing user engagement in non-game contexts, such as knowledge-sharing and sports-related communities.
6.1. Implications for Research

Researchers have investigated how technology shapes human behavior. In particular, understanding the impact of the hedonic aspects of technology has become an important agenda in IS research [6, 46]. The results of this study pave a way to examine why and how technology shapes individuals’ behavior using game dynamics. By developing and testing the model, this study contributes to a better understanding of how individuals’ experiences of engagement are associated with game dynamics, individuals’ needs satisfaction, and intrinsic motivation. This, in turn, will lead to a more nuanced view of human behavior online, especially focusing on how technologies can shape individuals’ behavior. The proposed model serves as a theoretical platform to further examine the roles of game dynamics in many other non-game contexts.

6.2. Implications for Practice

Our results also have implications for practice. Based on the findings of this study, we can advise managers or designers who try to gamify their systems or applications. Drawing on the findings of this study, our recommendation to increase user engagement is to employ game dynamics in a way that satisfies users’ basic psychological needs. In doing so, we recommend that not only PLB, but also the other dynamics, namely self-expression, competition, and altruism should be purposely designed, considering how each dynamic influences users’ needs satisfaction.

Another contribution of this study to practice is its recommendation on how to design information systems in organizations. Currently, many organizations are deploying rewards and competitive tactics commonly found in the gaming world to make employees’ tasks more enjoyable [44]. For example, companies gamify the processes in which employees receive points or badges for completing jobs or meeting time limits for work assignments. Our findings suggest that a level of competition influences individuals’ competence confirming the notion that individuals are motivated by competition in that higher levels of performance can be achieved when a competitive environment is established [38]. Leaderboards can be used to let employees view others’ performance, which may encourage friendly competition and motivate performance. Thus, designing competition dynamics will help motivate employees to engage in their tasks. Given that little research has empirically examined the impact of such game dynamics on employees’ performance, the results of our study can provide descriptive and prescriptive values to practitioners who want to employ game elements in their work environments. Our model and measurement items can be used in diverse gamified systems to assess how designed game dynamics operate to increase user engagement and to identify problems with regard to the game design elements and their effects on user behavior.
6.3 Limitations and Further Research

Although we believe that our efforts contribute to a better understanding of user engagement in gamified systems, it should be noted that the impacts of game dynamics on user engagement can vary depending on the different purposes of systems to be gamified. For example, while we found that competition positively influences relatedness, there is controversy about the effects of competition. Competition may have negative effects on intrinsic motivation by undermining feelings of autonomy and competence. Some researchers argue that competition decreases intrinsic motivation because high levels of competition are detrimental to outcomes such as creativity, cognitive flexibility, and problem solving [1, 31]. We call on researchers to examine the proposed model in different contexts to reconcile the controversies around competition. A second limitation is the possible positive bias in our data, as we surveyed active members, who may have had a relatively positive experience when compared to those who had not been attracted by gamification. Future research could extend the generalizability of these studies by including data obtained by observing people who ended their activities as a result of negative experiences.

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8. References