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When Students are Players: Toward a Theory of Student-Centric Edu-Gamification Systems

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ABSTRACT

The idea that games impact learning is not new to pedagogy. Within the last decade, there has been an increased use of games for higher education, social engagement, marketing, and business training. When used within a higher education setting, a gamification system does not operate within a vacuum, but rather is imbued with and embedded in the learning content of the course. So, to thoroughly understand the system's impact on learning outcomes, we must consider how the learning content within the system and the instructor's behaviors might impact student motivation to use the system and thus the outcomes of use. A gap in knowledge exists regarding how to include these aspects in the examination of the phenomenon. This gap is addressed through the presentation of a Theoretical Model of Student-Centric Edu-Gamification Systems. Additionally, references are provided for established empirical instruments that can be adapted to operationalize the proposed model. Taken together, these contributions set the stage for both practitioners and academics to engage in research toward the development of student-centric educational gamification systems.

Keywords: Game-based learning, Gamification, Student learning, Technology acceptance model (TAM), Learner-centered education

1. INTRODUCTION

The idea that games impact learning is not new to pedagogy. Young children are engaged with games to learn colors, letters, and how to make associations. They engage in team sports to learn skills like teamwork, leadership, and accountability to others. The advent of technology brought new types of games into the environment – video games – and researchers have been studying the impact of these games on child development for years. However, games aren't restricted to children. Within the last decade there has been an increased use of games for higher education, social engagement, marketing, and business training (Rodrigues, Costa, and Oliveira, 2013; Hamari, Koivisto, and Sarsa, 2014; Jipa and Marin, 2014; Varannai, Sasvari & Urbanovics, 2017). This phenomenon is referred to as gamification and can be defined as "the use of game-based elements such as mechanics, aesthetics, and game thinking in non-game contexts aimed at engaging people, motivating action, enhancing learning, and solving problems" (de Sousa Borges et al., 2014, p. 216). Studies regarding gamification have focused on the theories used to examine gamification in education (Muntean, 2011; Nicholson, 2012; Reiners et al., 2012; Putz and Treiblmaier, 2015; Schunk and Dibenedetto, 2016), the effective elements of gamification (Wood and Reiners, 2012; Gibson et al., 2015; Cheong, Filippou, and Cheong, 2014; Schöbel, Söllner, and Leimeister, 2016; Schaffer and Fang, 2018), the application of gamification (Fernandes et al., 2012; Blohm and Leimeister, 2013; Banfield and Wilkerson, 2014; Cheong, Filippou, and Cheong, 2014; Iosup and Epema, 2014; Eckardt and Robra-Bissantz, 2018; Kwak et al., 2018; Talaei-khoei, Kerr, and Motiwalla, 2018), and literature reviews aggregating what has been researched thus far (de Sousa Borges et al., 2014; Hamari, Koivisto, and Sarsa, 2014; Scott, Links, and Basten, 2014; Dey and Eden, 2016; Inocencio, 2018; Osatuyi, Osatuyi & De La Rosa, 2018).

Studies have focused on the elements of the systems used to gamify courses and how they motivate students to learn. Additionally, researchers have studied the learning outcomes and if the gamified course content improved them. Although research has found that "[g]ames work best when coupled with effective pedagogy" (McClarty et al., 2012, p. 13), little attention has been given to the pedagogical content incorporated in the gamified systems and how instructors guide the use of the system. "At the most general level, learning occurs through the cognitive engagement of the learner with the appropriate subject matter knowledge. The two central figures in this statement are the learner and the subject matter knowledge" (McLaughlin et al., 2005, p. 3). When used within a higher education setting, a gamification system does not operate within a vacuum, but rather is imbued with and embedded in the learning content of the course. To thoroughly understand the system's impact on learning outcomes, we must consider how the learning content within the system and the instructions regarding system use might impact student motivation to use the system and thus the outcomes of use.

A gap in knowledge exists regarding how to include these aspects in the examination of the phenomenon. The presentation of a Theoretical Model of Student-Centric Edu-Gamification Systems addresses this gap. It is a modified version of the Technology Acceptance Model (TAM) (Venkatesh, Viswanath, and Bala, 2008). Critics of TAM have acknowledged "its incompleteness and called for extending TAM to specific contexts and including specific variables" (Yang, Asaad, and Dwivedi, 2017, p. 461). In response to this call, aspects of the educational environment as well as elements of Expectancy-Value Theory (McLaughlin et al., 2005), a gamified learning theory (Landers, 2014), and "casual relationships between constructs in gamification science" (Landers et al., 2018, p. 320) are incorporated in the proposed modification and thus bridge the gaps between existing gamification models, gamification development plans, and information systems user studies specifically in educational settings.

This adaptation affords two major contributions. The first contribution includes the model and propositions for studying how system, task, and instructor characteristics, along with individual psychological and motivational components, impact system/course engagement and thus educational performance. The second contribution supports the first and is comprised of references for established empirical instruments that can be adapted to operationalize the proposed model. Taken together these contributions set the stage for both practitioners and academics to engage in research toward the development of student-centric educational gamification systems. To the author's knowledge, this is the first paper to present a model and mechanisms for studying how to create a student-centric educational gamification system based on the extended TAM and incorporating elements of gamification science. The remainder of this paper includes a review of the extant literature, a presentation of the theoretical model, the potential instruments for adaptation, and concludes with the contributions and future research.

2. LITERATURE REVIEW

The quantity of studies on gamification is growing each year. They can be found in domains such as information systems, education, organizational behavior, psychology, and marketing. Those studies most pertinent to this study fall into three themes: defining gamification, the elements of the gamification system, and the theories used to study gamification systems. Literature in each of those themes is presented here.

2.1 Defining Gamification

As previously noted, gamification can be defined as the application of gaming elements to non-gaming contexts (Muntean, 2011; Wood and Reiners, 2012; de Sousa Borges et al., 2014; Liu, Samtjama, and Webster, 2017; Osatuyi, Osatuyi, and De La Rosa, 2018). However, this is one basic understanding in a sea of interpretations. The concept of gamification took root in education in the 1980s, though the term was not coined until decades later. Nick Pelling was the first person to use the term gamification in 2002/2003. As a consultant, he worked to make hardware more fun (Dale, 2014). It wasn't until 2011 that the term was added to the Oxford Dictionary with a definition of "the application of concepts and techniques from games to other areas of activity" (Dale, 2014). This was the same year that organizations started buying into the concept of gamification. Table 1 presents examples of the common definitions uncovered in the extant gamification literature.

Definition	Field of Study	Authors
The use of game design elements in non-game contexts	Media environments	Deterding et al., 2011
A process of enhancing services with (motivational) affordances in order to invoke gameful experiences and further behavioral outcomes	Systems science	Hamari, Koivisto, and Sarsa, 2014
The concept makes use of elements from games, which are well known for motivating and engaging players for lengthy periods, and applies them to non-game contexts in order to recreate the same level of motivation and engagement for other purposes (specific to information systems education)	IS education	Cheong, Filippou, and Cheong, 2014
Utilizing a digital platform to incorporate game-like elements in non-game contexts with the aim to positively influence user motivation and to improve user engagement in desired behaviors	Technology innovation	Ruhi, 2015
Game-based incentivized approaches to customer engagement	Services marketing	Harwood and Garry, 2015
The incorporation of game design elements into a target system while retaining the target system's instrumental functions	Information systems	Liu, Samtjama, and Webster, 2017
The enhancement of information systems technology via design features borrowed from (video) games	Systems sciences	Morschheuser et al., 2017
Utilization of game-like design elements in a non-game context to motivate people and solve problems (regarding computers in any pedagogical area)	Computers and education	Huang and Hew, 2018

Table 1. Examples of Gamification Definitions

The definitions reported in Table 1 include the concepts of motivation, engagement, and behavioral influence that are commonly found in definitions of gamification. However, most definitions stop short of including the outcome of performance. While many studies talk of aligning goals with performance in the system (Farzan et al., 2008; Deterding, 2015; Sarangi and Shah, 2015; Vinichenko et al., 2016; Marques et al., 2017), the outcome of performance is part of the description of the system and/or planning the mechanics of the game. For example, Huotari and Hamari (2017) offer the definition: "Gamification refers to a process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation" (p. 25) and emphasize its focus on the goal of gamification, not the goals of the users within a gamified system (Huotari and Hamari, 2017). However, the author's assertion is that an instructor desiring to successfully implement a gamified system in an educational environment must define that system to include the student/user, the system, and the performance goals. For this reason, the current paper aligns with Dale's (2014) discussion on gamification that references Gartner's definition as "the use of game mechanics and experience design to digitally engage and motivate people to achieve their goals" (Burke, 2014).

2.2 Studies Focused on System Elements

Extant literature on gamification has a strong focus on the gaming elements utilized within the systems. Studies have examined which elements are effective in learning, motivate students to use the system, and generally are liked by the users (Gibson et al., 2015; Schöbel, Söllner, and Leimeister, 2016; Sailer et al., 2017). While games differ in content and goal, there are some common elements shared amongst a majority. These include such things as point systems, leader boards, a player profile, teams, progress bars, and achievement badges. Iosup and Epema (2014) created two gamification-based courses, one at the undergraduate level and one at the graduate level. Technically, they discovered that performance badges are very popular, short quizzes and student feedback can improve the gaming analytics, and the class rhythm can be achieved through announced tests that offer points (Iosup and Epema, 2014). In another study, Cheong, Filippou, and Cheong (2013) found the elements of points, leader boards, profiles, teams, progress bars, and badges to be useful elements.

Regarding badges specifically, they are an element that can digitally represent an accomplishment, interest, or affiliation. Affordances of digital badges for education include such things as motivation, status recognition, and evidence of achievement (Gibson et al., 2015). Sailer et al. (2017) found that badges were related to an increase in users' perceived task meaningfulness and competence needs satisfaction. Additionally, Abu-Dawood (2016) asserted that game elements such as badges, avatars, or educational agents can enhance cognitive engagement. However, Schöbel, Söllner, and Leimeister (2016) found that leader boards and badges do not motivate all users. Rather, they found that users desire intrinsically motivating gamification elements such as levels, points, goals, and status. As these gaming elements are tools within the system, their mere existence is not a motivating factor. Instructors must apply the gaming elements effectively as they relate to the content of the course. While an understanding of the specific gamification system elements is important to the research, there are interrelated aspects within the educational setting that also need to be considered when studying designing these systems.

2.3 Examining the Theories

Several theories have been used to examine gamification (Oprescu, Jones, and Katsikitis, 2014; Seaborn and Fels, 2015). To assist in the establishment of a theory-based research agenda for gamification, Putz and Treiblmaier (2015) developed a guide to IS theories suitable for the context. Through collaboration with IS researchers, they identified 11 possible theories and, with possible research questions, discussed how those theories could be used to study gamification. A goal was to structure the domain of study. Their analysis resulted in two themes of theories: those focused on changing behavior and/or attitude and those focused on the design of applications for gamification. Interestingly, they categorize Keller's Motivational Model under design theories as opposed to behavioral, though it deals with expectation, motivation, attention, and engagement (Putz and Treiblmaier, 2015). Another motivational model, Fogg's Behavior Model (FBM), incorporates motivation, ability, and triggers. Because gamified learning management systems can be viewed as persuasive technology, FBM is also a suitable theory that can be applied to gamification (Muntean, 2011). These elements can foster student engagement with the course material, which is reported as being the "important metric for success in gamification" (Muntean, 2011, p. 328). Recently used theories include self-determination, intrinsic and extrinsic motivation, situational relevance, situated motivational affordance, universal design for learning, user-centered design, and the Transtheoretical Model of Behavior Change. These theories come from such fields as psychology, educational psychology, information studies, computer-human interaction, and education. Additionally, from the information systems field, the Technology Acceptance Model (Venkatesh, Viswanath, and Bala, 2008; Rodrigues, Costa, and Oliveira, 2013; Jipa and Marin, 2014; Yang, Asaad, and Dwivedi, 2017) has also been used.

Intrinsic and Extrinsic Motivation introduces the notion of separate banks of motivation factors: those that come from inside individuals and those that exist outside of them. Extrinsic motivators include the ability of one to identify them, find value in them, and set goals of attainment. Additionally, they can prioritize those goals. Intrinsically, individuals are motivated by their interest in the goal and pleasure found in the attainment of that goal (Ryan and Deci, 2000b). *Self-Determination Theory* takes the concepts of intrinsic and extrinsic motivation one step further, placing them on a continuum that ranges from non-self-determined behaviors to self-determined behaviors. Individuals who experience non-self-determined behaviors are amotivated, and the locus of control is impersonal. On the other end of the spectrum, individuals who engage in self-determined behaviors are intrinsically motivated and regulated. The spectrum between those two ends encapsulates the extrinsic motivations (Ryan and Deci, 2000a).

What this means for educational gamification is that students can experience a range of behaviors related to the gamified system. Extrinsically, they can experience rewards, place value on the system, and align the regulations with their own values. Intrinsically, individuals are motivated to use the system out of enjoyment or interest, gaining some degree of satisfaction from using the system. Banfield and Wilkerson

(2014) described gamification as a type of pedagogy and implemented a gamification method based on experiential learning theory. Using participant observation and a loose interviewing method in a computer networking course and systems administration course, the authors found that the introduction of gamification resulted in an increase in intrinsic motivation and self-efficacy (Banfield and Wilkerson, 2014). Also, intrinsic motivation can be improved through gamification in the areas of user satisfaction, conveyance of optimism, facilitation of social interaction, and provision of meaning. Behavioral changes that support the learning processes that accompany those changes are also impacted (Blohm and Leimeister, 2013).

Situational Relevance and *Situated Motivational Affordance* offer similar underpinnings for gamification. Situational relevance is the idea of aligning the goals of the system with what users deem as relevant to them. Motivation affordance acknowledges "a user is motivated by an aspect of a system only when there is a match between that aspect and the background of the user" (Nicholson, 2012, p. 3). While again stressing the importance of understanding the multi-faceted nature of the user base, there is still a lack of direction for obtaining this depth of information about the users.

The *Universal Design for Learning,* however, recommends focusing on the content of the system, how users will communicate their grasp of the content, and linking the content to the users' background (Nicholson, 2012). This perspective once again turns the focus to the students accessing the content in a way that allows them to achieve performance and take away knowledge from the system. Nicholson (2012) asserts that all three of these are part of a larger picture: *User-Centered Design*. He goes so far as to state that the phrase 'user-centered' should be included in the definition of gamification as the concept is paramount to the creation of meaningful gamification systems. Norman's (2002) theory of user-centered design requires the consideration of the users' needs and goals in every development phase (Norman, 2002). This supports the inclusion of user perspectives throughout the gamification development process and thus the system itself aligned, of course, with the educational performance goals.

The *Transtheoretical Model of Behavior* is a stage model of human behavior and attitude change (Sakamoto, Nakajima, and Alexandrova, 2012). As applied to gamification, it can examine the impact of four extrinsic values: informative, empathetic, economic, and persuasive on an individual's intrinsic motivation. Coupled with the individual's ideological value, these can positively impact one's thinking and self-efficacy, increasing the likelihood of a positive outcome (Sakamoto, Nakajima, and Alexandrova, 2012). The extrinsic values are the gaming elements executed in the system. The storyline, which is the content in the system, invokes the ideological values of the users. As noted by the authors, "the five values lead to the self-efficacy to improve a player's gaming skills with his/her friends' cooperation and support" (Sakamoto, Nakajima, and Alexandrova, 2012). Further work with values includes Ishizawa et al.'s (2015) study of user experiences with augmented reality in which they evaluate empathetic, aesthetic, ideological, authentic, and informative values. For gamification, understanding the value that users place on aspects of the system increases our understanding of the users' motivations for engaging with the system to achieve their goals.

The *Technology Acceptance Model* has been used more in the study of gamification in the technology and business domains (Herzig, Strahringer, and Ameling, 2012; Rodrigues, Costa, and Oliveira, 2013; Jipa and Marin, 2014; Raeisi and Meng, 2016; Rodrigues, Oliveira, and Costa, 2016a, 2016b; Lai, 2017; Yang, Asaad, and Dwivedi, 2017) than in the educational domain (Varannai, Sasvari, and Urbanovics, 2017). However, they all incorporate the constructs of perceived usefulness and perceived ease of use from the original TAM (Venkatesh, Viswanath, and Davis, 2000; Venkatesh, Viswanath, and Bala, 2008) with the final dependent variable varying between intention to use (Herzig, Strahringer, and Ameling, 2012; Rodrigues, Costa, and Oliveira, 2013; Raeisi and Meng, 2016; Rodrigues, Oliveira, and Costa, 2016b; Varannai, Sasvari, and Urbanovics, 2017), brand attitude (Yang, Asaad, and Dwivedi, 2017), and a measurable outcome such as system use (Jipa and Marin, 2014) and business impact (Rodrigues, Oliveira, and Costa, 2016a).

Important to note is that while these theories are largely user-focused, there is still a lack of synthesis of these concepts into a framework that can be operationalized to provide applicable results to the development of student-centric edu-gamification systems. One area of significance that is absent from the current theories and models is the educational environment. As such, the next section introduces the Theoretical Model of Student-Centric Edu-Gamification Systems. The model is an extension of Venkatesh et al.'s (2008) Technology Acceptance Model 3 in which they represent "the cumulative body of knowledge accumulated over the years from TAM research" (p. 276). The author synthesized the aforementioned theories and identified gaps in the evaluation of gamified system users to identify where Expectancy-Value and gamification science are most appropriately incorporated into the model. Additionally, the author collected potential resources for validated instruments that can be adapted for use in operationalizing the model.

3. THEORETICAL MODEL OF STUDENT-CENTRIC EDU-GAMIFICATION SYSTEMS

The birth of gamification as a concept in education led to the literature in that field. As such, the author noted that the purpose of gamification in education is often to improve learning outcomes. However, educational performance is not just about the outcome, but also about the journey to that outcome – the experience. Therefore, the author searched education literature to source out theories or models of learning that may be applicable to student-centric edu-gamification systems. The shift from an instructor-centric approach to a student-centric approach requires a deeper understanding of the student base (Talaei-khoei, Kerr, and Motiwalla, 2018) through such aspects as their beliefs about their academic capabilities (Jinks and Morgan, 1999), computer capabilities (Compeau, Higgins, and Huff, 1999), and competence toward learning (Williams and Deci, 1996). Additionally, since the focus of this study is on a student-centric model of an edu-gamification system, it is important to evaluate the role that the instructional process plays in the phenomenon through the inclusion of evaluation of student perspectives on the instructor's active learning attributes (Kember and Leung, 2008). Figure 1 depicts the Theoretical Framework of Student-Centric Edu-Gamification Systems, referred to as the SES framework going forward.

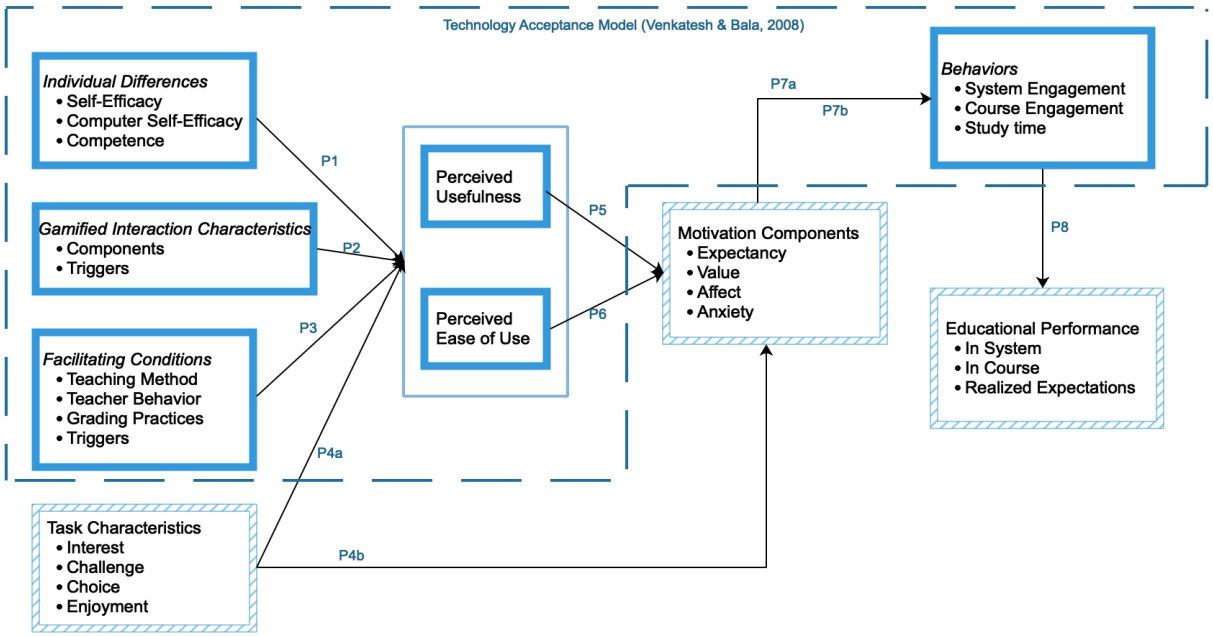

Figure 1. Theoretical Framework of Student-Centric Edu-Gamification Systems (SES)

The importance of including both the instructional and system aspects in the model is based upon "[t]he most fundamental and intuitive causal relationships in the theory of gamified learning" (Landers, 2014, p. 760). These are the most "consistently demonstrated relationships in the educational and organizational training research literatures" (Landers, 2014, p. 760) and support that "improved instructional content can alter learning outcomes and learner behaviors across a wide range of content areas and approaches" (Landers, 2014, p. 760). As such, while gamified systems should enhance instruction and not replace it, they should also be supported by the pedagogical techniques of the instructors implementing them. Imagining student success without including an examination of the instructional techniques leaves a gap in that teaching characteristics have been found to "strongly influence perceived learning" (Abrantes, Seabra, and Lages, 2007, p. 963), and instructor factors influence class activity which in turn impacts students' sense of community in class (Martin and Bolliger, 2018, p. 207). These gaps are addressed in the proposed model.

3.1 Individual Differences

The model begins with user perceptions of their competence and capabilities. The individual differences component in the SES framework has been adapted to the educational environment based upon its inclusion in TAM 3 (Venkatesh, Viswanath, and Bala, 2008) and gamification science (Landers et al., 2018). Where the organizationally focused TAM 3 incorporates "traits or states of individuals" (Venkatesh, Viswanath, and Bala, 2008, p. 276), in an educational setting we are concerned with those traits/states as they pertain to a student's learning self-efficacy (Jinks and Morgan, 1999), computer self-efficacy (Compeau et al., 1999), and competence for learning (Williams and Deci, 1996). Perceived *self-efficacy* "is concerned with people's beliefs in their capabilities to produce given attainments" (Bandura, 2006, p. 307). It is important to understand that self-efficacy is not a stand-alone concept but must be "tailored to the particular domain of functioning that is the object of interest" (Bandura, 2006). In an educational environment, this is the student's perception of their educational capabilities. Since perceived self-efficacy is one's judgment about their capability to perform, it can be supposed that it would be positively related to both one's perception of the gamified system and the tasks therein. Similarly, *computer self-efficacy* "refers to a judgment of one's capability to use a computer" (Compeau and Higgins, 1995, p. 192). This is applicable in a gamification study as these types of systems are executed on some type of computing device (e.g., laptop, desktop, tablet, mobile device, etc.). Thus, assessing users' perceptions of their capabilities with computing devices expands the understanding of the user base. We can once again suppose a positive relationship between this concept and one's perception of the system and the tasks. The third individual psychological component, *competence*, is defined within Self-Determination Theory as a psychological need and has been used to predict behavior change, ambient values, and performance (Deci et al., 1994). As a facilitator of performance outcomes, it is also supposed to have a positive relationship to one's perception of the system and the tasks. Therefore, as a group, the proposition is:

> *P1. Individual differences will have a positive impact on a student's perceptions of perceived usefulness and perceived ease of use of the edu-gamification system.*

3.2 Gamified Interaction Characteristics

The characteristics of the system refer to the gaming elements implemented programmatically and the mechanisms by which users are encouraged to interact with the system. *Components* are the "basic achievements for end users who interacted with the system" (Ruhi, 2015, p. 8). These refer to elements such as points, leaderboards, levels, and ranks. User perspectives

regarding these elements have been studied to determine which ones are 'best' (Iosup and Epema, 2014; Gibson et al., 2015; Schöbel, Söllner, and Leimeister, 2016; Sailer et al., 2017). The results of these types of studies indicate that there is no silver bullet component that increases motivation to engage with a gamified system (Cheong, Filippou, and Cheong, 2014; Schöbel, Söllner, and Leimeister, 2016). Rather, different components used with differing content may impact how students perceive the usefulness and ease of use of the system. If they like the components, it may increase the positive perceptions of the system. As such, a presumed positive relationship exists between gaming components and perceived ease of use and usefulness of the system. Additionally, a *trigger* is something used to "tell the user to complete the action in a certain moment" (Muntean, 2011, p. 324). Triggers are directly related to perceived ease of use and usefulness of the system because they are an explicit notification of the need to take action within the system. They may be visual, such as a pop-up dialogue box, or even auditory via a sound that indicates something needs to be completed in the system. Given this, the following is proposed:

P2. Gamified Interaction will have a positive impact on a student's perceived ease of use and usefulness of the edu-gamification system.

3.3 Facilitating Conditions

Within TAM 3, facilitating conditions are the "organizational support that facilitates the use of an IT" (Venkatesh, Viswanath, and Bala, 2008, p. 276). In an educational setting, that support is provided by the instructor in the form of active learning. The *teaching method* employed in the class refers to how well the teacher actively engages students using a variety of learning tasks (Kember and Leung, 2008). *Teacher behavior* is the personability of the instructor (encouraging, relevant, etc.) (Kember and Leung, 2008). *Grading practices* refer to the alignment of assessments to learning outcomes (Kember and Leung 2008) and the interactions that students have with the instructor regarding grading (Robinson and Hullinger, 2008). *Triggers* here are a similar concept to system triggers, but from the instructor. So, this includes items like providing a useful schedule or instruction documents about system use. Because these should support the usefulness and ease of use of the system, the proposition is:

P3. Facilitating conditions will have a positive impact on a student's perceived usefulness and ease of use of the edu-gamification system.

3.4 Task Characteristics

Task characteristics address the content executed within the gamified system. Due to the nature of games, there is an identified need to evaluate the tasks with regard to the pleasurable aspects that draw individuals to gameplay. The four elements presented here (interest, challenge, choice, and enjoyment) are dimensions associated with both motivation and learning in the extant literature (Gentry, Gable, and Rizza, 2002). For the current study, *interest* is considered a context-specific concept that serves as a directive force (Schiefele, 1991). Research in education has found that, within the classroom, subject matter interest has a positive impact on student motivation (Schiefele, 1991). Because the gamified system is the location of experience and learning, a positive relationship is proposed to exist between interests in the tasks within the system, an individual's perceived usefulness and ease of use, as well as an individual's motivation to use the system. *Challenge* is defined as an opportunity "for action that stretches (neither overmatching nor underutilizing) existing skills" (Nakamura and Csikszentmihalyi, 2014, p. 90). Within an educational environment, the stress of challenge is said to have a positive impact on an individual's motivation. The learner is motivated to exert more effort to meet the challenge to achieve a high learning outcome (LePine, LePine, and Jackson, 2004). Thus, there is a positive relationship between task challenge and motivation. There may also be a positive relationship between task characteristics and perceived usefulness and ease of use should the challenge aspect be a result of the system design itself. *Choice* goes back to the Universal Design for Learning and providing the students with options regarding what they accomplish in the system, how they accomplish it, and how it is tied to their background (Nicholson, 2012). Ultimately, giving students choices of tasks may have a positive relationship with their motivation to use the system. *Enjoyment* in this context is defined as the factors which make computer games fun (Ghani, Supnick, and Rooney, 1991). Enjoyment also describes the positive reactions that individuals experience in response to the gameplay (Fang and Zhao, 2010). Due to the inherent positive nature of the term enjoyment, an equally positive relationship is proposed between enjoyment, perceived usefulness and ease of use, and motivation. Thus, those proposals are:

P4a. Task characteristics will have a positive impact on a student's perceived usefulness and ease of use of the edu-gamification system.

P4b. Task characteristics will have a positive impact on motivation components of the edu-gamification system.

3.5 Perceived Usefulness and Perceived Ease of Use

Perceived usefulness (PU) and perceived ease of use (PEU) have accepted understandings within the IS field. However, in gamification science, these could be categorized as what Landers et al. (2018) refer to as design-relevant moderators that "influence the effectiveness of game elements on immediate, targeted psychological state changes" (p. 325). *Perceived usefulness* is the idea that a user will be of the opinion that the system positively impacts the action being taken (Venkatesh, Viswanath, and Bala, 2008; Lai, 2017). *Perceived ease of use* is understood from the viewpoint that a user could easily access and use the functions of the system (Venkatesh, Viswanath, and Bala, 2008; Lai, 2017). In the original versions of TAM, the concepts of expectations and value (specifically, self-efficacy) and computer anxiety (Compeau, Higgins, and Huff, 1999) influenced PEU. However, in an educational setting, the current innovative nature of gamification systems creates a situation in which students may have general anxiety about the idea of using a game to learn, but until they actually use the system and experience it, computer anxiety specific to the edu-gamification system wouldn't manifest until after use and is therefore included and discussed in the motivation components section. This would thus be a part of their motivation to use the system. Additionally, as is explained in more detail in the next section,

the expectations and value referred to in the motivation components are educationally focused, thus differing from the expectations in the computer and learner self-efficacy. Perceived usefulness and ease of use have been identified as positively correlated to attitudes around blended learning (Hsieh, Lu, and Lee, 2014). Attitudes are what Landers et. al (2018) consider psychological states and thus can be influenced by the usefulness and ease of use of an information system. Motivational components are also psychological states that can be influenced. Thus, it is logical to posit that:

P5. Perceived usefulness will have a positive effect on a student's motivation components.

P6. Perceived ease of use will have a positive effect on a student's motivation components.

3.6 Motivation Components

Motivation encapsulates the catalysts that cause an individual to enact a behavior or engage in an activity (Seaborn and Fels, 2015). For gamification, motivation involves what will cause the users to decide if they will engage with the system. A successfully gamified system effects the individual. "[U]nderstanding proximal changes in a target person's psychological states and the effect of those state changes on their behaviors is key to understanding when and why gamification creates distal change" (Landers et al., 2018, p. 323). Expectations, value, affect, and anxiety are the psychological states of motivation recommended for examination. *Expectations* in this study are related to outcomes. "Individuals are more likely to undertake behaviors they believe will result in valued outcomes than those they do not see as having favorable consequences" (Compeau and Higgins, 1995, p. 191). Within a gamified system, this refers to engaging with the system because the attainment of the goal is valued (Deterding, 2015; Ruhi, 2015) and having expectations regarding one's performance educationally. It can be supposed that having expectations would have a positive impact on behaviors because individuals view the engagement in those behaviors as resulting in favorable outcomes. *Value* is task-dependent. It refers specifically to the qualities of the task and their influence on a person's decision to complete said task (Wigfield and Cambria, 2010). Once again, there is a presumed positive relationship because having high value in a task could result in engaging in the behaviors to complete that task. *Affect* refers to how well an individual likes the behavior in which they need to engage. It has been found to have a significant positive relationship with computer usage (Compeau and Higgins, 1995; Compeau, Higgins, and Huff, 1999; Saadé and Kira, 2009). Thus, that effect will have a positive relationship with the behavior of engagement with and in the gamified system. An individual's *anxiety* about using computers has been reported to have a negative relationship with their actual usage (Compeau and Higgins, 1995; Compeau, Higgins, and Huff, 1999; Saadé and Kira, 2009). This is the only one of the motivation components that has a negatively related impact on the behaviors. What this means is that the higher levels of anxiety a student might experience regarding the use of the gamified system may cause them to not engage with or in the system. As such, for this group the propositions are:

P7a. The motivation components of expectations, value, and affect will have a positive impact on behaviors.

P7b. The motivation component of anxiety will have a negative impact on behaviors.

3.7 Behaviors and Educational Performance

One significant difference between the proposed model and TAM 3 is the use of behaviors rather than behavioral intent. Behaviors in which students 'intend' to engage do not provide a direct measure to educational performance. The model is designed to represent the impacts of the gamified system and instructional methods on educational performance. Therefore, the current model addresses the behaviors that the system actually influences rather than impacted student intent. Behaviors act as mediators to the outcomes of the system (Landers, 2014; Landers et. al, 2018), represented as educational performance in the proposed model. The desired *behaviors* for an edu-gamification system occur both internally and externally. Internally, specific system engagement will vary. Common engagement action may include logging into the system, completing content in the system, moving through ranks, gaining experience points that move one up the leaderboard, getting rewards for completing certain activities within the system, etc. (Stanculescu et al., 2016). Other behaviors include engaging with course content outside of the system and the number of hours spent studying for the course. These are important as they all play a role in educational performance and are thus directly related to learning outcomes.

Through the mechanics of the gamified system, students work up through ranks, gain titles, acquire experience points, etc. (Chow and Chapman, 2013; Harwood and Garry, 2015). Elements of system performance should be reflective of ideas such as knowledge acquisition or skill mastery. The idea is that the in-system performance is meaningful to the student, something in which they place value and see relevance (Ruhi, 2015; Vinichenko et al., 2016; Vesa et al., 2017). Logic tells us that the more an individual engages with and in the system, the higher the probability that they improve performance. In an educational environment, the overall performance is an outcome as well and could be measured via final course grade, project grade, exam grades, etc. Additionally, after engaging in the desired behaviors, students should experience *realized expectations* they held about the system. The power of student expectation realization lies in identifying how closely aligned the system and its outcomes are with the user bases' perceptions. The best-case scenario is that the students set high expectations of the system and they are met. Thus, engagement with and within the system should have a positive relationship with realized expectations. As such, for this group the propositions are:

P8. Behaviors of engagement will have a positive impact on educational performance.

While this model may seem intricate and the idea of operationalizing it daunting, there have been multiple studies conducted on these concepts in fields such as information systems, education, and psychology. The following section presents studies with established instruments that may be adapted to actualize the model.

Concept	Authors	Title	Field
Individual Differences			
Self-Efficacy	Jinks and Morgan (1999)	Children's Perceived Academic Self-Efficacy: An Inventory Scale	Education
	Bandura (2006)	Guide for Constructing Self-efficacy Scales	Psychology
Computer Self-Efficacy	Compeau, Higgins, and Huff (1999)	Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study	Information Systems
	Saadé and Kira (2009)	Computer Anxiety in E-Learning: The Effect of Computer Self-Efficacy	Education
Competence	Williams and Deci (1996)*	Internalization of Biopsychosocial Values by Medical Students: A Test of Self-Determination Theory	Psychology
	Black and Deci (2000)*	The Effects of Instructors' Autonomy Support and Students' Autonomous Motivation on Learning Organic Chemistry: A Self-Determination Theory Perspective	Education
Task Characteristics			
Interest, Challenge, Choice, Enjoyment	Gentry, Gable, and Rizza (2002)	Students' Perceptions of Classroom Activities: Are There Grade-Level and Gender Differences?	Education
Facilitating Conditions			
Teaching Method, Teacher Behavior, Grading Practices	Kember and Leung (2008)	Establishing the Validity and Reliability of Course Evaluation Questionnaires	Higher Education
Motivation Components			
Expectations	Compeau, Higgins, and Huff (1999)	Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study	Information Systems
	Kong, Kwok, and Fang (2012)	The Effects of Peer Intrinsic and Extrinsic Motivation on MMOG Game-Based Collaborative Learning	Information Systems
Value	Deci et al. (1994)*	Facilitating Internalization: The Self-Determination Theory Perspective	Psychology
	Wigfield and Eccles (2000)	Expectancy-Value Theory of Achievement Motivation	Education
Affect	Compeau, Higgins, and Huff (1999)	Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study	Information Systems
Anxiety	Compeau, Higgins, and Huff (1999)	Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study	Information Systems
	Saadé and Kira (2009)	Computer Anxiety in E-Learning: The Effect of Computer Self-Efficacy	Education
Goal Attainment			
Realized Expectations	Compeau, Higgins, and Huff (1999)	Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study	Information Systems

*Articles contain description of instrument use. Actual instruments can be obtained at http://selfdeterminationtheory.org.

Table 2. Articles Containing Adaptable Instruments for Model Operationalization

4. OPERATIONALIZING THE THEORETICAL MODEL OF STUDENT-CENTRIC EDU-GAMIFICATION SYSTEMS

One of the biggest challenges when studying users and information systems is the development of instruments to accurately measure the constructs of interest (Mayer et al., 2014). The framework presented in Section 3 (Figure 1) is a combination of concepts across disciplines. Thus, the author recommends adapting pre-established instruments for the individual psychological components, task characteristics, facilitating conditions, motivation components, and the realized expectations portion of educational performance. While not an exhaustive list, Table 2 presents studies containing established instruments that may be adapted for use in operationalizing the model. It is important to note that items for behaviors and in-system educational performance will target aspects that are specific to the course content and the chosen system. This is a movement beyond previous models such as the one posed by Mayer et. al (2014) that focused on behavioral intentions rather than actualized behaviors. Because the study addresses actualized behaviors, it is recommended that the data for these concepts be pulled directly from the gamified system in order to observe actual system use rather than using questionnaires to obtain user perspectives on these topics. Examples of adaptations include specifying the gamified system as the technology in question regarding self-efficacy as well as anxiety and user expectations regarding using online games for education.

While not an exhaustive list, Table 2 provides a starting place for researchers and practitioners who wish to study a student-centric edu-gamification system. Additional discussion regarding this is included in the contributions section of the conclusion.

5. CONCLUSION

5.1 Contributions of the Paper

This article makes four contributions to the literature regarding gamification within the educational environment. First, in agreement with extant literature, this paper acknowledges the need for further investigation into gamified systems within educational environments, specifically regarding successful development and deployment. Second, the Theoretical Model of Student-Centric Edu-Gamification Systems extends TAM. Situated on the idea of learning, it (a) can be used within any educational discipline option to incorporate gamification, (b) clearly delineates between the characteristics of the system, task, and facilitating conditions, and (c) aligns the behaviors and performance with the educational setting. Additionally, having the dependent variable of educational performance moves the model beyond system/course engagement to actualized performance outcomes.

Third, beyond providing a Theoretical Model of Student-Centric Edu-Gamification Systems, the paper identified the need for a cross-disciplinary approach to gamification research. Because gamified systems are, at their core, information systems, it is recommended that information systems be used as an exemplar for the study of these systems. Information systems research has a history of drawing on other fields of study for theoretical bases and instrument design, primarily because of the human-computer interaction component of this type of research. As such, the paper recommends reviewing literature from fields such as education, psychology, and organizational studies when conducting gamification research. Finally, the paper includes a list of articles that contain empirically tested instruments for potential adaptation to operationalize the model. This eases the burden on researchers and practitioners as they don't have to start from scratch should they choose to use the model to examine a gamified system.

5.2 Limitations

The contents of this theoretical paper are based on the review of literature as well as the authors' experiences both playing video games and using video games pedagogically. Thus, there are possible biases built into the view of gamified systems as presented here. The author previously noted that there is no silver bullet to gamified information systems. The variety of system functions and focuses make it nearly impossible to theorize about all gamified systems in one model. As such, additional literature and system models may provide insight to expand upon and improve the presented model. Also, it is important to note that gamified information systems are not suited for all content. Their use should be limited to content that lends itself to being taught using games. Forcing gamified information systems into a course where the concepts of gaming don't fit the content in order to study the system effects may be detrimental to student learning.

5.3 Future Research

The starting place for future research is to empirically test the proposed model. During this step, the validity and reliability of the constructs must be tested. Once the correct items are identified, it should then be tested for generalizability. This could include testing it in a variety of industries and organizations, with a variety of educational settings and disciplines, and with a variety of gamified systems and performance outcomes. Researchers may discover additional aspects that need to be evaluated and/or determine that constructs existing in the model aren't pertinent. Additionally, it is important to consider that this is only one aspect of the development process for an edu-gamified system. Gamification is a phenomenon with staying power. "The gamification market size is projected to grow from USD 9.1 billion in 2020 to USD 30.7 billion by 2025 at a Compound Annual Growth Rate (CAGR) of 27.4%" (Gamification Market, 2020). As defined, gamification is about the users, the system, and the goals. Therefore, research needs to examine these aspects, not in silos, but regarding their interaction and impact on each other. Only when we understand gamification at this level will we truly be able to measure success in its implementation.

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