A Gamification–Motivation Design Framework for Educational Software Developers

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Abstract

Gamification is the use of game design elements in nongame contexts and has been shown to be effective in motivating behavior change. By seeing game elements as "motivational affordances," and formalizing the relationship between these elements and motivational affordances, it is the position of this article that gamification can be effectively applied to improve software systems across many different application domains. The research reported here aims to formalize the relationship between game elements and motivation, toward making gamification's use more systematic. The focus is on the development of a framework linking commonly occurring game elements with the components of a psychological motivational model known as the *self-determination theory*, coupled with a proposed framework of commonly occurring game elements. The goal is to inform system designers who would like to leverage gamification of the game elements they would need to employ as motivational affordances.

Keywords

gamification, motivational affordances, self-determination theory, framework of game elements

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Introduction

It is apparent that players of games are highly engaged (Prensky, 2003), thus attracting interest in other domains that wish to capitalize on this engagement. Gamification is the process of applying elements made popular in games to other contexts (Deterding, Dixon, Khaled, & Nacke, 2011, p. 9), with the intent of increasing user engagement: Organizations looking to promote social change (Recyclebank, 2004), groups creating games where players are solving an underlying problem (Von Ahn, 2006), educational websites (Stack Overflow, 2008), and companies looking for ways to increase loyalty and engagement with customers (Foursquare, 2009) have successfully used game elements in order to achieve their specific aims.

Ferrara (2013) argues that games "are able to contain and communicate persuasive messages" (p. 294). While this can be seen as a negative phenomenon, where innocent game players are exploited by gamification designers (Bogost, 2011), Gee (2003, 2014, 2015) argues that persuasion can be used for positive behavioral change as well. Accordingly, Ramirez and Squire (2014) suggest that gamification should be an item in an educator's motivational toolbox, with which to stimulate students.

Since its inception, gamification has been dismissed as "pointsification" (Robertson, 2010), derided as "exploitationware" (Bogost, 2011), and labeled a "fad" (Ferrara, 2013, p. 289). Game designers have attempted to distance themselves from what they see as unnecessarily simplistic renditions of what can be so very powerful in well-designed games, setting themselves apart from those who would just "tack" on these game elements (Ferrara, 2013, p. 291) to their systems. However, while many of these criticisms are undeniably valid, it would seem that there has been something of a shift in the attitudes of game designers toward the concept. Some game designers are now offering design principles to make gamification better, thus signaling a shift away from the universally negative discussion of gamification of such earlier criticisms. Gamified systems which demonstrate a clear understanding of the psychological needs of their proposed participants can be utilized to engender a sense of intrinsic motivation in these participants (Ryan & Deci, 2000a).

To demonstrate this "clear understanding" system, designers incorporating gamification as a motivational tool for learning should be cognizant of the links between commonly used game elements and constructs known to motivate learning. The aim of this article is to forward this agenda.

To do so, two preliminary steps need to be addressed. The first is the enumeration of the individual game elements. While many articles have articulated game elements, relatively few have tried to consolidate these into an overarching taxonomy. Those articles differ in the elements included and in the naming of the elements, making comparison difficult, and so this article reviews the literature in the field toward this goal. Second, constructs of motivation need to be

identified. This article adopts self-determination theory (SDT; Ryan & Deci, 2000a), as it has been empirically tested across a range of different domains and has been shown to be an extremely effective prism through which to evaluate the motivational possibilities of games (Denis & Jouvelot, 2005; Rigby, 2014; Ryan & Connell, 1989; Ryan, Rigby & Przybylski, 2006; Standage, Duda, & Ntoumanis, 2005). SDT posits that a person will experience a feeling of intrinsic motivation to undertake a task if three constructs are satisfied: competence, autonomy, and relatedness.

Once these two preliminary steps are addressed, linkages need to be made between the motivational constructs and the game elements that are related to those constructs. In the work reported here, this is undertaken as a two-stage process: The first is conjectural analysis based on an extensive review of the literature. The second is evaluation of the veracity of the game elements and their links to the motivational constructs, through a survey of game experts.

The ultimate research question addressed by this article is this: "How are game elements related to motivational constructs?" Accordingly the two core contributions of this article are

- an explicit, evaluated taxonomy of 18 game elements: A valuable vocabulary for system designers who are trying to gamify their educational systems; and
- evaluated, explicit relationships between these game elements and the motivational constructs of competence, autonomy, and relatedness, allowing designers guidelines to hone the motivational affordances of their systems through consideration of the appropriate game elements.

The Gamification and Motivation section reviews the state of the art in terms of game elements and motivational theories. The Methodology section describes the method employed to derive the initial framework and the subsequent method to evaluate and refine the framework. The Results section presents the initial and refined framework leading to a discussion in the Discussion section.

Gamification and Motivation

The term *gamification* appears to have been initially coined in 2002 by Nick Pelling (2011), who used it to describe "applying game-like accelerated user interface design to make electronic transactions both enjoyable and fast." In subsequent years, this term has come to be more widely applied, whereby game design elements are implemented in nongame settings in order to change user behavior. Some commentators have spoken simply of placing a "game layer" over everything (Priebatsch, 2010), but the most commonly cited definition is that gamification is "the use of game design elements in non-game contexts" (Deterding et al., 2011, p. 9).

For most commentators, the players are the most important aspect of gamification. For those commentators, gamification is "the integration of game-inspired elements" (Thom, Millen, & DiMicco, 2012, p. 1067), the purpose of which is to "create a sense of playfulness in non-game environments . . . so that participation becomes enjoyable and desirable" (Thom et al., 2012, p. 1067), or so that the interaction becomes "fulfilling, thought-provoking, challenging, and also difficult, painful, and even compulsive" (Koster, 2005, p. 144). In an educational context, the idea of "playfulness" is probably better expressed as a sense of engagement.

Thus, there is a consensus that game elements have the potential to afford participants considerable opportunities to feel motivated (Deterding, 2011a; Ferrara, 2013), but many people looking to design gamified systems do not have experience in the area of game design (Robinson & Bellotti, 2013) and do not always have full cognizance of motivational theories. This lack of knowledge is often termed as *pointsification* (Robertson, 2010), where game elements such as points, badges, and leaderboards (PBL; Werbach & Hunter, 2012) are overlaid onto a system, without any thought being given to their underlying usefulness. The suggestion is that gamification is "the process of taking the thing that is least essential to games and representing it as the core of the experience" (Robertson, 2010). The proposition of applying game elements to a system, without an integrated sense of the design and the objectives behind that application, has been shown to be a significant demotivator (Forde, Mekler, & Opwis, 2015; Rigby, 2014; Weiser, Bucher, Cellina, & DeLuca, 2015). For example, whereas leaderboards which showcase active, engaged players can add to player motivation (Kim, 2011), one study showed that their use to introduce competitiveness to staff in a particular hotel led to lower achievement of these targets, and considerable dissatisfaction among the workers (Werbach & Hunter, 2012).

In addition, gamification has attracted criticism as it is practiced in the world of marketing and customer loyalty. For example, Zichermann (2011) says that he only needs to provide users with rewards and status, in order to encourage them to participate in a system. This paring down of the powerfulness of games into nothing more than rewards aggravates critics such as Bogost (2011, 2014) and Deterding (2011b), who see Zichermann's approach as allowing customers to be "(fleeced) to the benefit of the company", rather than games that enhance a participant's life. Deterding even claims that Zichermann lauds those that "dupe customers", manipulating them to undertake tasks they would not otherwise do, and Bogost (2011) characterizes the resultant systems as "exploitionware".

However, this point becomes moot if the persuasive power of gamification can be harnessed for learning, this sense of manipulation may be put to use in a positive, "socially valued" way (Gee, 2014, p. 37) and lead to people improving their position in life through, for example, learning another language (Von Ahn, 2011). It is in this positive context that this article explores gamification, trying

to refine design skills in the area toward social value. Using the concept of game elements as "motivational affordances" (Zhang, 2008), this work will move toward a systematic approach to help designers of educational systems to motivate learners through a combination of game elements.

Game Elements

Game elements are "a set of building blocks" (Deterding et al., 2011, p. 12), from which to construct a game, or, conversely, with which to analyze a game. Several commentators (Bogost, 2011; Ferrara, 2012) have argued for an explicit discussion of specific game elements, although Ferrara (2012) suggests that fun will only emerge from the experience "when all of the elements work well together" (p. 33). Likewise, for Kapp (2012), it is the "interplay of the elements that makes for the most effective games" (p. 50). Regardless, an initial starting point for any discussion of game elements involves the collating of a standardized listing.

There are many works that identify game elements (Aparicio, Vela, & Sánchez, 2012, p. 2; Cheong, Filippou, & Cheong, 2014, p. 234; Flatla, Gutwin, Nacke, Bateman, & Mandryk, 2011; Fogg, 2009; Hunicke, LeBlanc, & Zubek, 2004, pp. 2–3; Kapp, 2012, pp. 26–29; Kim, 2014a, 2014b; Linehan, Kirman, & Roche, 2014, pp. 82, 84; Reeves & Read, 2009, pp. 64–90; Robinson & Bellotti, 2013, p. 3; Sailer, Hense, Mandl, & Klevers, p. 30; Weiser et al., 2015, p. 273). Most overlap, but they often differ significantly, to the degree that it is difficult to aggregate them into a consolidated set. Also, several of these lists are of higher level ideas. For example, Hunicke et al. (2004, pp. 2–3) breaks down games into a mechanics–dynamics–aesthetics framework, under which, presumably, more grounded game elements exist. But, if designers are not familiar with game elements (Robinson & Bellotti, 2013), this higher level thinking will not necessarily be a useful aid in the design process, as they will not know how to translate it into implementation.

Consequently, a consolidated listing of grounded game elements would be useful but difficult to delineate, and any useful attempt must be restricted to the "elements that are found in most (but not necessarily all) games, readily associated with games, and found to play a significant role in gameplay" (Deterding et al., 2011, p. 12). The most commonly referenced game elements in the literature were identified in the literature review performed here: badges (14 articles), points (12 articles), leaderboards (10 articles), rewards/achievements (9 articles), and avatars (8 articles). This aligns strongly with the maligned "PBL" characterization discussed earlier: "points, badges and leaderboards" (Werbach & Hunter, 2012, p. 69). Only rewards/achievements and avatars (ranked fourth and fifth) are nearly as prevalent. Indeed, the case could be made that rewards/achievements relate closely to points and badges.

In the review, three particularly useful articles emerged toward defining a consensus of game elements: Fitz-Walter (2015), Seaborn and Fels (2015), and Werbach and Hunter (2012). These three articles are particularly interesting because of their different origins: Werbach and Hunter were themselves game players and took the elements that they consider to be the most important from their own experience of game playing, whereas the other two articles are both surveys of over 30 published works (see Table 1 for a comparison of the three).

There is considerable overlap between the two surveys and Werbach and Hunter's list. But there was also significant term–inconsistency and this is detailed in Column 4. For example, while Werbach and Hunter's categories of Achievements, Avatars, Badges, Gifting, Leaderboards, and Points appear under the same classification names in the two survey lists, Levels and Quests are discussed in Seaborn and Fels (2015, p. 27) under status, progression, and narrative. Likewise, Boss fights and Combat (Werbach & Hunter, 2012, p. 80) are represented as competition, goals, mini-games, and challenges (Fitz-Walter, 2015; Seaborn & Fels, 2015). Based on a term-consolidation undertaken by the authors, Table 2 presents a set of aggregate game elements from the literature, with an associated description.

Motivation

Gamification can be seen as a "motivational system" (Mitchell, 1982) with participants being given the opportunity to express their motivation to act on

Table 1. Comparison of Game Elements Mentioned in Three Major Sources.

Game element	Werbach and Hunter (2012)	Fitz-Walter (2015)	Seaborn and Fels (2015)	Alternative names across articles
Achievements	X	X	X	
Avatars	X	X	X	
Badges	X	X	X	
Gifting	X	X	X	
Leaderboards	X	X	X	
Points	X	X	X	
Levels	X	X	X	Status/Progression
Quests	X	X	X	Narrative
Teams	X	X		
Virtual goods	X	X		
Boss fights	X	X	X	Competition/goals/ mini-games
Combat	X	X	X	Challenges
Collections	X	X	X	Feedback/tangible rewards
Content-unlocking	X	X	X	Feedback/tangible rewards
Social graphs	X	X	X	Feedback/tangible rewards

that system. Motivation can be described as the sense of being "moved to do something" (Ryan & Deci, 2000b, p. 54) and is also about the "choice" of an action and the "effort" expended on it (Dörnyei, 2001, p. 7).

There are "over twenty internationally recognized theories of motivation" (Dörnyei, 2001, p. 12), but it is beyond the scope of this article to cover them all (the interested reader is directed to Ertmer & Newby, 1993). Instead, we concentrate on SDT, a theory proposed by Ryan and Deci (2000a) and how it fits into other established psychological theories of education.

SDT suggests that Competence (mastery), Autonomy (choice), and Relatedness (social connection) are the constructs that drive motivation. The idea of an individual constructing their own meaning, as seen in Constructivism (Ertmer & Newby, 1993, p. 64), is extended in SDT, as the reasons why this is important are underscored through SDT's exploration of the importance of an

Table 2. Game Elements Consolidated From the Literature.

Game element	Description
Achievements	In-game content that is earned by player behavior, e.g., Content for avatar customization
Avatars	Visual representation of a player in a game, personalized with chosen elements
Badges	Visual representations of rewards or achievements
Boss fights	Final challenges in order to Level up
Collections	Sets of in-game items that may or may not be useful within the game
Combat	Fights, battles, duels within games
Content-unlocking	Content withheld from players until a certain level of ability is reached
Gifting	The practice of giving in-game Virtual goods to other players, as a reward or as part of a Team strategy
Leaderboards	All players' positions in a system, usually in relation to the number of points they have been awarded
Levels	Levels express the number of Points a player has, and subsequent levels become more difficult as a player progresses
Points	Awarded for various deeds in a game
Quests	Specific tasks which act as goals and can further a narrative thread in a game
Social graphs	Information data sets presented to specific groups or Teams of people within a game, e.g., to spur one group on to compete against another
Teams	Groups of people who may or may not know each other outside the game
Virtual goods	In-game items which may be purchased by performing tasks within a game

individual being afforded the chance to experience Autonomy. Vygotsky's Cognitive Development Theory is also enhanced by SDT, in that the capacity to extend one's conceptual abilities is reflected in the fulfillment of a feeling of Competence. The concept of learners constructing their own mental models in Constructionism is covered by SDT, both through the concept of Competence, where those mental models allow for a feeling of mastery, and through the concept of Autonomy, as the same act of constructing these models assists in the feeling that the individual has been heavily involved in their own learning. SDT fleshes out the social and environmental context in which Socioculturalism (Littleton, Toates, & Braisby, 2002) occurs, by examining why the Relatedness context is important. Finally, "flow," the approach heavily favored by much of the existing game design literature (Csikszentmihalyi, 1991), is further developed by examining it through the perspective of SDT, where the fact that flow occurs is incidental to the reasons why it does. SDT posits that participants experience flow because they are fulfilling each of the senses of Competence, Autonomy, and Relatedness while being immersed in a well-designed game which has taken all of these needs into account.

SDT has been tested across a range of disciplines (Denis & Jouvelot, 2005; Ryan & Connell, 1989; Ryan et al., 2006; Standage et al., 2005) and has been shown to be a highly useful prism through which to examine motivation in relation to games and gamification (Deterding, 2011a). One of the main arguments against the use of game elements as motivational tools is that external motivators can take away from participants' feelings of intrinsic motivation (Ryan & Deci, 2000a). However, Deterding (2011a) argues that a good understanding of SDT allows designers to understand how to implement external motivators that will support, rather than thwart, a person's intrinsic motivation to perform a task (p. 3).

Looking at the design of a gamified system as a way of utilizing game elements as "motivational affordances" (Deterding, 2011a; Jung, Schneider, & Valacich, 2010; Zhang, 2008) ties gamification and motivation more concretely together. In this view, game elements are seen as a way of affording participants the chance to feel motivated, by relating specific motivational drivers (Competence, Autonomy, and Relatedness) to the types of elements that may be used to bring about behavior change. With an understanding of motivational theory, game elements can be understood as conduits for affording a sense of motivation, and thus lead to better design in gamified educational systems.

Games and Learning

Games would seem to be the perfect medium for promoting learning, because "all humans love to learn when it isn't forced upon them" (Prensky, 2003, p. 2). Bruckman (1999), however, notes that historically, educational games are often

more like "chocolate-dipped broccoli" (p. 75), where learning is presented as "an unpleasant core that you need to hide in a chocolate coating" (p. 75).

But games, as described by Prensky (2003, p. 2), allow players to build on their existing knowledge and potentially extend the very limits of their abilities. This idea of building further knowledge by repeating previously learned concepts is an important tenet of constructivist learning theory, where constructivists argue that we bring prior knowledge to everything that we learn, and it is the way in which this previous understanding is enveloped into the new material which will ensure its appropriation. As described in Vygotsky's (1978, p. 86) zone of proximal development, students are encouraged to develop from their own existing knowledge and extend beyond their boundaries through guidance from adults or more able peers. This resonates with Krashen's (1987) assertion that, for example, language acquisition happens when our boundaries of understanding are continually pushed "'a little beyond' where we are now" (p. 21). Games which have their learning objectives blended into the action of the game are pushing the boundaries of those playing, in effect edging them toward their own zone of proximal development, and so it seems clear that games could work well to promote a positive attitude toward learning.

Methodology

There are numerous research methodologies one could choose when linking game elements to motivational constructs. One approach could have been to go to a group of independently highly motivated gamers, observe them playing games of varying types, and try to determine, empirically, which game elements they used, and which game elements motivated them to return to play. An inductive analysis of these observations could then result in a proposed taxonomy (Gray, 2009, p. 14). Further research performing just such a task would be extremely useful and complementary to the approach we have taken and serve as a basis to provide another data source and basis of validation.

For this study, we have adopted a more deductive perspective; the approach adopted was to start with the literature, examine patterns which emerged, and attempt to connect the disparate aspects of that literature in a more cohesive way. Identifying these patterns led to the development of a theory as to the predominant game elements and the relationship between these game elements and their utility in motivating key behaviors. In this way, "the deductive process move(d) towards hypothesis testing, after which the principle is confirmed, refuted or modified" (Gray, 2009, p. 14).

Thus, the initial taxonomy of proposed game elements was derived from the existing literature (see Table 2). The additional "game element" of "Discussion forums" was added to the taxonomy because game forums are widespread and function as places for the satisfaction of the Relatedness strand of SDT, through their social/community-building aspects. In addition, discussion forums are an

integral part of developing a community of practice (Annetta, 2010; Lave & Wenger, 1991; Li, Grimshaw, Nielsen, Judd, Coyte, & Graham, 2009), and this is one aspect of gamification that has been seen to be extremely positive (Movshovitz-Attias, Movshovitz-Attias, Steenkiste, & Faloutsos, 2013).

The goal of the empirical work here then is to

1. assess and refine the game elements derived from the literature review, and
2. determine the linkages between these game elements and the motivational constructs in SDT, thus providing a "Gamification–Motivation Design Framework (GaMDeF)."

For classifying ideas, and providing a common language, an initial approximation of GaMDeF was developed using a conjectural analysis (Dickey, 2007). Here the initially identified game elements were examined by the researcher for their motivational possibilities. This initial "interpretive" analysis (Dickey, 2007, p. 255) arose out of a reflective process informed by the first author's experiences with games. But this was buttressed with conversations with a number of gamers at regular intervals during the conjectural analysis process. In addition, the first author elaborated her findings to the second and fifth authors in separate sessions. These briefings happened periodically and both of those reviewing authors had to be independently satisfied with the rationale behind the proposed linkages to date, before the analysis was allowed proceed.

A potential weakness in much of this approach is that it is largely theoretical in nature (Bailey, 1994). Thus, a survey of self-reported gamers (Gray, 2009), who give their insights into the nature of GaMDeF, is employed (Section 3.3). The introduction of the survey both acknowledges and addresses the weaknesses of the more theoretical approach behind the framework's development. The survey resulted in the taxonomy of game elements and the framework being refined. The survey is discussed in Section 3.1 and the overall derivation/refinement process is depicted in Figure 1.

The Survey

A survey allows for the possibility of "gathering a large amount of information quickly in a form that is readily processable" (Dörnyei, 2003, p. 1). Such data may then be generalized "to a larger population than the group you targeted" (Oates, 2006, p. 93). Given that our purpose was to validate the assumptions in the creation of our proposed taxonomy, the responses to this survey were of great consequence to our analysis if they could assist in the improvement of the utility of the taxonomy. Although "survey research is used to identify the characteristics of a broad population of individuals" (Easterbrook, Singer, Storey, & Damian, 2008, p. 298), with this group of self-identified gamers, we are working with a "self-selection" sample (Oates, 2006, p. 98), offering insights "into

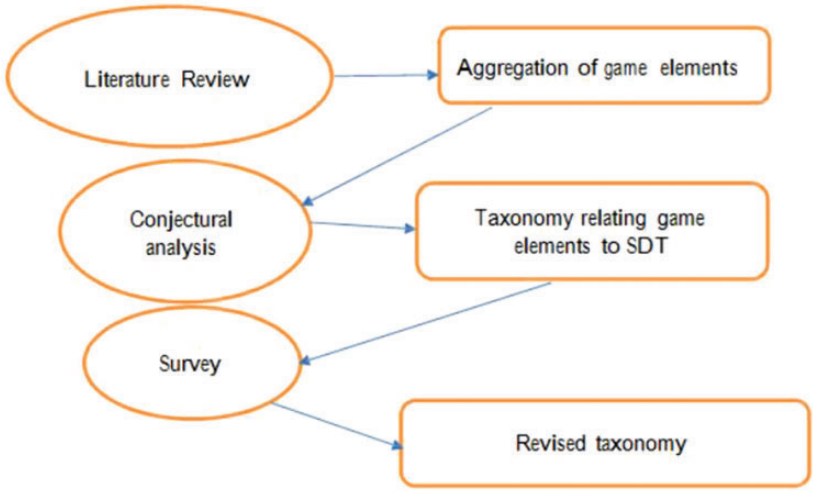

Figure 1. The Derivation/Refinement process for GaMDeF.

particular practices that exist within a specific location, context and time" (Gray, 2009, p. 180).

In designing the survey, Likert scales were chosen, as they are "the most commonly used scaling technique" (Dörnyei, 2003, p. 36). They are "simple, versatile, and reliable" methods which "require the respondent to make an evaluative judgement of the target" (Dörnyei, 2003, p. 36). By seeking these types of evaluative judgments, we were attempting to quantify how emphatically our proposed taxonomy had measured the perceived links between game elements and motivation, and to restructure a revised taxonomy if the results required such a rethink. When using Likert scales, the questions return data that are quantitative in nature, but the inclusion of short answer questions also provides for a small amount of qualitative questioning, where "the researcher enters the (participants') world and through ongoing interaction, seeks the (participants') perspectives and meanings" (Creswell, 2003, p. 198).

The survey was conducted online, using Google forms. It began with a statement outlining the overall purpose of the research, a request for consent (University of Limerick Ethics Committee, approval number: 2016_10_06_S&E), and a brief explanation of the concepts behind the three motivational constructs. After a short demographics section, it then presented each of the game elements separately. It offered the participant a description of the game element, a Likert scale (Dörnyei, 2003, p. 36) with which to decide whether their experience of that particular element in a game context could fulfill a sense of Competence, Autonomy, or Relatedness and space for an open response (see Figure 2). The survey ended with three open questions, which provided a

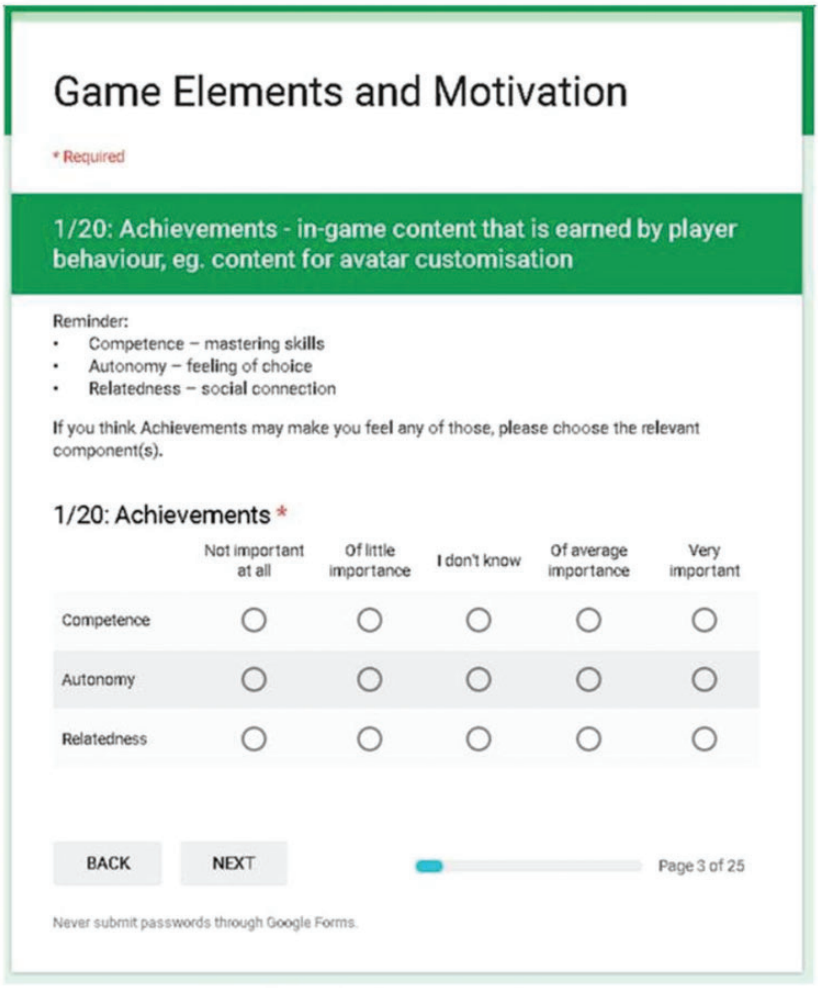

Figure 2. Screenshot of question one from the survey.

mechanism for respondents to respond if they had an opinion on other elements which had not been included, for each of the three motivational constructs. Nine gamers (seven men, two women), known to the researcher, piloted the survey. This served to shorten the description of SDT and also resulted in a new survey title.

After the pilot stage, the survey was released in October 2016 and was live for a month. A link was posted as a public post on Facebook, using hashtags such as #gamification and #motivation to attract attention. Similarly, the same link

was posted on Twitter, both on a personal Twitter account and a second Twitter account used for academic and professional purposes, with a University of Limerick–based e-mail address. Game designers Brenda Romero (Romero Games, University of Limerick) and John Ferrara (Vanguard) also publicly shared the link to the survey to their Twitter followers. Games academics Jennifer Lade (RMIT University, Melbourne), Chris Exton (University of Limerick), and gamification academic Kevin Werbach (University of Pennsylvania) also publicly shared the link. In total, a number of 107 responses were received, with 4 unable to complete because of our requirements that participants be over 18 (as determined by the demographics page). Results were then tallied for a total of 103 responses.

Results

Of the 107 participants, 20 responded as female and 81 responded as male. Of the six humorous responses, two were implicitly male ("A handsome fella," "sexy bro"); 51.4% of the respondents gamed for between 2 and 10 hours per week with 29% of the respondents claiming to play more than 10 hours per week; 19.6% gamed between 0 and 2 hours per week. In total, 97.2% stated that they had been playing computer games for over 10 years.

The proposed framework and the results of its evaluation in the survey are presented in Table 3. In Column 1, each of the game elements is named, in alphabetical order. In Column 2, the results of the initial conjectural analysis are presented in cases where the game element was originally envisaged by the research team. In cases where the game element was a result of the empirical study, no proposed linkage to the motivational constructs is shown. In Column 3, the outcome of the empirical study is detailed, and in Column 4, the effect (if any) on GaMDef is presented. For example, because 81% agreed that Achievements were related to Competence, the relationship suggested by the conjectural analysis was supported. In contrast, 58% of the participants thought that there was a link between Achievements and the SDT construct of Autonomy (a finding conflicting with the conjectural analysis). Hence, there was an action taken to relate Achievements to Autonomy in the updated taxonomy. Where percentages given are under 50, a decision to update the framework was taken if that still represented the majority of respondents, when removing "don't know"s from consideration.

Of the elements approved per component, the average level of agreement was 70.9% for Competence, 60.8% for Autonomy, and 57.2% for Relatedness. The table also shows that there was 68% agreement between the original conjectural analysis and the revised taxonomy, updated with these results and excluding the added game elements. This suggests that the original conjectural analysis was effective, but the results also suggest that it was conservative: None of the game

Table 3. Refining GaMDeF.

Element	Conjectural analysis	Agreement	Action
Achievements	C ✓	81% include	Add Autonomy
	A	58% include	
	R	48% exclude	
Audio (not in taxonomy)	C	51% include	Add as element, meeting all 3 CAR
	A	46% include	
	R	51% include	
Avatars	C ✓	54% exclude	Remove Competence
	A ✓	70% include	
	R ✓	61% include	
Badges	C ✓	64% include	Remove Relatedness
	A	49% exclude	
	R ✓	50% exclude	
Boss fights	C ✓	91% include	Add Autonomy
	A	51% include	
	R	46% exclude	
Collections	C ✓	64% include	Add Autonomy
	A	60% include	
	R ✓	44% include	
Combat	C ✓	89% include	Add Autonomy and Relatedness
	A	69% include	
	R	49% include	
Content-unlocking	C ✓	84% include	Add Autonomy
	A	61% include	
	R ✓	47% include	
Discussion forums	C ✓	50% exclude	Remove Competence and Autonomy
	A ✓	44% exclude	
	R ✓	68% include	
Gifting	C	62% exclude	No change
	A ✓	56% include	
	R ✓	72% include	
Leaderboards	C ✓	64% include	No change
	A	58% exclude	
	R ✓	71% include	
Levels	C ✓	92% include	No change
	A ✓	64% include	
	R ✓	46% include	
Points	C ✓	85% include	Add Autonomy
	A	49% include	
	R	48% exclude	
Quests	C ✓	83% include	No change
	A ✓	86% include	
	R ✓	47% include	

(continued)

Table 3. Continued

Element	Conjectural analysis	Agreement	Action
Realistic graphics [not in taxonomy]	C	46% include	Add Competence and Relatedness
	A	46% exclude	
	R	49% include	
Social graphs	C ✓	46% include	No change
	A	51% exclude	
	R ✓	53% include	
Teams	C	60% include	Add Competence and Autonomy
	A	53% include	
	R ✓	80% include	
Virtual goods	C ✓	61% include	Remove Relatedness
	A ✓	67% include	
	R ✓	52% exclude	

GaMDef = Gamification–Motivation Design Framework.

elements were shown not to contribute to the constructs and the majority of link changes were additions.

Discussion

In Figure 3, we see a consolidated version of the resultant framework, presenting 18 game elements and their perceived linkages to the motivational constructs of Competence, Autonomy, and Relatedness. Figure 4 presents the three elements that are seen by the gamers to be the most useful in the fulfillment of each of these motivational constructs, suggesting that, to achieve a broad span of SDT coverage, educational software designers might consider adding Levels, Quests, and Teams to their systems. While it is quite easy to see how Levels and Teams could be accommodated in educational systems, the incorporation of Quests may seem a less obvious possibility. However, in terms of Autonomy, Quests were clearly perceived to be the most associated game element (see Figure 5) and other game elements with a higher autonomy association (combat, avatars) would seem similarly difficult to implement for learning contexts. Interestingly, the ability to incorporate quests seems heavily related to the presence of avatars and this suggests a certain role-playing paradigm from the start of the design. Suggesting a role-playing based design may be one aspect that educational technologists should consider when presenting educational material.

Figure 6 presents the game elements associated with a sense of competence. Three seem to be particularly related: Levels, Boss Fights, and Combat, with another four (Points, Content Unlocking, Quests, and Achievements) being

Game Element	Competence	Autonomy	Relatedness
Achievements	•	•	
Audio effects	•	•	•
Avatars		•	•
Badges	•		
Boss fights	•	•	
Collections	•	•	•
Combat	•	•	•
Content-unlocking	•	•	•
Discussion forums			•
Gifting		•	•
Leaderboards	•		•
Levels	•	•	•
Points	•	•	
Quests	•	•	•
Realistic graphics	•		•
Social graphs	•		•
Teams	•	•	•
Virtual goods	•	•	
Totals	15/18 Competence	13/18 Autonomy	13/18 Relatedness

Figure 3. The consolidated, evaluated GaMDeF.

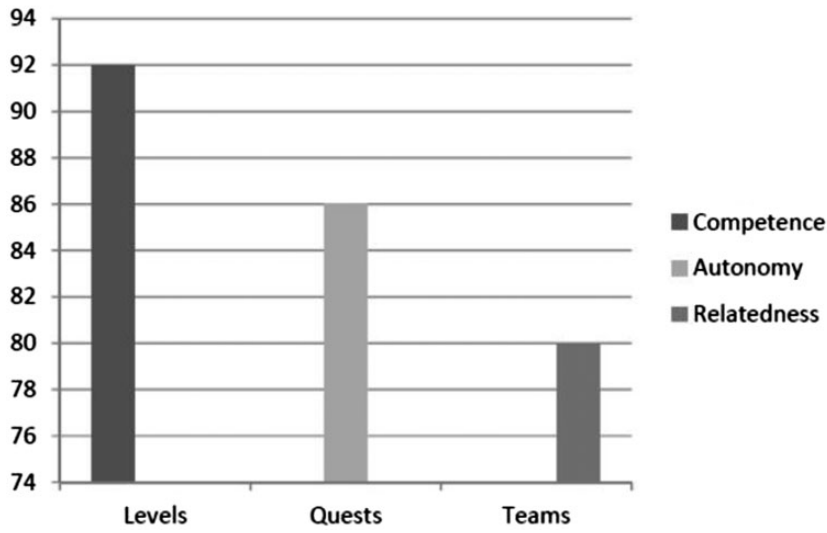

Figure 4. Game elements with highest utility per component.

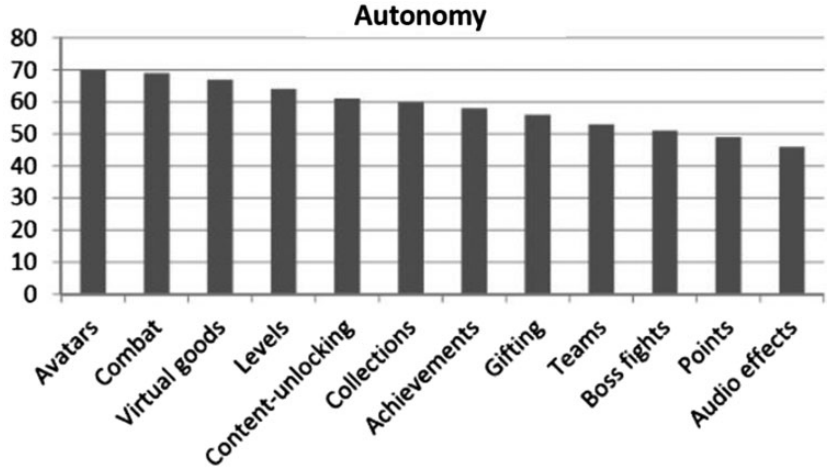

Figure 5. Game elements associated with Autonomy.

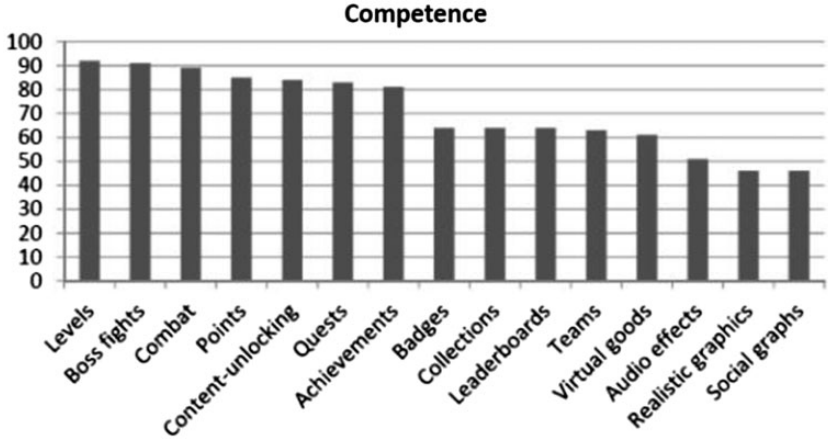

Figure 6. Game elements associated with Competence.

more related than the remainder of the other game elements. Again, these will be related to role-playing and combat-oriented systems only.

Relatedness appears to be the least well represented as a motivational component, with only one element reaching 80% approval for this sense (Teams), and the spread of approval of the other 12 elements being low, from 44% to 72% (see Figure 7). However, there is a noticeable difference in how closely three are associated with relatedness: Gifting, Leader Boards, and Discussion Forums.

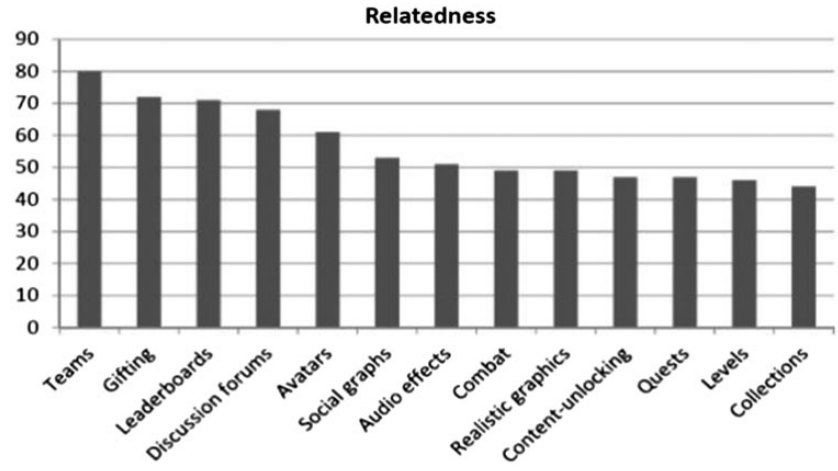

Figure 7. Game elements to satisfy Relatedness.

Seven elements were found to facilitate all three constructs of Competence, Autonomy, and Relatedness, as shown in Figure 3. Quests get an average of 72% agreement from the survey across the three constructs, followed closely by Combat (69%), Levels (67%), Teams (64%), and Content Unlocking (64%). These average figures could serve as an initial indicator of the best game elements to set about trying to include in an educational system. However, while Levels, Teams, and Content Unlocking would seem easy to incorporate into educational offerings, Combat and possibly Quests should perhaps also be considered if appropriate. In addition, the removal of Quests in particular suggests that such systems might suffer from lesser Autonomy.

The discussion made earlier details the relationship between the game elements and the motivational constructs, and describes how some game elements may not be appropriate for some educational contexts. But it also illustrates that there can be quite complex relationships between the game elements themselves, and that some are not possible without the presence of others. Figure 8 aims to present the interrelationships between these game elements to illustrate these associations.

The elements described here can be grouped into two categories: activities and rewards. They lead into one another, and knowledge of this integration may add to their motivational benefit. Those elements placed under the category of "activities" require some action to be performed by a player: Boss fights and Combat require some kind of fight or battle, and lead to the reward of Points, which help a player Level up, and can affect their position on a Leader Board or Social graph. Quests may also lead to Points, or they could unlock further Content. Similarly, Discussion forums and Teams require active

Figure 8. Interrelationships of game elements.

participation—those who post on forums may receive Virtual goods, or Content-unlocking, while Team players may receive Points or improve their position on a Social graph. The element of Gifting allows a player to give some of their own Virtual goods to another player, who in turn will receive them as a reward.

It is perhaps most useful to view using elements in an integrated way. For example, Boss fights fulfill Competence (91%) but are not rated as fulfilling Relatedness. They can, however, be used to unlock Content, which has a rating of 47% for fulfilling Relatedness. Unlocked Content can allow a player to Level up, and Levels have been rated as having a 46% utility for Relatedness. In all three cases, the rating for Competence is high (Boss fights 91%; Content-unlocking 84%; Levels 92%), and all three fulfill Autonomy to some degree (Boss fights 51%; Content-unlocking 61%; Levels 64%), so the idea of cross-component utility is strong in their use together. If Teams and Quests were to be utilized together, all three of the constructs would be very highly supported, with Teams offering 80% on Relatedness, while Quests, at 83% for Competence, and

86% for Autonomy, would address the motivational needs covered by the other two constructs. Comparing elements across the constructs in this way, and in how they can be used together, could be very useful for a designer.

Finally, researchers' weariness of the triage of "PBL" seems to be somewhat well founded. Points were considered important in terms of competence (85%) but not Autonomy or Relatedness. Badges had a similar profile but were less closely associated with Competence (64%). Leaderboards seem to be the best of the three, being associated with Relatedness (71%) and Competence (64%).

Validity Issues

A number of issues arose in the running of the survey, some to do with surveys in general, and others, problems that became obvious once we undertook the analysis. It is important that we look at these "potential weaknesses in the study design" (Easterbrook et al., 2008, p. 306) in the hope that we have addressed them. Sometimes, the validity of a questionnaire can be affected by the wording of the questions it contains. But even if individual questions are valid, a poor sequencing of questions or confusing structure or design of the questionnaire can all threaten its validity (Gray, 2009, p. 375).

With this in mind, we tried to achieve "a tight match between (our) questionnaire and what (we) are trying to research" (Gray, 2009, p. 375). There were times, however, when the results appeared to show that we had not got this balance right. As we saw earlier, there were occasions where respondents did not seem to have fully understood the questions we were asking, with one case in point being the repetition of game elements specifically referenced in the questions when respondents were asked to list elements that had not been previously mentioned. A listing of the game elements on the screen that assessed this question would probably have negated the possibility of this happening, if this study were to be repeated.

Unfortunately, the nature of online questionnaires is such that they are delivered in an impersonal manner, not allowing for any discussion either of the concepts we have listed, nor the concepts the participants are trying to explain. There is, therefore, some room for interpretation error. However, in comparing the results of the survey with the conjectural analysis undertaken to produce the proposed taxonomy, this has been addressed.

Related to this problem is the amount of space we were able to give respondents to answer the longer questions. One respondent mentioned privately after finishing the survey that he was looking for some way to offer more qualitative answers. The survey did not permit this type of response until the final three questions, but even there, these were still quite controlled questions. The depth of our respondents' answers could perhaps have been complemented by more space for qualitative answers or qualitative interviews. In a similar vein to this, the question arises whether the respondents were rating how much they liked an

element, rather than its usefulness, and the only way to control for this would be explicitly to ask respondents to rate elements first, and then to comment on why they think they like them. Perhaps respondents could be asked directly, as in this survey, or it could be left for more open responses, which may overcome some of the inherent difficulties we encountered with this research measure. Unfortunately, this was not foreseen as a risk.

Receiving only 107 responses in total, with 4 unusable because the participants were under 18, meant that the potential representativeness of the sample is limited. This is a problem for online research in general: "mainly because certain demographic segments of the population may be under-represented or simply not represented at all" (Gray, 2009, p. 247).

As we have argued, however, those who did participate form a self-selected group of gamers (Oates, 2006), whose opinions are valued because of their high level of experience, and therefore the responses can be "used to generalize from that sample to the population" (Easterbrook et al., 2008, p. 298). There is still the possibility that another cohort of gamers: Those who are not inclined to volunteer are not represented in this survey.

This is also true for women gamers who were severely underrepresented in this cohort. The gender question showed that we had a 77.6% response rate from men, with that number possibly rising to 81.3%, if we take into account the "humorous" responses given as short answers. According to Grubb (2014), men make up only 52% of gamers, meaning that the survey results would have been much stronger if we could have attracted more answers from female gamers.

In addition, we did not ask our gamers what genres of games they played. As we found in the literature review, game elements often go by different names across the different genres. Despite the short descriptors offered per element, it is clear from the results of the short answer section that not all participants understood the naming conventions we were using in this instance. This raises the related problem of keeping surveys short by avoiding information overload. In this instance, it was felt that the descriptors were clear enough for the majority of respondents to understand; however, some of the responses would indicate that perhaps our assessment was not right for everyone. We intuit that, for some genres, certain elements would be highly effective, such as Haptic effects in genres which require movement and activity. These same effects, however, would not necessarily be useful in a language-learning environment, for example, where movement is not important to either the learning or the gameplay. This type of information could be invaluable to gamification designers if we consider they are often not from the world of game design (Robinson & Bellotti, 2013).

It is also possible that the existence of an element in a game or gamified system will not necessarily produce the results intuited for it. We have seen that game elements work best when integrated together, and there are other

factors which may affect an element's utility as a motivational affordance. These could relate to the frequency of its usage, how prevalent it is as an element, and whether or not the game element is being used as an opportunity for learning (in the case of Competence-related elements) or an opportunity for boasting about one's skill level. These nuanced observations could be teased out in any further studies based on our analysis.

Conclusion

This work derives a taxonomy of 16 commonly used game elements and GaMDeF, whereby each game element is associated with the motivational constructs of SDT: Competence, Autonomy, and Relatedness. This is an important first step in designing gamified educational systems that embody motivation. Several game elements are associated with all three constructs and they would seem like good candidates to enhance user motivation in educational software.

But it should be emphasized that this is just a first step in this work. For example, several of these game elements are probably unsuitable for educational contexts (e.g., Combat) and the overall design envisaged for the system may prohibit others (Avatars, Quests). Consequently, designers may be limited in their choice of game element.

Likewise, our analysis of the field suggests that there are relationships between the game elements that require further probing. Often it is the interplay between game elements that is associated with the individual motivational constructs. In addition, we believe that it is incorrect to say that the presence of a game element in itself is sufficient for the presence of the associated motivational construct: Instead, the element should be integrated into the game seamlessly, and should be congruent with the educational goals. With these caveats, GaMDeF should be considered a guide rather than a definitive design doctrine.

Future work in this area should explore the relationship between game elements and how these relationships might impact the motivational constructs, thus enhancing the framework itself. It should also focus on evaluation of the utility of the framework for designers. Specifically, the aim of GaMDeF is to help design engaging (educational) systems. So the central question going forward is "does knowledge of the framework facilitate the design of, or even the evolution of, highly motivating educational systems?" While it is difficult to envisage experimental studies in this area, case studies could provide rich insights and, given the needs of inexperienced gamification designers, could possibly be performed on available cohorts of undergraduates and postgraduate students on Game Development or Educational System Development courses.

Although the main framework used in this article is SDT, the authors acknowledge that it represents only one particular perspective. For example, the adoption of other alternative frameworks such as Perceptual Control Theory (PCT; Powers, 1973, 1978) may provide different insights into the

relationship between game elements and motivation. PCT examines the role of an individual's behavior on their environment. Vancouver and Putka (2000) explain that researchers tend to manipulate environments and measure the degree to which these manipulations have an effect on individuals. They say, however, that it is rare for the effects of *individuals'* goals on the environment to be measured, which is where PCT comes in.

Their article describes two research methods based on PCT for examining dynamic data (Vancouver & Putka, 2000). We feel that these methods are particularly suited to adaptation and implementation in computer games, given the potential of the game elements listed here to change the game environment, and so envisage a PCT-based study, parallel to the one we have described earlier. This study would provide an interesting new perspective on the complex interaction between the effect of the gamification environment on the individual, the effect of the individual on the gamified environment, and the resultant effects on learning.

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