

Gamification mechanics for behavioral change: A systematic review and proposed taxonomy

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ABSTRACT

In the last few years, gamification has been proven as an effective strategy to improve people's motivation and performance. Many authors have reported success examples of gamification in areas such as education, entertainment, health and business. This paper is focused on the use of gamification for health, specifically for the promotion of behavioral changes. Firstly, this paper describes a systematic review conducted to identify in the literature the gamification elements that are being used to promote behavioral change. The results of this systematic review evidence the broad terminology related to gamification elements, with different perspectives and levels of abstraction. Based on these results, a taxonomy for gamification mechanics has been proposed. The taxonomy identifies and classifies the most common gamification mechanics and relates them with psychological fundamentals on behavioral changes.

Author Keywords

Gamification; Taxonomy; Serious Games; Behavior Change; Systematic review; Game mechanics; Coaching; Psychology; Modelling.

ACM Classification Keywords

H.5.2. User Interfaces. J.3 Life and medical sciences (Health). J.4 Social and behavioral sciences (Psychology)

INTRODUCTION

Gamification is the application of several techniques, methodologies or mechanics used in games to a non-gaming context. From the point of view of the user, it has

been studied that gamified contexts are better to work than non-gamified ones [1]. Gamification improves engagement and motivation, with the users becoming more productive and resolitional by improving the interest in the tasks they made. From the business point of view, gamified contexts are suitable to address customer loyalty and monetization, becoming the product more interesting, usable, and, in general, an important advantage from competitors.

Gamification can be applied in almost every area of knowledge. The most common areas where we can find gamification are: (a) *education*, not only with applications or serious games [2], we can also gamify teaching to increase academic performance [3]; (b) *entertainment*, gamification is used to increase user experience and ensure loyalty; (c) *health*, there are lot of examples of gamified applications of telemedicine [4], and self-learning about diseases [5] and to support the treatment and diagnosis [6][7]; (d) *business environments*, trying to improve the productivity and satisfaction of workers [8], and (e) *marketing*, where gamification can improve the visualization of the product and becomes it nearer to the final consumer.

Being aware of the number of successful examples of gamified contexts, there is still a gap in the definition and classification of gamification elements. In this paper, we aim to identify the most common gamification elements and we propose a taxonomy of gamification mechanics that can be applied in health to promote behavioral changes.

This paper is structured as follows: Section 2 is dedicated to explore the psychological fundamentals related to behavioral change. Section 3 describes the performed systematic review on gamification techniques for health. Section 4 presents the taxonomy of gamification mechanics for behavioral change. Finally, Section 5 concludes the paper.

PSYCHOLOGICAL FUNDAMENTALS

In this article, we are focusing on how gamification mechanics influence and promote changes in user behavior. The human behavior is the capacity to learn new responses

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and regulate the behavior consequently. Also, it explains how and why the human acts. Relating gamification and behavior, it is remarkable the definition of Huotari and Hamari: where gamification is “a process of enhancing services with motivational affordances to invoke gameful experiences and further behavioral outcomes” [9]. Cugelman [10], proved the relation between gamification and evidence-based health behavior change. In a simple view, the behavior changes are related to reinforcement and punishment involved in the success of explicit goals. For this reason, many gamified contexts are centered on rewards. However, the determinants for behavioral changes are multidimensional [11] and can be categorized as triggers (related to motivation and ability) [12] and personal drivers (personality and emotions). This work is focused on triggers, following the Fogg behavioral model, widely used in gamification, omitting the personal drivers because they are out of the study scope.

From the literature on behavioral change, we can identify components related to oneself, social environment and external stimuli.

Related to oneself, we remark the concept *self-efficacy*, as the personal aptitudes that promote the self-awareness, that is close related to the autonomy and perseverance. The self-efficacy affects motivation, because the types of outcomes that people anticipate depend largely on their judgments of how well they will be able to perform in given situations [13]. Also, the learning of new skills (*cognitive restructuring*) are cognitive changes that involve behavioral changes.

The *social influence* in the behavior represents the goals that we would reach compared with others or based on our social desirability.

The last component is the most complex because it determines how our conduct is affected by external stimuli, i.e. behavioral regulation. One of the fundamentals of behavioral regulation is the *vicarious learning* [14], the process of observational learning where the behavior of a person acts mimicking a model. This is important when we acquire new knowledge from others. Close to it, we can remark the *shaping* concept in psychology, a method of behavior training in which reinforcement is given for progressively closer approximations of the desired target behavior [15]. Talking about behavior maintenance, it is necessary to introduce the *nudge* concept of Richar Thaler [16] who explained that people make decision in an unreasonable way. One of the main findings of this theory is that indirect and non-forced suggestions can influence in decision making at least as effectively, or even more, than direct instructions. In other terms, the perseveration is important in attention-based theories [17][18] because they denote the ability to selectively attend to the relevant information. The perseveration can reach the concept *behavioral momentum* [19], that determines the state of resistance of change. This state is important to trigger the

behavioral change and, then, to maintain a desirable behavior. Table 1 shows a summary of relevant psychological concepts described above.

Psychological Concept	Definition
Self-efficacy	Strength of one’s belief in personal aptitudes to reach goals
Cognitive-restructuring	Learning process to identify and confront ineffective and disruptive behaviors
Social influence	Social power to change behavior of others in a particular direction
Vicarious learning	Learning that is derived from indirect sources, rather than direct instruction.
Shaping	Gradually molding to perform a specific response by reinforcing responses that are similar to the desired response
Nudge theory	Reinforcement and indirect suggestions to try to achieve non-forced expected behavior.
Behavioral momentum	Relation between resistance to change and the rate of reinforcement obtained.

Table 1. Main psychological fundamentals (theories and concepts) related to gamification for behavioral change.

SYSTEMATIC REVIEW

Being aware that there has been a huge scientific effort during the last years related to the gamification, a general taxonomy of well-known and validated gamification techniques could be expected, at least for health purposes. In our case, we are interested in the use of gamification techniques for persuasion or to promote behavioral changes in terms of health and well-being. In this sense, we developed our first research question:

RQ1. What are the main gamification elements that are being used to promote behavioral change?

Thus, we conducted a systematic review to answer the formulated RQ1. The protocol to perform the systematic review was the following: (a) To determine the electronic database(s) where exploring the state of art related to the objectives of this study; (b) To clearly identify the target keywords and define the searching string; (c) To define inclusion/exclusion criteria, i.e. the mandatory eligibility factors to include documents into the current study; (d) To screen those documents that previously accomplished the eligibility factors by means of the title and abstract; (e) Based on the content of the papers, to select those documents that provide information about gamification techniques; (f) To determine the metrics to characterize them and provide the results of this systematic review.

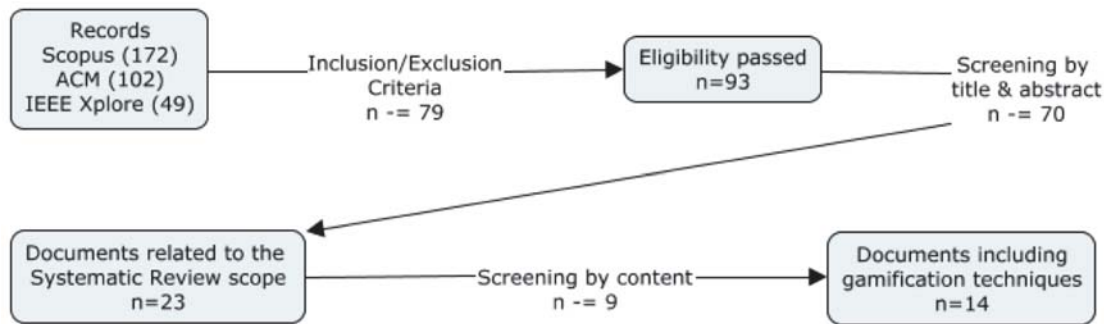


Figure 1. Flow diagram of the systematic review process.

Searching terms

As we have introduced previously, the goal of this systematic review is to identify the main gamification techniques or mechanics applied to behavioral change in the domain of health. Thus, we have selected the terms “gamification” and “health” as mandatory search words and, at least, one of the following terms: “behavior”, “taxonomy”, “technique” and “mechanic”:

(Gamif AND Health*) AND (Behavio* OR Taxonom* OR Technique* OR Mechanic*)*

Eligibility criteria

This systematic review aims to identify high quality research works (high impact) developed recently and tightly-related with Computer Science and Medicine. Consequently, we define the following inclusion criteria:

- Impact: based on citations per year, to ensure certain quality. The criterion is to have a minimum of 1 citation per year from the date of publication. (no citation expected for papers published in the ongoing year)
- Publication year: we limited the search to recent publications, particularly those published in the last five years.
- Domain: The target knowledge areas are Computer Science and Medicine.

The exclusion criteria aim to exclude early reporting and work in progress of studies. Also, those works that barely focus on the scope of this systematic review. The exclusion criterion is formulated as follows:

- Type of document: Extended abstract, work in progress papers, PhD thesis and editorials. Actually, the previous query did not provide any PhD thesis, extended abstract neither work in progress. Thus, only editorials need to be explicitly excluded.

The final search string that includes the eligibility criteria is the following (searched on March 16th, 2017):

TITLE-ABS-KEY ((gamif AND health*) AND (behavio* OR taxonomy OR technique* OR mechanic*) AND (LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015)*

OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013)) AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "MEDI")) AND (EXCLUDE (DOCTYPE , "ed"))

Document collection

Considering the domains related to this systematic review, being Computer Science primarily and Medicine secondarily, we have selected Scopus, ACM and IEEE Xplore as electronic databases of this study. However, after searching documents with the previously mentioned search string, the database that provided more papers was Scopus (n=172) and most of results given by ACM (n=102) and IEEE Xplore (n=49) were duplicated records from the Scopus results. For this reason, we limited the electronic databases to Scopus.

Manual screening

After screening the results through the eligibility criteria, 93 articles remained. The next step was to review the title and abstract of those documents to determine whether they fulfil our objectives based on the formulated research questions (see introduction chapter). This step reported 23 potential documents that were carefully reviewed to explore which articles provide, explicitly, a list of gamification techniques or mechanics (also named as gamification elements, tactics and ingredients). Finally, 14 articles were selected and described in Table 2. Figure 1. shows the flow diagram of this systematic review process. For each article we collected the title, keywords, paper type, author’s countries, and the list of gamification techniques.

Results

Initial search string

The results obtained from the initial search string can provide an overview of the outputs and state of researching on gamification techniques for health. Based on the eligibility criteria but omitting the restriction of citation per year (because it is not needed to characterize the recent state of researching on gamification techniques for health), the search string retrieved 172 documents. Figure 2 shows the count per each country of first author affiliation. One can observe that United States and United Kingdom were main countries followed by Canada and Spain.

Publication	Summary	Keywords	Gamification Mechanics	Publication Type
Guarneri et al. 2016 [20]	Pegaso Fit 4 Future - aims to promote sustainable behaviors geared towards achieving healthy lifestyles. Behavior-change techniques are applied as a preventative measure to accomplish positive behavior change outcomes.	Gamification, PEGASO, Health Game, Behavior Change, Nutrition	energy bar, research, online app, mini-games, quizzes	Conference paper
Landers, 2014 [21]	This paper reframes a game attribute taxonomy presented by Bedwell and colleagues. A psychological theory of gamified learning is developed and explored.	Gamification, Health, Wellbeing, Systematic review	Action language, assessment, conflict/challenge, control, environment, gamefiction, human interaction, immersion, rules/goals	Journal article
Dale, 2014 [22]	This article takes a critical look at the potential of gamification as a business change agent that can deliver a more motivated and engaged workforce	Not provided	achievements, exercises, community, result transparency, time, luck, points, achievements, levels, missions, contests, leaderboards, notifications, anti-gaming mechanics	Book chapter
Choi Ki Wong et al., 2016 [23]	In this article, they explore the use of several gamified features designs used to achieve some motivational affordances, like Competence and Relatedness, including a description of each of them.	Mobile Health, Gamification, Exercise Motivation, Motivation Affordance, Self-determination Theory	Achievement badges, leaderboard, like function, form a team	Conference paper
Johnson et al., 2016 [24]	They analyzed empirical evidence on the effect of gamification on health and well-being. Results were clear for health-related behaviors, but mixed for cognitive outcomes.	Gamification, Health, Wellbeing, Systematic review	Reward, progress, leaderboard, backstory, avatar, social interaction, levels, narrative, feedback, challenges,	Journal article
Masthoff et al., 2015 [25]	This tutorial covers the role of personalization in behavior change technology, and methods and techniques to design personalized behavior change technology	Behavior change, persuasive technology, personalization, gamification	goal setting, monitoring, feedback, review goals, reward, comparison, punish, prompt, threaten, verbal persuasion, motivational interviewing	Tutorial
Phillips et al., 2013 [26]	This research was conducted to ascertain the validity of existing videogame reward categorizations. An overview of current videogame reward types is provided and the need for further research in videogame reward systems was identified	Reward; motivation; gamification	Rewards	Conference paper
Bamidis et al., 2016 [27]	Discussion about game techniques, and its implications for health and health social media. They summarized the existing evidence on how games have been related to health; they presented the different uses of game techniques to improve healthcare outcomes, and the techniques used for health social media and its effects on behavioral change	Attitudes, behavior, game attribute taxonomy, game attributes, game element taxonomy, game elements, gamification, gamified learning, learning, learning outcomes, mediation, model, moderation, psychology, serious games	Goal Settings, Capacity to overcome, Providing Feedback, Reinforcement, Compare progress, Social connectivity	Journal article

Publication	Summary	Keywords	Gamification Mechanics	Publication Type
Landers et al., 2014 [3]	This article links specific game elements common to leaderboards (conflict/challenge, rules/goals, and assessment) with a focal learner behavior, time-on-task, by exploring educational research on competition and psychological research on goal-setting theory.	Reward, motivation, gamification	Leaderboards	Journal article
Wen et al., 2015 [28]	This study correlates the existing arguments from academic researches and healthcare practices into a systematic review.	Gamification, Healthcare, information system, systematic review	Points, levels, badges, quests, ranking, voting, betting	Conference paper
Seaborn et al., 2015 [29]	They present a multidisciplinary review of gamification in action, focusing on empirical findings related to purpose and context, design of systems, approaches and techniques, and user impact	Gamification, Gameful design, Motivation, User experience	Points, progression, achievements, challenges, levels, rewards, time pressure, mini-games, badges, leaderboard, status, avatars, roles, immediate, - avatar, narrative	Journal article
Dithmer et al., 2016 [30]	The aim of this article is to describe the development and testing of a prototype application (“The Heart Game”) using gamification principles to assist heart patients in their telerehabilitation process in the Teledialog project	Gamification, Gameful design, Motivation, User experience	Daily challenges, leaderboard, points, achievements, surprise mechanic, including the spouse/family member, variation, meaning, collective goal	Journal article
Cugelman, 2013 [10]	It provides a behavioral science view on gamification and health behavior change, describes its principles and mechanisms, and reviews some of the evidence for its efficacy.	Gamification, Health, Wellbeing, Systematic review	goals, challenge, levels, points, progress, feedback, rewards, badges, achievements, game leaders, story, theme.	Journal article
Miller et al., 2014 [31]	A game plan: Gamification design principles in mHealth applications for chronic disease management.	consumer health, health informatics, innovation, mHealth, patient engagement	badges, leaderboards, points, levels, challenges, quests, social engagements loops, onboarding	Journal article

Table 2. Systematic review on gamification elements overview.

Regarding the evolution over the year of publication is shown un Figure 3 and can be observed a clear increasing trend from 2011 to 2016.

Figure 4 shows the most frequent keywords of the retrieved documents. Gamification appears explicitly as keywords in most of the papers. Less frequent but remarkable is the frequency of terms such as Human and Health, followed by Human-Computer Interaction, Motivation, Serious Games, Health care and Behavioral Research.

Final selected papers

Once analyzed the 23 documents directly related to the scope of this study and, particularly after analyzing the selected 14 documents, there is a high variety of terminology to define the elements needed to develop gamification. Most of papers, used the term *techniques* (61%), also it is very common to use the term *elements*

(39%) and *mechanics* (35%). Less frequent is the use of *tactics* (9%) and *ingredients*, (4%).

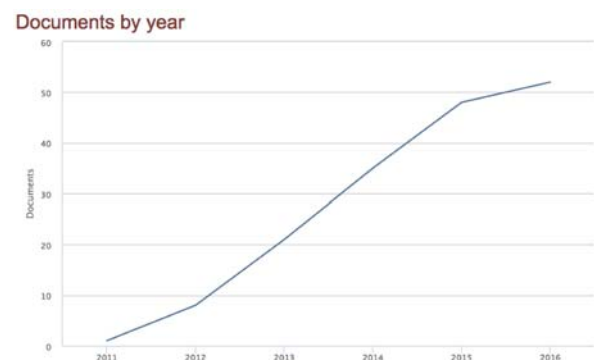


Figure 3. Distribution of number of articles per year

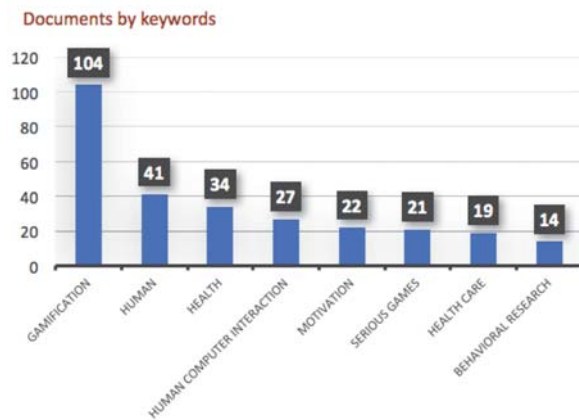


Figure 4. Distribution of number of occurrence of keywords provided in the 172 retrieved papers

Considering the most used terms, we propose to omit just the term element due to the generalist meaning: the objective of the systematic review is to identify those elements that define the way in which gamification is developed. Both mechanics and techniques denote the way in which something is done, however technique denotes skillful or efficiency. Since we are not evaluating the efficiency of gamification, we will use gamification mechanics as the better and well-known terminology for defining those “*elements that define the way in which gamification is developed*”

Another detected problem is the level of abstraction used where gamification mechanics are defined and, also the confusion between mechanics and other kind of elements related to gamification, such as particular benefits, psychological aspects, design strategies and specific ways of implement a mechanic.

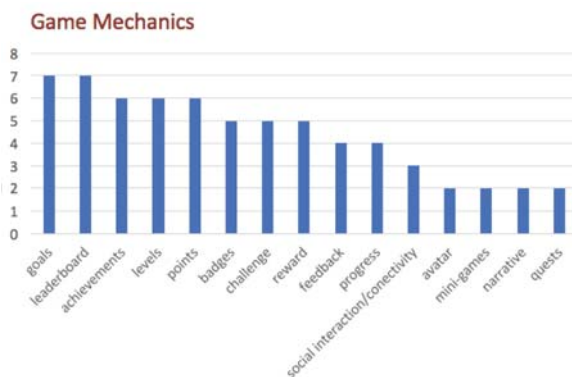


Figure 5. Distribution of number of articles in which each mechanic is mentioned

The analysis of documents retrieved a total of 65 terms that authors defined as gamification elements. Figure 5 shows the frequency of occurrence of each game element. The Figure only includes those terms that appear at least in two documents. The rest of mechanics collected were: action

language, affective-avatar-based-feedback, anti-gaming technique, assessment, backstory, betting, capacity to overcome, comparison, community, conflict, contests, control, Daily challenges, energy bar, environment, exercises, form a team, game leaders, gamefiction, human interaction, immediate, immersion, include family members, like function, luck, meaning, missions, monitoring, motivational interviewing, notifications, onboarding, online App, prompt, punish, quizzes, ranking, reinforcement, research, result transparency, roles, rules, status, story, surprise, mechanic, theme, threaten, time pressure, variation, verbal persuasion, voting.

Next chapter describes and analyzes those gamification mechanics in the context of the proposed taxonomy.

PROPOSED TAXONOMY

To our knowledge, there is no validated taxonomy about gamification mechanics for behavioral change. Indeed, we have observed a huge terminology in terms of gamification elements, following diverse approaches and abstraction levels. As an example, we can find in the literature high abstract elements that could be categorized as benefits or objectives, instead of elements, e.g. feedback, progress, rewards, rules, social interaction, etc. and very specific elements that represent specific implementations of mechanics, e.g. badges, online APP, quiz, or mini-game.

Based on those findings, we propose the definition of a taxonomy that identifies and classifies actual gamification technologies and their relationship with behavioral change principles. Consequently, the research question related to the development of the taxonomy is the following:

RQ2: How can be classified the main gamification mechanics for behavioral change?

Based on the results of the systematic review, the main goals of the taxonomy can be summarized as follows:

- To identify the most common high-abstract gamification mechanics.
- To classify common mechanics into categories and subcategories
- To define each category and subcategory from a general point of view
- To relate gamification mechanics with behavioral change principles.

Gamification elements classification

The first step to build the taxonomy was to categorize the retrieved terms into the following sets:

- *Gamification mechanics* that fit the proposed definition (elements that define the way in which gamification is developed), independently from the level of abstraction but omitting examples of implementation. These mechanics were included in the taxonomy (Table 3)

Gamification Mechanics	Subcategories	Definition	Related terminology	Psychological fundamentals
GOALS Main reasons and way of acting based on users' ambitions and efforts	Achievements	Milestone that determines progressive stages in the game/context		Self-Efficacy Cognitive restructuring Social Influence Shaping Behavioral momentum
	Challenges	Journey of actions that a user must overcome		
	Quests	Challenge that needs to be solved in a collaborative or competitive way	Contest, Conflict	
	Levels	Subdivision of complex elements in simpler ones to control progress, learning and difficulty.		
	Aversion	Influencing the user behavior through the need of avoiding punishment		
STATUS Set of characteristics of a user that differentiate for the rest	Ranking	Hierarchical classification of users by status		Self-Efficacy Social Influence
	Leaderboard	Way to show the leading competitors	Game leaders, Hall of fame	
	Social sharing	Mechanics to share the progress or status externally		
RANDOMNESS Characteristic of the game that makes it seem unpredictable	Free Lunch	User feels that they're getting something for free		Nudge Behavioral momentum
	Luck	Mechanics to give the users the feeling that the result of an event is not affected by their actions	Betting, Lottery	
	Variations	Set of mechanics that make the context always changing	Infinite game	
	Surprise	Parts of the context that are not expected by the users, like special rewards or hidden elements		
APPOINTMENT Dynamics in which at predetermined time a user must log-in or participate.	Countdown	Users are only given a certain amount of time to do something		Nudge Behavioral momentum
	Schedule	The timeframe and delivery mechanisms through which special events are delivered		
SCORING Is the way to feedback the user for his work	Points	Running numerical value given for single actions		Self-efficacy Social Influence Nudge
	Combos	Award skills through doing a combination of actions		
	Bonus	Extra award that requires exceptional effort		
INMERSION Deep mental involvement in something in the gamified context.	Role	The assumed or expected functions played by a user in a specific situation	Avatar	Self-efficacy Vicarious learning Shaping Behavioral momentum
	Narrative	Defines the story, context and all its components	Story, Backstory, Gamefiction	
	Exploration	Mechanics that encourage the user to discover the whole elements	Collectables Environment	

Table 3. Taxonomy of gamification mechanics for behavioral change.

- *Implementation examples*, very specific elements that represent a way of implementing a mechanic. This set included the following terms: Mini-games, badges, missions, assessments, quiz, notification, exercises, voting, energy bar, affective avatar, and like function.
- *General objectives/benefits of gamification*, that cannot be considered mechanics because they do not define a way to develop gamification but declare purposes or fundamentals. This category includes feedback, reinforcement, transparency, control, comparison, monitoring, form a team, prompt, progress, onboarding, rewards, community, meaning, research, and overcome.
- *Excluded terms*, elements that do not belong to the previous categories and are too general or not significant to this study. The excluded terms are: human interaction, immediate, family members, anti-gaming, action language.

Selected gamification mechanics categorization

Once selected the terms that actually represent gamification mechanics, they have been grouped and classified, identifies general gamification mechanics as disjoint sets (categories) and subcategories that must be specialization of each category (subcategories). Some of the candidate terms have been identifies as alternative terminology of subcategories. Table 3 shows the proposed categorization of gamification mechanics and describes them in detail.

Related behavioral change principles

The last part of the taxonomy is the relation between each gamification mechanic category and the psychological fundamental that mechanics address.

As the Table 3 shows, self-efficacy is related to the goals that set what we want to achieve. For example, the levels mechanic helps to model the perception of oneself skills and our progress, that can be also compared with others through mechanics such as those related to the status. The immersion-related mechanics also contribute to the self-efficacy because a projection of oneself can make us more objective.

Regarding the cognitive restructuring, those mechanics related to positive and negative reinforcements (achievements, points, aversion, etc.) make conditional to our behavioral response at cognitive level and determine the future actions based on previous reinforcements. This psychological fundamental is present in most mechanics.

The social influence, not only impacts directly on the behavior because of others, but also determines our psychological proprioception. Again, can be linked to many mechanics, specially with those that compare users by definition, e.g., status and quests.

Many mechanics deal with providing models to mimic somehow, mainly mechanics to create users' immersion. Indeed, this is the fundamental of vicarious learning. When the behavioral regulation is achieved by progressively closer approximations we talk about shaping and it happens

when we propose progressive and incremental goals. Both cases are typically explicit. When we guide the expected behavior of users in an implicit way, these mechanics follows the principles of nudge theory.

Finally, there are some mechanics that can be designed based on the concept of behavioral momentum. There are two main approaches: when we need to cause it to create a habit, typically through appointment-related mechanics, and when we need to reduce the resistance of change, related to create randomness mechanics to break the routine.

CONCLUSIONS

In this paper, we have evidenced the broad interpretation of gamification elements, including a diverse terminology to define the way in which gamification is developed. In this sense, we propose the use of gamification mechanics as aseptic but concrete terminology, or technique when we need to remark the proved effectiveness of mechanics.

A systematic review has been conducted that proves the wide variety of gamification elements, being retrieved a total of 65 terms of gamification elements from 14 selected papers that were screened from a total of 172 documents. Only a few terms are generally used: goals, leaderboard, achievements, levels, points, badges, challenge and rewards. However, only some can be considered actual gamification mechanics and that have not a similar abstraction level.

Attending the results of the systematic review, we propose a specific taxonomy of gamification mechanics including two levels of abstractions (general and concrete) and identifying those terms that are being used as gamification mechanics but they cannot should be considered as such. Additionally, the taxonomy relates each mechanic with the psychological fundamental that can be reached to trigger behavioral changes.

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