

Gamification of Education Using Computer Games

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Abstract. We review the literature on gamification and identify principles of gamification and system design elements for gamifying computer educational games. Gamification of education is expected to increase learners' engagement, which in turn increases learning achievement. We propose a gamification framework that synthesizes findings from the literature. The gamification framework is comprised of principles of gamification, system design elements for gamification, and dimensions of user engagement.

Keywords: Gamification, Education, Learning, System Design, Engagement.

1 Introduction

Gamification is the process of game-thinking and game mechanics to engage users and solve problems [1]. It is a strategy to infuse ordinary activities or processes with principles of motivation and engagement based on the gaming concept. Gamification can be used in applications and processes to improve user engagement and learning. By turning an activity or process into a computer game, i.e., through various game design elements such as rewards for achievement, desirable behavioral change can be induced. For example, gamification can be used to improve motivation and learning in informal and formal settings. The trend of gamification connects to a sizeable body of existing concepts and research in human-computer interaction and game studies, such as serious games, pervasive games, alternate reality games, or playful design.

2 Background: Gamification and Its Application to Education

Games and game-like elements have invaded various domains of the real world, including marketing, politics, health and fitness [2]. Gamification can be used to promote a business, a product, a political candidate, or wellness. For example, marketers have used advergames to integrate marketing into games to promote their products and services, and some companies are working with third-party vendors such as Get Heroik to utilize gamification to encourage their employees to keep fit.

Gamification attempts to harness the motivational power of games and apply it to real-world problems, such as the motivational problems of students in schools [2].

The application of gamification in the educational context can help to increase student motivation in learning. As Lee and Hammer [2] explained, schools have been using game-like elements in classroom activities, such as giving points to students for completing assignments; these points are then converted into “badges,” more commonly known as grades. Using such an incentive system, students are rewarded for desired behaviors and punished for undesirable behaviors. Students “level up” at the end of every academic year if they perform well.

Despite attempts to use gamification in schools, it remains challenging to fully engage students in classroom-based activities. Computer games, however, excel at engagement. Hence, educational institutions are interested to understand how education can be delivered through computer games. In order to do so, teachers or professors and game designers need to work together. Computer games, if appropriately designed, can keep users (i.e., players) engaged with potentially difficult assignments and learning tasks. This gamification experience can help to give students a clear, actionable task and promise them immediate rewards instead of vague long-term benefits. Games allow repeated failure, and after each failure, the student learns something new. In this way, students can learn from their mistakes while taking failure and the negative experiences in a positive and meaningful way. Thus, gamification has the advantage of reframing failure as a necessary part of learning [2].

3 Development of Gamification Framework

Given the benefits of gamification in education and learning, we propose a gamification framework to provide guidance and suggestions to software designers and researchers in gamifying their educational applications.

3.1 Principles of Gamification

Based on our review of the literature, we identify five main principles of gamification: (i) Goal orientation; (ii) Achievement, (ii) Reinforcement, (iv) Competition, and (v) Fun orientation.

Goal Orientation. It is important for educational games to be structured in such a way that there are various “layers” of goals [3]. For example, to complete the long-term goal of completing an educational game, the player is presented with the medium-term goal of completing the levels in the game, and to complete each of these levels, the player is presented with the short-term goal of completing the missions in each level. Each mission can further be broken down into multiple tasks. As the player advances through the missions and the levels, the challenge of the educational game increases. Player engagement is sustained by balancing the player’s knowledge and skills with the challenge required to advance in the game [4-7]. Hence, having a layered goal orientation allows the learner to progress systematically from a beginner to an expert or master as one demonstrates mastery of the skills and knowledge. Having clear and well defined goals of the game also helps to sustain the learners’ motivation and engagement.

Achievement. We use the terms, achievement and accomplishment, interchangeably here. When players are recognized for their achievement, their sense of gratification increases which further enhances their motivation and engagement. Hence, recognition of achievement can also be applied in the context of educational games to increase learner engagement and consequently, learning achievement. Achievements can be recognized in the form of badges or other kudos systems (e.g., trophies, ranks, stars, awards).

Reinforcement. The behavioral learning model purports that learning takes place through reinforcement (e.g., verbal praises/compliments or tangible/intangible rewards) [8]. Hence, it is common for games to have a reward structure that is based on player performance and a feedback system to support reinforcement. In the context of educational games, positive reinforcement, in the form of points or virtual currency, offers gratifications to players and can be used to promote learning from the game. Negative feedback (or reinforcement), on the other hand, can offer corrective information, knowledge or skills to help players achieve their learning goals more quickly.

Competition. Competition is not only an important principle but it is also a given in most games. As noted by Liu et al. [9] citing McGonigal [10], a game motivates a player using intrinsic rewards and competitive engagements. In the context of an educational game, competition plays an important role in sustaining or increasing one's engagement and focus on the (learning) task. Rules of the game should be well defined, explicit and strictly enforced in order for the players to develop an internal sense of control [11], which further helps to enhance their level of engagement [12]. To further enhance player motivation and engagement as well as opportunities for learning to take place, an educational game may allow players to generate rules within the game. Generation of rules by players can facilitate discovery learning, an important component of active learning.

Fun Orientation. Fun or enjoyment goes hand in hand with engagement or cognitive absorption [12]. When one is experiencing fun with a game, one can become so engaged in the task that one loses track of time [12], [13]. Fun is a necessary requirement of most, if not all, computer games. Hence, for an educational game to be effective in motivating and engaging learners, having a fun component or orientation is very important.

3.2 System Design Elements for Gamification

For every game application, a set of design mechanisms has to be outlined before its development. Take a simple and well known example of the Carrom board game. The game system comprises the coins, a board, players and a score board. These are the elements which combine and interact to create a game play. The overall experience of a game play depends on how well the system design elements are kept in mind to enhance user experience.

For a system to work properly, some of the elements like input, processing and output are required. Apart from those, it needs users to take control, check out the environment and boundaries, and most importantly, interact through an interface. If we map the design elements to the gaming environment, input and output are the game mechanics which drive the game forward. The process that happens inside the system is required for the users to experience the game play. These are the game dynamics that happen in the background and usually get unnoticed. These hidden elements form the game dynamics that are required for proper functioning of a game. The system needs ‘attractive’ or ‘magnetic’ cues to entice people to the game and to continue playing the game. Game components are needed to enhance the players’ interest in the game and to make the game meaningful.

A game developer should always keep in mind the interest of the user. When we take the example of the angry birds game, the basic concept is simple. But what drives people crazy to become so engaged or even addicted to the game is how the elements are designed in the game, i.e., the use of the various weapons (i.e., game components). Moreover, the game designer is able to utilize game mechanics that sustain and increase the interest of the users. The quality of the game is one important aspect which amazes the users in getting them captivated by and immersed in the game. The outlying theme of a game is usually tricky to design. It is always best to keep the main theme simple. The sound tracks must be attractive enough to keep the user’s mind in the game at all times. However, if the game is simple, it may not be necessary to have a sound track. So, what are the basic mechanics in a game?

Zichermann and Cunningham [1] suggest focusing on seven primary elements in implementing game mechanics: points, levels, leaderboards, badges, onboarding, challenges/quests, and social engagement loops. In this section, we also discuss other game mechanics that can enhance engagement. They are: feedback, teams/social dynamics, rules (explicit and player-generated), marketplaces/economies, avatars, visual/3D space/sounds, customization, narrative context, and roleplay. As a whole, these game mechanics form the core system design elements for gamification.

Points are the basic game component that drives one’s goal. Levels indicate progress towards higher-level goals and the fulfillment of intermediate goals. Leaderboards allow players to compare their performance with others. Badges signify the recognition of one’s accomplishment or achievement. Onboarding refers to the act of bringing a novice into the system to convey and manage complexity through scaffolding. Quests can be used to create challenges for users. Onboarding and quests work hand to hand to balance challenges and skills, which is a necessary requirement for user engagement. Social engagement loops refer to viral loops that are capable of continually re-engaging users.

Feedback is an important system design element that serves as a form of reinforcement. Competition can be enhanced through social components such as when teams or individuals compete as well as through simulations of an economy where players strive to maximize gains and minimize losses. Competition in a game takes place under explicit rules that are enforced, and these rules can be rules of the game or player-generated rules within the game [11]. To increase the fun component of a game, avatars, visual/3D space/sounds, customization, narrative context, and roleplay can be implemented.

Each of these system design elements is further discussed below.

Leaderboards. The leaderboard brings pride to users in a game. It shows the world the leading scorers of the game. It is possible to personalize the leaderboard to suit specific users' requirements so as to allow them to assess their attainment of specific goals in the game. Having well-defined goals motivate users to stay focused and engaged [4-5].

Levels/Milestones. Levels or milestones signify completion of intermediate goals in the game. They show users their progress during the game. In addition, badges or leaderboards can be offered at every milestone. Hence, levels and milestones not only enhance goal orientation in the game but they also signify achievement.

Points. Points are the basic scoring schema in a game to indicate progress. Using points, users can claim rewards or even cash them to advance in the game. Hence, points are a basic component of the reward system in the game.

Onboarding. Onboarding is a scaffolding method that can help players progress and advance from a novice to an expert or master. When challenges are substantially higher than a player's skills or abilities, anxiety is high which may cause one to give up. Hence, onboarding through scaffolding is important to sustain user engagement.

Challenges/Quests. Challenges are useful to keep users focused on a game, and to stay engaged and interested. Challenges can be introduced in various forms such as time pressure, difficulty, and special quests. A series of challenges in the form of quests can be kept separate and by achieving those targets, players can be well rewarded. In the context of educational games, challenges in the form of quests can offer opportunities for learners to practice what they have learned and be rewarded for doing so.

Badges. Badges serve to reward users as well as recognize their achievement and accomplishment. Users can share and showcase their badges in the game environment as well as in other virtual communities such as Facebook. Badges are social status that can be displayed or showcased to others. Users can also be attracted by the style (graphics) of the badges. Other forms of kudos systems such as trophies, ranks and stars serve similar purposes as badges.

Immediate Feedback. Feedback is a form of reinforcement. The immediacy of feedback is a necessary component of gamification [1]. Points and levels are two examples of the feedback system in a game. However, feedback goes beyond the use of points and levels. It can demonstrate outcomes (i.e., desired or undesired) to reinforce performance. It also shows progress, thus keeping users interested and engaged [4-5].

Social Engagement Loops. Zichermann and Cunningham [1] suggest four components of an engagement loop: (i) motivating emotion – motivation to use an application

such as an educational game, (ii) player reengagement – social or other event entices one back to the application, (iii) social call to action – call to participate in a social event, and (iv) visible progress or reward – recognition for, or rewards of, participation that prompts motivating emotion which begins another loop or cycle. Hence, the social engagement loop repeats and reinforces itself such as in the case of Facebook where users are continually enticed back to the application due to prompts and notifications from their social circles and involvement in associated activities.

Teams/Social Dynamics. When teams or individuals compete, their levels of engagement increase [10-11]. The use of social dynamics in a gaming context is very powerful, which is one of the success factors of World of Warcraft. The social dynamics in a team bring a deeper level of richness and involvement in the game where individuals feel a greater sense of responsibility and commitment to each other. Their sense of identity and social positioning is also enhanced. The increased richness and dynamics in a social setting increase their level of engagement in the game.

Rules. Rules of a game need to be explicit and enforced for players to trust the game and perceive them to be fair [11]. Players need to know exactly what it takes to win in order to stay engaged and to continue to play the game. Having clear and explicit rules also increases one's sense of control which increases one's level of engagement [11-12]. In games where the players are also allowed to generate rules of the game, their sense of personal control is enhanced and their level of engagement increases.

Marketplace/Economies. Competition can be enhanced and made more realistic through simulations of a marketplace or economy. To increase the realism of a game, virtual/synthetic currency can be used. A virtual marketplace is created to enable a variety of transactions in the virtual world. Users can perceive the realism of the game and learn concepts of economics in such settings. The realism and intense competition created by the marketplace and economy in the game helps to enhance player engagement and interest in learning.

Visual/3D Space/Sounds. 3D graphic-rich environments are common in gaming. A person can imagine himself/herself in the 3D virtual world by mapping to physical real world existence. For example, one may perceive a high level of telepresence to the point of feeling totally immersed in the virtual environment. Also, the 3D or visual space is particularly helpful for simulating concepts or events that are difficult to or cannot be demonstrated in the real world such as nuclear reactions. Hence, the visual/3D space can be used to simulate and teach abstract concepts or subjects. Sounds can also be used to enhance the presentation of learning material as well as to increase user engagement with the virtual environments.

Avatars. An avatar is an animated character to represent a person in a virtual world. For example, companies can implement real time scenarios of their work place in a game by letting people choose their customized avatars and work in a game environment. Today, online gaming websites are using the avatar concept to give identities

and recognitions to individual players. The use of avatars in a gaming environment can be used to enhance player engagement by simulating a real or fantasy world that players can relate to.

Customization. Customization is particularly important in a learning context. In order to maximize learning outcomes, the educational game can be customized to respond to a player based on his or her knowledge, skills and performance. Customization can be general or specific to individuals. General customization includes addressing players by their names, greeting them, and personalizing display to their needs or preferences. Specific customization, on the other hand, leverages on performance assessment of the player in order to present a learning module that is suitable for his or her level of knowledge in the domain. Both forms of customization increase engagement of users.

Narrative Context. “Good games have good backstories” [11, p. 68]. The narrative context or theme of a game keeps people engaged in the game. The narratives guide action, offer hints to fulfillment of goals, and induce psychological responses. Stories can be used to drive fulfillment of goals, give meaning to the tasks in the game, and enhance our social and emotional experience. As stories are a human specialty [11] and an important part of our daily life, we relate better to the game if it is grounded in a narrative context that has a storyline.

Roleplay. Roleplay is an important element of a game. The narrative context of the game offers opportunities for a variety of roleplay. Each player may be given a role in the game or may choose among a set of roles. A central theme will be the common element for all the characters (i.e., taking on a variety of roles) operating in the virtual gaming environment through cooperation and competition. In the context of an educational game, these roles could correspond to the job roles that are most closely related to the learner’s domain of specialization or training. Roleplay gives meaning and relevance to a game, and hence, it enhances engagement in learning. For example, learners or players can take on the role of their idealized job to practice and polish their skills or to experience the job role in order to decide whether it is what they want to pursue as a career.

3.3 Outcomes of Gamification

The main goals of gamification of education are to increase cognitive absorption or engagement [1], [11] as well as learning achievement. In this research, the terms, cognitive absorption and engagement, are used interchangeably. Both refer to the degree to which one is in a state of deep attention and involvement and is perceptually engrossed with the experience [12].

In the context of game-based learning, cognitive absorption or engagement is a direct outcome whereas learning achievement is an indirect outcome (i.e., mediated through engagement).

A direct outcome of game-based learning, cognitive absorption or engagement, can be assessed using the following two sets of measures. The first set of measures is presented by Zichermann and Cunningham [1], where the following metrics are used: recency, frequency, duration, virality, and ratings. Recency refers to the time elapsed since the game was last played. Frequency refers to how often the game is played. Duration is the amount of time spent playing the game. Virality refers to the degree to which this game has spread and is adopted by others. Ratings refer to players' subjective evaluations of their level of engagement with the game.

The second set of measures was proposed by Agarwal and Karahanna [12] where cognitive absorption is assessed by subjective evaluations of the following metrics: (i) Curiosity, (ii) Control, (iii) Temporal Dissociation, (iv) Focused Immersion, (v) Heightened Enjoyment. Curiosity refers to the extent to which the experience triggers sensory and cognitive arousal. Control refers to the degree to which users perceive that they are in charge of the interaction. Temporal dissociation refers to the inability to register the passage of time while engaged in interaction. Focused immersion is the experience of total involvement where other attentional demands are largely ignored. Heightened enjoyment refers to the pleasurable aspects of the interaction.

In the context of educational games, we are also interested to assess the players' learning achievement. After playing an educational game, we expect the players' performance or learning achievement to increase. Hence, objective tests and assessments can be used to evaluate the indirect outcome of gamification, learning achievement (i.e., that is mediated by engagement).

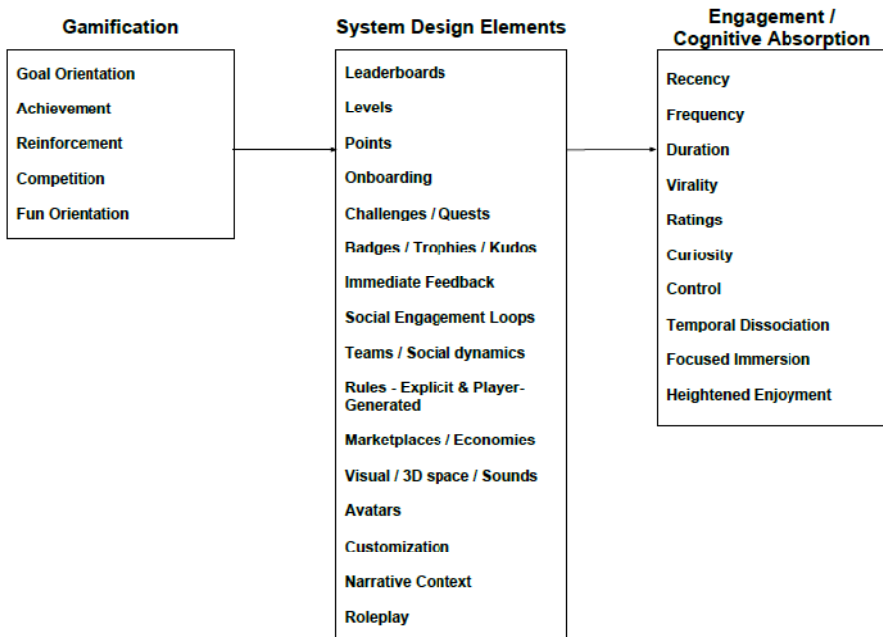


Fig. 1. Framework for Gamification

3.4 Gamification Framework

The proposed gamification framework is presented in Fig. 1.

4 Conclusions and Future Research

In this research, we developed a gamification framework for computer educational games. We review the literature, synthesize the findings from the review, and present a summary of the findings in this paper.

In subsequent and follow-up research, we are interested to assess the gamification framework using laboratory experiments. We plan to use experiments to assess the effects of these system design elements on learner engagement and learning achievement.

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