

Gamification of Education: A Review of Literature

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Abstract. We synthesized the literature on gamification of education by conducting a review of the literature on gamification in the educational and learning context. Based on our review, we identified several game design elements that are used in education. These game design elements include points, levels/stages, badges, leaderboards, prizes, progress bars, storyline, and feedback. We provided examples from the literature to illustrate the application of gamification in the educational context.

Keywords: Gamification, Game design elements, Education, Learning.

1 Introduction

Gamification refers to the application of game design elements to non-game activities and has been applied to a variety of contexts including education [1]. Various elements have been used in gamification to increase user engagement. Examples of these elements include points, badges, leaderboards, and storyline [2]. Educational institutions are interested in gamification of education, where educators create gamified learning environments to enhance learner engagement and improve learning outcomes [3-5]. Given the potential of gamification of education, we are interested in identifying game design elements that have been used to gamify education as well as the impact on learner outcomes. Hence, in this paper, we review the literature on gamification of education and report our synthesis of the findings from the literature.

2 Review of Literature

We carried out a review of the literature on gamification in the educational and learning contexts. Various design elements for gamification of education are discussed in these papers along with their impact on the learners, which we referred to as learner outcomes. Table 1 provides a summary of the review.

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Table 1. Summary of Literature Review

Reference	Design Elements for Gamification	Learner Outcome(s)
Barata et al. (2013)	Experience points, Levels, Leaderboards, Challenges, Badges	Engagement, Participation
Berkling & Thomas (2013)	Levels, Progress bars, Points, Immediate feedback, Leaderboards, Peer interaction and collaboration	
Betts et al. (2013)	Experience points, Levels, Freedom to choose difficulty level	
Brewer et al. (2013)	Points, Prizes	Motivation
de Freitas & de Freitas (2013)	Experience points, Levels, In-game rewards	Engagement, Enjoyment
Eleftheria et al. (2013)	Onboarding, Points, Levels, Badges, Challenges, Replay or do over, Un-lockable content, Customization	Engagement, Enjoyment, Productive learning experience
Gibson et al. (2013)	Badges	Motivation, Engagement, Sense of achievement, Status
Goehle (2013)	Levels, Experience points, Achievement	Engagement, Sense of accomplishment
Kapp (2012)	Storytelling, Feedback	Engagement
Kumar & Khurana (2012)	Levels, Stages, Points, Badges	Engagement
O'Donovan et al. (2013)	Storyline, Visual elements, Goals, Rewards - Points, Progress bars, Badges, Leaderboard	Engagement, Performance

Table 1. (Continued.)

Raymer (2013)	Frequent feedback, Progress bars, Rewards, Character upgrades, Peer motivation	Engagement
Santos et al. (2013)	Badges	Achievement, Engagement, Motivation, Recognition
Todor & Pitic (2013)	Avatar, Feedback, Points, Badges, Rewards	Interest in course
Villagrasa & Duran (2013)	Storyline, Scoreboard	Engagement, Motivation

Barata et al. [6] gamified a course in Information Systems and Computer Engineering by introducing multiple game design elements into the course design, including experience points, levels, leaderboards, challenges, and badges. The results suggest that the gamified course led to greater student engagement and participation in online course activities based on the number of downloads of the lecture slides and number of online posts (e.g., online discussions of class materials and online queries related to course content). The gamified approach also had a positive influence on lecture attendance. However, gamification did not significantly improve student grades.

Berkling and Thomas [7] introduced a gamification platform that was used to teach a course in Software Engineering. A web-based learning platform that contained game dynamics, such as status, achievements, competition, altruism, and game elements, such as points, levels, progress, immediate feedback and leaderboards, were introduced to students to learn the course. A survey was administered to the students to understand the effectiveness of the new teaching method. The results revealed that students were generally not interested in such a gamified environment because they did not find it helpful. Berkling and Thomas [7] noted that students who underwent a traditional classroom style of education for more than 12 years did not automatically get enticed to the new ways of learning.

Betts et al. [8] described a gamified web-based collaborative learning tool called Curatr (www.curatr.co.uk) that was used in an online course. Game design elements such as experience points, levels, and freedom to choose difficulty level were used. The results show that the number of experience points earned was correlated with assignment scores. There was also a correlation between the level of participation and the overall scores. However, those who received the highest overall scores did not have the most experience points, whereas those who received the lowest overall scores had the lowest experience points. Hence, the authors suggest that quality or performance may not be reflected by experience points. Instead, educators may use a minimum participation threshold for assessment of effort that can be integrated into the final grades.

Brewer et al. [9] conducted a lab experiment to assess the effect of gamification on children. To address the problem of lack of motivation among children, the authors

introduced the scoring system and the prize system into the experimental tasks. The result indicates that the task completion rate increased from 73% to 97% with the gamified systems. Hence, gamification helped to increase the motivation of children in task completion.

de Freitas and de Freitas [10] applied the concept of gamification into a system called "Classroom Live" which was used in a computer science class for undergraduate students. The authors took into account various game design elements including experience points, levels, and in-game rewards. The learning experience of the students was more enjoyable while students' engagement was also enhanced.

Eleftheria et al. [11] proposed using augmented reality and gamification techniques to design a gamified augmented reality book for learning science. By using augmented reality, a book can provide 3D simulations of science experiments to increase student understanding of the concepts. To enhance motivation and engagement of the students, game design elements such as onboarding, points, levels, badges, challenges, replay or do over, unlockable content, and customization were applied. The objective of gamification was to create an alternative method to make the learning experience more engaging, enjoyable and productive.

Gibson et al. [12] explained that badges, when used with points and leaderboards, can be a powerful means of creating competitions and signaling goal attainment, achievement, and status. Badges can also motivate learners to improve their performance through higher engagement, greater skill acquisition, and time spent on learning.

Goehle [13] implemented two video game mechanics, i.e., leveling/experience points system and achievement system, into a web-based homework program called WebWork. By comparing the final levels and achievements of the students, it was found that most students with high scores on their homework also received high achievement scores, indicating that their high engagement levels could be attributed to the achievement system. The results also suggest that the implementation of the leveling/experience points system and achievement system heightened the sense of accomplishment of the students.

Kapp [14] indicated that gamification can increase learner engagement in the learning process. Game design elements such as storytelling and feedback were discussed. Storytelling refers to the narrative of the game which can be used to sustain learners' interest and engagement. The frequency, intensity, and immediacy of feedback are also important for sustaining engagement throughout the learning process. Kapp [14] also noted that the balance between learning and gameplay is a key success factor for a gamified educational project.

Kumar and Khurana [15] found that students did not show much interest in learning programming languages, such as C and C++, in the traditional method of classroom teaching. Students were, however, interested in a gamified approach to learning programming languages. Utilizing the gamification approach, a game design was proposed that incorporated elements such as levels, stages, points, and badges to motivate students to learn. In addition, students were assigned different levels of expertise, such as "Beginner", "Intermediate", "Advanced", and "Expert", as they progressed through the gamified learning process. Kumar and Khurana [15] indicated that the goal of gamifying an educational scenario or a pedagogical approach is not fulfilled unless the objective of "learning with fun" is incorporated into the game.

O'Donovan et al. [16] utilized storyline, vivid elements, goals and subgoals, points, progress bars, badges, and leaderboard to gamify a game development course and assessed the effectiveness of gamification using a questionnaire administered to students. The results indicate that student engagement (e.g., lecture attendance) and performance (e.g., course grade) improved as a result of gamification.

Raymer [17] suggested that providing frequent feedback, measuring progress, offering character upgrades, rewarding effort, and utilizing peers as a source of motivation can help to increase learner engagement.

Santos et al. [18] conducted a case study that explored students' experiences while earning badges in a learning process. More than 90% of the students agreed that the badge system in education made them more focused, motivated, and engaged. The results suggest that badges are considered as "symbols of recognition" and they offer a sense of achievement during classroom activities.

Todor and Pitic [19] incorporated game elements such as avatar, feedback, points, badges, and rewards into an e-learning platform for a course in electronics. The results indicate that after applying the gamified platform, the students' interest in the course increased.

Villagrassa and Duran [20] introduced gaming components, such as storyline and scoreboard, in gamifying a 3D art class for university students. The goal of gamification is to increase engagement and motivation of students as compared to traditional teaching methods.

3 Game Design Elements for Education

Based on our review of the literature, we identified eight game design elements that are used extensively in the educational and learning contexts.

1. Points

The point system functions as a measure of success or achievement. These points may be used as rewards, as a form of investment for further progression towards the goals, or to indicate one's standing. There are different types of points and they vary across games. For example, Experience Points (XP) (i.e., points earned by completing tasks) and Steam Points (i.e., points that correspond to in-game currency) were used for some of the role-playing games in education [16]. Points can also be considered as credits in an academic environment [15].

2. Levels/Stages

The level system is used in various game designs to give players a sense of progression in the game. Initial levels tend to require less effort and are quicker to achieve, whereas the advanced levels require more effort and skills. Even though levels/stages are a widespread and popular gamification concept and they serve as a form of rewards for task or assignment completion, students' learning abilities may not progress or improve as a result of leveling [13].

3. Badges

Badges are recognized as a mark of appreciation or task accomplishment during the process of goal achievement. In order to maintain learners' motivation, the use of badges is helpful for engaging the learners in subsequent learning tasks. Badges

are effective in inspiring learners to work towards future goals [16]. The majority of the student respondents in Santos et al.'s [18] survey also felt that badges helped to keep them engaged, especially in the classroom context, and motivate them to carry out future learning tasks.

4. Leaderboards

The objective of a leaderboard is to keep the learners motivated and create a sense of eagerness to advance their names for the achievements they have accomplished. Leaderboards are used to create a competitive environment among students. A leaderboard is used to display the current levels of high scorers and the overall scores. In order to avoid demotivation for those who are lower ranked, leaderboards usually display the top 5 or 10 scorers only. The survey findings by O'Donovon et al. [16] suggest that leaderboards rank highest in motivating learners.

5. Prizes and Rewards

The use of prizes has been found to be effective in motivating learners [9]. The timing and scale of rewards can also affect learner motivation [17]. In general, it is better to give multiple small rewards than one big reward. Also, the schedule for giving out rewards should be evenly distributed throughout the learning process. An example of in-game rewards is character upgrades [17]. A character upgrade is a way to motivate learners by displaying their progress in the form of characters. It allows others to recognize the amount of effort a learner has spent to reach his or her current level. In order to use character upgrades as a game design element, one must be given a virtual character which allows him or her to upgrade from time-to-time by means of the points or rewards earned [17].

6. Progress bars

Several researchers [7], [16], [17] have utilized progress bars to gamify education. While badges demonstrate achievements towards a particular level/goal, progress bars are used to track and display the overall goal progression. In an educational game, progress bars are used as a display mechanism to motivate people who are close to achieving their educational goal or sub-goals. Progress bars can also encourage them if they are falling behind in their progress.

7. Storyline

Storyline refers to the narrative or story in the game. Kapp [14] suggests that a good storyline can help learners to achieve an ideal interest curve, where interest peaks around the beginning and end of the learning process, and to stay motivated throughout the learning process. A storyline also provides a context for learning and problem solving as well as helps to illustrate the applicability of concepts to real-life [16].

8. Feedback

The frequency, intensity, and immediacy of feedback are helpful for learner engagement [7], [14], [17]. The more frequent and immediate the feedback is, the greater the learning effectiveness and learner engagement. Clear and immediate feedback has been shown to be important for attaining the flow state, which is a state of engagement and immersion in an activity [2], [21], [22]. Hence, feedback is an important criterion for performance and engagement.

4 Examples of Other Gamified Educational Applications

A variety of applications have been developed based on the gamification concept. In order to engage and motivate learners, companies and educational institutions are investing time and money into gamification. An example of such applications is a website development tool provided by DevHub (www.devhub.com) [23]. In this particular website, users can develop and launch their own websites. An interesting component of this website is that as users progress towards their goals, online rewards, such as points and badges, will be awarded. The use of progress bars also keeps users motivated. Another example is Stack Overflow (www.stackoverflow.com) where computer programmers interact with one another in a community-like environment [24]. Those who answer questions posted by their fellow website users will earn rewards such as reputation points and badges. After collecting a certain number of points, they will be provided with special privileges, such as moderator, which enhance the user's reputation.

The gamification concept is also being implemented in a library by an application development company, RunningInTheHalls [24]. In order to reward those who use the libraries frequently and to make academic studies or search tasks in a library more interesting, a library game (www.rith.co.uk/#librarygame) was developed. Using the game, some of the activities, such as borrowing a book, spending time in the library, and visiting the library frequently, will be rewarded. There is another variant of this library game called 'Lemontree,' where the focus is on libraries in academic institutions. A trial of this game was conducted at the University of Huddersfield where positive feedback and outcomes of the game were received. Based on observations, it was found that students utilized library resources more effectively and the game facilitated friendly competition among students and between departments.

There are many gamified systems in the market to help increase user engagement when learning new techniques. Games, such as "QuizeRo", that are based on geolocations have been shown to be of interest to users by motivating them to explore places and learn about new locations [25]. Microsoft Ribbon Hero (<http://www.ribbonhero.com/>) offers an example of gamification in learning Microsoft Office tools. Adobe LevelUp (<http://success.adobe.com/microsites/levelup>) is a gamified system to help users explore Photoshop through puzzle games. Online services, such as Khan Academy (<http://www.khanacademy.org>), are available for users to learn about various subjects while experiencing gamefulness [6].

5 Conclusions

In this paper, we carried out a review of the literature on gamification of education and identified several game design elements that have been used to gamify education. Gamification of education has increased in popularity but systematic studies to assess and evaluate its impact on learning are in the infancy stage. We encourage practitioners and researchers to use a design science approach [26] to evaluate the impact of gamification in education. Specifically, they can develop gamified educational appli-

cations and carry out systematic evaluations of them using scientific approaches and methodologies such as experiments and surveys.

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