Chapter 11
Gamification and Game Mechanics-Based e-Learning: A Moodle Implementation and Its Effect on User Engagement

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Introduction

Over the past few years, various attempts have been made to define Gamification. Some researchers generically refer to it as "The use of game design elements and game mechanics in non-game contexts" (Deterding et al. 2011), or as "The process of game-thinking and game mechanics to engage users and solve problems" (Silva 2010). For the purposes of this paper, the following definition will be used: Gamification is the process of applying elements associated with (video) games in non-game applications which aims to increase people's engagement and to promote certain behaviors.

Gamification has been incorporated with commercial success into web applications (Zichermann and Cunningham 2011), while education is an area with high prospective for application of this concept (Kapp 2012). Despite the fact that most empirical studies indicate that gamification provides positive effects on user engagement and motivation (Hamari et al. 2014), empirical evidence reports mixed results (De-Marcos et al. 2014), some surveys indicating that gamification can affect negatively intrinsic motivation and user satisfaction (Hanus and Fox 2015), and case studies reporting gamification's failure on real-life learning settings (Berkling and Thomas 2013). Therefore, further research is required to investigate the effect of gamification on user engagement.

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The term engagement indicates the connection between a consumer and a product or service. There is no single metric on the web technology that sufficiently measures engagement. Therefore, "engagement should be better considered as a series of interrelated metrics that combine to form a whole. These metrics include recency, frequency, duration, virality, and ratings" (Zichermann and Cunningham 2011). Moreover, it is really essential to define the importance of each metric on a given system, as they can vary depending on the type of the application. Turning an experience into a game, by including some reward for achievement, aims to provoke users' behavior change. This change indicates that users will score higher percentages of the engagement metrics.

In order to create a gamified system that increases student engagement, it is necessary to focus on the fundamental elements that make games popular to people. "Games are motivating because of their impact on the cognitive, the emotional and the social areas of players" (Lee and Hammer 2011). There are actually two types of gamification. Structural gamification is the application of game elements to propel a learner through content with no alteration or changes to the content, while content gamification is the application of game elements and game thinking to alter the content to make it more game-like (Kapp 2012). Kapp also stresses that in order to successfully gamify a learning experience, "the first priority is to codesign instructional elements along with gameplay elements and not as an afterthought."

Some of the most popular game elements are points, levels, leaderboards, and badges. Those elements are also the most common in structural gamification. Badges have existed for a long period, since people desire badges for all kinds of reasons. For many players, collecting them is a powerful drive, while other players enjoy the sudden rush of surprise or pleasure when an unexpected badge shows up in a gamified system.

Related Work

Literature reviews carried out in the area report that gamification is gaining increased attention during the past few years (Caponetto et al. 2014; Hamari et al. 2014). Those reviews attempted to shed light on the emergence and consolidation of gamification in education/training and emphasized the rapid increase in the publication of academic writings during the past couple of years. They also indicated that the total research is evenly split between conceptual/theoretical papers (51 %) and empirical studies (49 %), as well as that the 43 % of the target population of the research focuses on University students (Caponetto et al. 2014). From a global perspective on usage of uptake of gamification in education, there is a big digital divide with USA, England, Spain, the Netherlands, and Germany being the largest users, while developing countries have limited usage (Surendeleg et al. 2014).

Some of the conceptual approaches, in which gamification is thoroughly treated, are "Gamification by design" (Zichermann and Cunningham 2011) and "The gamification of learning and instruction" (Kapp 2012). The first textbook indebts to the work of notable game designers, which helps clarify the process of game design, making it a quantifiable science, while the second provides the game methods, the design strategies, and tactics for training and education. Moreover, theoretical papers that shaped a rich theoretical background in the area of gamification indicated that gamification is linked to added value in the learning process (Lee and Hammer 2011), and confirmed gamification's close relationship with learner engagement (Muntean 2011) and motivation (Khaled 2011). Many empirical studies on gamification have based their experiments on the Self-Determination Theory (Deci and Ryan 1985) which states the existence of two types of motivation: intrinsic and extrinsic, while Fogg's behavioral model for persuasive design is also highly referred to (Fogg 2009).

One of the first empirical studies in the field was conducted on University students and utilized an isolated gamification element, points (Gaasland 2011). The evidence indicated that the gamified e-Learning system was *somewhat motivating*, but was merely based on students' responses to questionnaires. Another study that also lacked control group but provided specific quantitative empirical evidence on users' engagement and task completion was conducted on teachers' training (Ferreira 2015). Instead of isolating a gamification element, the study added different gamification strategies to the original software, according to the individual characteristics of the users. Many empirical studies often lack controls between implemented game mechanics. Some studies have implemented both badges and leaderboards (Domínguez et al. 2013), while others combine a great range of different game mechanisms (Li et al. 2012). Empirical studies on the gamification of training and learning usually utilizes points (Gaasland 2011; Morschheuser et al. 2014), leaderboards (Witt et al. 2011; Hamari and Koivisto 2013), and badges (Denny 2013; De-Marcos et al. 2014). Most of the empirical evidence indicates that gamification provides positive effects on user engagement positive attitude toward learning and increased student learning productivity and motivation (Hamari and Koivisto 2013; Denny 2013; Morschheuser et al. 2014), while there are case studies reporting gamification's failure on real-life learning settings (Berkling and Thomas 2013).

Besides the academic writings, there are various successful web and mobile applications that use badges in order to establish long-term relationships with their users. Foursquare, for instance, uses badges to represent players' progress, as well as to create a sense of delight or surprise, due to the fact that *it doles out those badges with seeming randomness* (Zichermann and Cunningham 2011). Farmville, on the other hand, reveals the challenges more clearly to the player compared to Foursquare. Instead of badges, Farmville uses ribbons, which act in close concert with the challenges set by the application.

The literature review suggests that, indeed, gamification does work, since the majority of the reviewed studies did yield positive results. However, several shortcomings could be also identified (Hamari et al. 2014): (1) the sample sizes were small in some studies (around N = 20), (2) some experiments lacked control groups and relied solely on user evaluation, (3) controls between implemented game mechanics were often lacking and multiple mechanics were investigated as a whole, (4) many presented only descriptive statistics, and (5) experiment time frames were in most cases very short. Finally, since most of the experiments were conducted on custom platforms, there is limited empirical evidence on experiments conducted on gamified courses accommodated by Moodle, which is one of the most popular Learning Management Systems.

In this context, the research aims to contribute to the empirical evidence by implementing an isolated gamification element to a Moodle course and evaluating its effect on students using a systematic interrelated metrics approach (Zichermann and Cunningham 2011). By assessing the way control and treatment groups interacted with the system, the research aims to answer the following questions:

- How engaging can a reward system, merely based on badges be, when integrated to an e-Learning system?
- Is it possible to combine badges which represent students' progress to badges awarded with seeming randomness in order to motivate students in completing a course's challenges, while pleasantly surprising them with random trophies, so as to further engage?

System Design and Development

The design of the gamified e-Learning system was based on three axes, including designing the cognitive, the emotional, and the social areas of the learning experience. As mentioned before, this technique aims on utilizing game-like rule systems and player experiences to shape learners' behavior (Lee and Hammer 2011). Moreover, no alteration or changes to the content of the gamified course were made, while the application of badges aimed to propel the students as structural gamification indicates (Kapp 2012).

The cognitive area consisted of the system of rules, in which students would obtain the skills provided by the course, as well as the tasks that would guide the users through mastering those skills. In an attempt to keep the gamified platform as similar as possible to the typical one, a hierarchical tree was structured composed of three levels (Fig. 11.1). The first level matched the course's curriculum, which was distributed in the weeks that the experiment lasted; the second hierarchy level consisted of the different categories in which the curriculum's content was organized, while the third hierarchy level consisted of the curriculum's content itself. The system of rules defined the way students would interact with the third level, gain access to the content, get the rewards, socialize, and proceed further to the learning experience. Students could freely access any topic and its tasks once it had

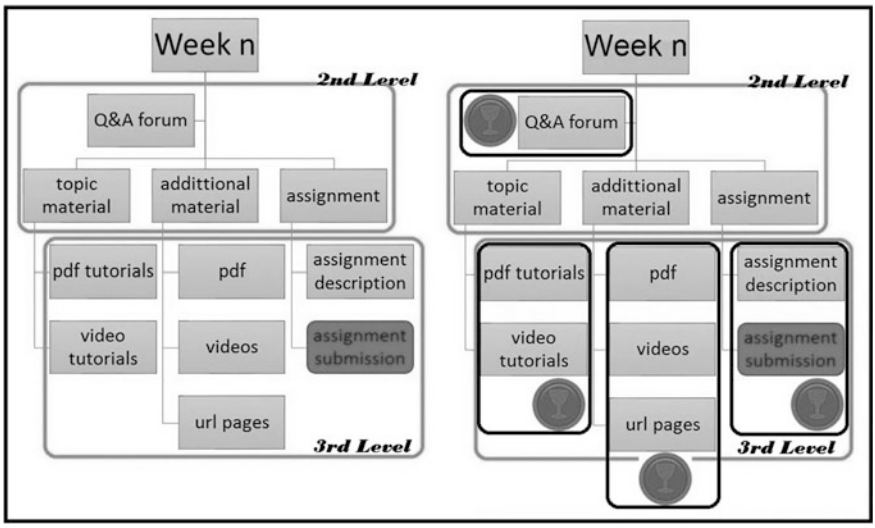

Fig. 11.1 Hierarchical tree of the structure of the SEAC200 course for both platforms

been introduced, and although repeated experimentation regarding the topic's material was allowed, assignments, quizzes, and questionnaires submissions were allowed only once. Regarding the gamified course, students would get rewards for accessing all different forms of the topic's material, as well as the additional material, and for successfully submitting their assignments. Moreover, "In game design, level complexity is neither linear nor exponential. Applying transitions in the complexity from one level to the next is how games work, and this is a process that has also proven highly engaging" (Zichermann and Cunningham 2011). Motivated by this particular notion, transitions were applied to the complexity of each week's lessons.

The next step was to design how to impact on the emotional area of the students. A virtual reward system should be included, so as to create positive emotions on task completion, thus motivating students to complete more tasks. For the particular gamified system, two major badges' categories were designed, with a view to impact the emotional area of the students. The first category, inspired by Farmville, consisted of badges designed to act in close concert with the challenges set by the e-Learning system. Such badges would be awarded to students on assignment, quiz, or questionnaire completion, and would serve students keeping track of their progress (Fig. 11.2). The second category, inspired by Foursquare, consisted of badges designed to be awarded on students' participation, and after they had taken combinatorial actions that met certain criteria. Those badges would be awarded with apparent randomness, since the criteria that should be met in order for those badges to be awarded were not revealed to the students, so as to create a sense of delight and surprise for the students (Fig. 11.3). Moreover, in an attempt to increase the

Level	Image	Name	Criteria	Level	Image	Name	Criteria
Level 1		Love U	Awarded by manager (Complete all three questionnaires)	Level 3		You Are a Web Star!	Awarded by manager (Complete website part 1/2)
Level 1		Riddler's 1st Quiz	Awarded by manager (Complete quiz)	Level 4		Web Site Developer Certificati on	Awarded by manager (Complete website part 2/2)
Level 2		You Are a Star!	Awarded by manager (Complete video capture and editing)	Level 5		Multimedi a Content Gold Cup	Awarded by manager (Complete multimedia content)
Level 2		Youtube Hero	Complete: "Ass ign - Create a Youtube account"	Level 6		Have a nice summer!	Awarded by manager (Complete final questionnaire)

Fig. 11.2 Badges awarded on tasks completion

participation & combinatorial actions			social interaction and collaboration		
Level	Image	Criteria	Level	Image	Criteria
Level 1		Complete ALL of: "PDF – expression encoder", "PDF - web expression", "PDF - Multimedia builder"	System		Complete: "Update profile"
Level 1		Complete: "URL - Client server model"	Complementary module		Complete: " Chat room"
Level 2		Complete: "PDF - Embedded content"	Complementary module		Complete: "General forum"
Level 2		Complete ALL of: "PDF - Creating a video", "VIDEO - Creating a video"	Level 1		Complete: "Q&A forum"
Level 3		Complete ALL of: "PDF - Creating a website 1/2", "VIDEO - Creating a website part 1", "VIDEO - Creating a website part 2"	Level 2		Complete: "Q&A forum"
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Fig. 11.3 Example badges awarded for participation and impact to social area

engagement of the students, the more they progressed in the system the more the difficulty with which they would earn a badge should increase.

The final design step was related to the social area of the system. There are different ways of student interaction: cooperative, competitive, and social (Lee and Hoadley 2007). Therefore, it was decided to combine cooperative mechanisms to

Fig. 11.4 Student profile on the typical platform and on the gamified platform

the social modules that had already been utilized, in order to motivate students' collaboration and avoid the negative impact of competitive mechanisms such as leaderboards. In the initial design chat rooms, general forums and questions and answers forums had already been integrated to the e-Learning systems. Therefore, it was decided to encourage students' social interaction and collaboration by awarding badges for actions that would include instant messaging, posting questions, and answering to classmates' questions, or other minor actions such as profile updating and photo uploading, which indicate commitment to the system (Fig. 11.3).

Finally, both e-Learning systems were designed to be identical. Therefore, the design of the typical system's cognitive area followed the same pattern as the design of the gamified one. The only difference between the two systems was that the typical one lacked badges. Figure 11.4 depicts how users would perceive the interface while interacting with each of the two systems.

Methodology

The experiment was conducted on a total of 32 undergraduate students of the Department of Special Education of the University of Thessaly in Greece, all female, who participated in the activities designed as the elective laboratory part of the course. The research was designed according to the model of semi-experimental design with pre-equivalent groups. According to this model, the students were divided into two groups, treatment and control, which were equivalent, and with a high degree of similarity in their composition. In order to achieve the required equivalence, pre-control was conducted in the form of 3 rounds of questionnaires. The first round of questionnaires recorded the familiarity level of students to use the computer and the Internet. The second round of questionnaires recorded students' prior knowledge on the learning subjects of the course's curriculum, such as their prior knowledge in video and multimedia content creation tools and their prior knowledge in building basic static websites. The final round of questionnaires

recorded students' attitudes on the use of ICTs and games to support the learning process. Students with similar skills, prior knowledge, and attitudes formed each of the two groups, one using the typical platform, while the other would work with the gamified one.

For the purposes of this research, badges, one of the most popular game elements, was selected, so as to isolate and measure the influence of its utilization in learning context. Moreover, since the study was conducted in the context of a semester course, the time period allowed for the students to test the system and provide data for the evaluation was limited to 6 weeks, and the content of the course was organized accordingly. The laboratory part of the course SEAC200 includes video and multimedia content creation and building basic static websites. The e-Learning course was designed to include a lesson each week. The first week students were taught general computer and Internet skills such as accumulating and installing all the necessary tools that they would need for the purposes of the course. The second week students were instructed on creating educational videos using Microsoft's expression encoder, while the next two weeks students were taught building basic websites using Microsoft's expression web. The fifth week the lesson included multimedia content creation for educational purposes, and students were instructed on Multimedia builder tool. The last week the lesson had a revising character and students were mainly assessed on the knowledge they had acquired during the past weeks.

Furthermore, in order to measure the engagement metrics noted by the students, as well as the task completion and their interaction with the system throughout the experiment, Moodle's statistical tools had been utilized. Moodle reports through log files the information about the frequency, the recency, and the duration of students' interaction and also provides useful data through activity and participation reports about the students' achievements and their actions in the context of the e-Learning systems. For the purposes of the evaluation, the data produced by those tools were gathered and processed.

Experimental Results

Frequency

Initially, the two groups noted similar frequency rates. Similar initial rates were expected, since the two groups had been selected to be equivalent. Moreover, by the third week, the frequency rates of the treatment group constantly rose, in contrast to the control group whose frequency rates ranged indistinctly. This fact is particularly encouraging, since users of the gamified platform tended to return more often to the system over time. Finally, an average of 1.407 and 1.516 logins is noted for users of the typical and of the gamified platform, respectively (Fig. 11.5a).

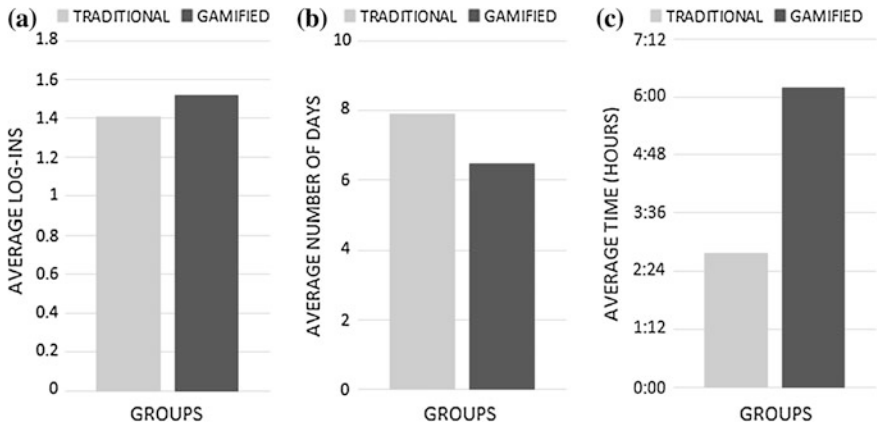

Fig. 11.5 **a** Average frequency per group, **b** average recency per group, **c** average duration per group throughout the entire experiment

Recency

In an attempt to generalize the amount of time that had gone by before a student returned to each system is being reported that for the typical platform, the students would return to the system every 7.896 days on average, while for the gamified one, they would return every 6.461 days on average. The period of time is sorted up to 18.2 % for the students of the gamified platform, compared to the students of the typical one (Fig. 11.5b).

Duration

Although the amount of time devoted by a student to an educational activity does not necessarily enclose pedagogical value, the fact that the students of the gamified platform spent more time on it, compared to the students of the typical platform, is particularly encouraging in respect to the purposes of this research. More precisely, students of the treatment group spent an average of 6 h and 11 min on the gamified platform throughout the entire experiment, which is up to 123.5 % higher, compared to the average of 2 h and 46 min that the students of the control group spent on the typical platform (Fig. 11.5c). Moreover, the duration that the treatment group interacted with the gamified e-Learning system constantly rose throughout the experiment.

Engagement

Collectively, frequency, recency, and duration had been amalgamated as an engagement score (Zichermann and Cunningham 2011). In order to form this score, relative importance of each of these metrics had been used. Duration, also called time on site, is one way of measuring visit quality. However, time on site can be misleading. Therefore, it was considered appropriate to assign to duration half the proportion assigned to frequency and recency, respectively. Moreover, although ratings is a popular mechanism, it was not integrated to the e-Learning systems presented by this thesis. Therefore, Ratings was a metric excluded from the proportions used to measure engagement. Finally, virality is widely used to describe social distribution, or more commonly, how many additional new users a system will get, given one new user. Therefore, since the number of the enrolled users of our system was predefined, and the system was confined, there was not any point in measuring virality. In summary, we selected the following relative weights for measuring the overall engagement: 40 % recency, 40 % frequency, and 20 % duration. In an attempt to qualitatively depict the difference in the engagement rates between the two groups, the average engagement of the control group was considered, as the overall average engagement rate, for any typical group given. Results suggested higher engagement up to 19.7 % for the treatment group which engaged to the gamified platform, compared to the control group which engaged to the typical one.

Course Participation

Complementary to the data collected, so as to measure the student engagement to each platform, data were collected in order to measure the general course participation, and, therefore, further evaluate the two e-Learning systems. Collectively for all modules integrated to the systems, an average of 92.066 actions per student were performed on the typical platform, while an average of 132.166 actions per student were performed on the gamified one. Therefore, up to 30.3 % more actions per student were performed on all modules cumulatively on the gamified platform (Fig. 11.6a). Actions, as defined in Moodle's report tools, are the number of views plus the number of posts made by the users in the course, over a period of interest.

Activity Completion

Furthermore, an additional way to measure students' accomplishments, and to evaluate how they interacted with both e-Learning systems, is to examine the data collected regarding the activities completed by the students. An average of 16.333

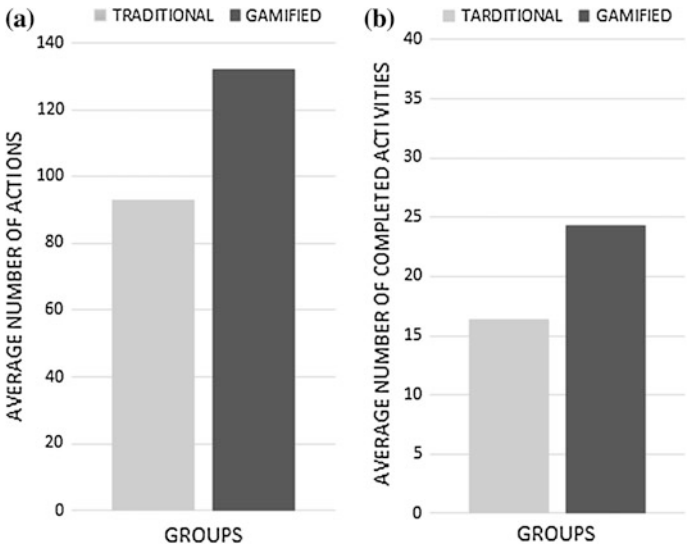

Fig. 11.6 **a** Average actions per group for all modules cumulatively, **b** average completed activities per group throughout the entire experiment

activities per student were completed in the typical platform, while an average of 24.25 activities per student were completed in the gamified one, which results in 32.7 % more activities completed in the gamified e-Learning system (Fig. 11.6b). Out of the 14 types of activities that Moodle offers, for the purposes of the experiment, the activities selected to be implemented to both platforms were assignments, quizzes, and feedback activities.

Conclusions and Future Work

The results of this particular research indicate that gamification had a significant effect on the engagement of the different groups of students, who perceived the learning experience in a different way in general.

Regarding the first research question, a reward system merely based on badges can be engaging when integrated to an e-Learning system. The amalgamated engagement score (Zichermann and Cunningham 2011) that treatment group noted was higher up to 19.7 % compared to the control group. Regarding the individual metrics that were used to form the engagement score, treatment group noted better rates compared to the control group. Students working with the gamified e-Learning system showed higher frequency rates up to 7.2 %, lower recency rates up to 18.2 %, and higher duration rates up to 123.5 %, compared to the students working with the typical e-Learning system. Regarding the second research question, results

suggest that it is possible to combine badges which represent students' progress to badges awarded with seeming randomness in order to further motivate students in completing a course's challenges. Students working with the gamified e-Learning system performed more actions and completed more activities to the modules integrated to the platform, compared to the students working with the typical e-Learning system. Up to 30.3 % more actions per student were performed on all modules cumulatively on the gamified e-Learning system, while 32.7 % more activities were completed in the same system.

This work aims to form the basis for a number of similar experiments which will investigate the use and effect of different gamification elements and gamification mechanisms in learning—this is the main reason behind the selection of Moodle as the underlying platform. In the context of this work, structural gamification was implemented, due to the fact that the course's content and the interface of both systems were chosen to be identical, in order to avoid any criticism on the part of the students. Currently, we are carrying similar experiments with students with learning difficulties, while our future work aims to investigate and compare the effects of different gamification elements for different categories of students with special needs. Moreover, our future work aims to combine structural gamification to content gamification, as game thinking is a more critical gamification factor compared to gamification elements by themselves, and since the two types of gamification together may have a wider impact.

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