Gamification and Learning Analytics to Improve Engagement in University Courses

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Abstract. Gamification is one of the most used techniques to improve active participation and engagement in different kinds of contexts. The use of game techniques is effective in pushing subjects to be involved in an activity. Since the early childhood, indeed, the promises of rewards are useful to affect specific behaviors. On the other hands, the learning analytics have been largely implemented in education in order to improve the assessment and the self-assessment of students, above all in e-learning settings. The research presented in this work aims at combining gamification techniques and learning analytics to improve the engagement in University courses. The paper describes a model of gamification and a learning dashboard defined based on data in Moodle e-learning platform. A pilot test of an app android in which both the solutions have been implemented pointed out promising results.

Keywords: Gamification · Learning analytics · E-learning engagement
Learning dashboard

1 Introduction

Mobile devices (such as smartphones and tablets) allow people to be connected and communicate all over the world. Thanks to the increasing Internet communication speed and the more powerful mobile Central Processing Unit (CPU), mobile devices can be used for a wide variety of tasks. According to the age of the user, the device is prevalently used: to play mobile games, to use email or messaging, to play videos etc. For the university students, the mobile phone is a critical device. As a matter of facts, it is used by boys and girls attending the university, not only to check the exam dates and share notes, but also to message information about lessons.

E-learning is a modern way to allow university students to attend lessons virtually, using the Internet connection. It is common for many universities to offer online courses, the MOOCs (Massive Open Online Courses) phenomenon is a proof of this trend [1, 2]. Many online platforms, such as, Coursera, EdX, Iversity deliver online contents to all students who have either a Personal Computer (PC) or a mobile device. This strategy has been so successful, that the main universities all over the world, both public and private, publish on those platforms their courses.

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The MOOCs have been a big revolution in Education, since the university courses can be attended by all people that need to acquire specific knowledge or competences without to necessary being physical in the site where the lesson is given. This means that even non-university students can access to high education without physical limitations. Moreover, these courses (and universities) release attending certificates, once the course has been completed, and qualification certificates if the student successfully passes the related exam. These certifications can be used to improve the curriculum vitae and then the personal job. Unfortunately, one of the main problems in using MOOCs and all kind of online courses is the engagement and motivation [3]. The flexibility and the freedom to attend the e-learning courses often translate into a high dropout rate [4]. Many problems can distract the student from the aim and, after a failure, the motivation without the teacher support dramatically drops [5]. This students' failure is a problem also for the educational system [6]. In this context, in order to mitigate this problem of online courses and activities, we propose to apply the gamification approach to improve the student's active participation and engagement in online university course. In order to measure the impact of gamification, a mobile application was developed to let the student be more engaged in attending online activities in her/his university course and, in general, in the university life.

This paper is organized as follows: in the following section some related works are reported; Sect. 3 describes the adopted gamification approach for monitoring engagement and Sect. 4 how it is implemented in a mobile application; in Sect. 5 some preliminary results of the user testing is reported, and Sect. 6 concludes the paper.

2 Related Works

E-learning systems are widely used in both the university and the work domain. This form of instruction has grown up during the last twenty years thanks to the greater Internet speed and the powerful devices that can play videos. There are many guidelines on how the e-learning systems should be designed [7]. Those fall into the HCI field, where the users need to be considered during all the stages of the development process. For example, more and more solutions use the same framework to deliver different contents [8]. The study of how people really learn from this new way to teach is constantly monitored by the companies that deliver e-learning contents [9]. The e-learning is thus a recent and evolving topic. More and more techniques are used in order to engage people and let them be more proficient in following courses and learn. One of them is the so called "Gamification".

Gamification is defined as "the use of game design elements in non-game contexts" [10]. The term "gamification" is sometimes controversial, but the definition given above and the survey provided in [10] clarify that "gamified" applications are different from (video) games, serious games or just software applications that provide a playful interaction, like those considered in [11].

Gamification has been proved that improve participation and engagement in e-learning activities [12, 13], in fact, suggests that gamification strategies, aligned with instructional objectives and user context, are effective in improving student participation and encouraging extracurricular learning. Moreover, game elements such as points,

badges, and leaderboards, are useful strategy in Massive Open Online Courses as [14–16]. On the other hands, once that the online environment stimulates student motivation and engagement, it is necessary to measure it. In e-learning settings, characterized by the distance both in terms of time and places, it is necessary to monitor and track the student activities in online environments. The Learning Analytics (LAs), i.e. the measurement, collection, analysis and reporting of data about learners and their contexts [17] are very useful to meet this objective. There are some research works that investigate on the relationships among the LAs and engagement [18, 19]. The main novelty of the proposal described in this paper is to combine the use of game elements in order to foster student engagement in online activities in academic contexts and the LAs in order to measure and visualize the level of engagement for each single student.

3 The Gamification Approach for Monitoring Engagement

In e-learning platforms, keeping track of the user's learning activities is very important to make effective and reliable assessment. To improve the quality of assessment in online courses, even with a large population (as happens in MOOCs), in literature different solutions have been implemented [20–22]. An interesting solution is the use of a Learning Dashboards (LD) in the e-learning environments to visualize student's engagement in e-learning paths. Usually, LDs allow to visualize the Learning Analytics. The LAs can be automatically or manually collected by the system. In this research, LAs and LDs have been used in order to keep high student's engagement and motivation. To address this challenge, VeeU2.0, a learning dashboard for Moodle, has been designed and developed to support assessment by both teachers and learners in e-learning courses [3, 21]. The defined model has been conceived to monitor the engagement in an e-learning course through measures of the student's participation, in terms of user's actions in wikis and social posts. Following the game mechanics, eXperience Points (XP) were defined. In order to classify the kind of activities performed in the e-learning platform, the XP were subdivided in Degree Course XP (DC) and Single Course XP (SC). The student can gain DC performing general activities (Table 1) in the e-learning platform and in all online courses published for her/his degree course. The SC points are gained performing general activities in any specific course that student is attending (Table 1). In other words, if the student accesses (Activity A1) to the e-learning platforms to browse all the online courses of her/his degree course s/he gain 10 DC points. If the student creates a wiki page in the "Programming course" s/he gains 5 SC points.

When the user reaches a certain amount of XP, it gains a new level. Every new level (for a maximum of 100 levels) allow the student to gain a higher reputation in both virtual and real class. In order to make visible this reputation, badges can be collected according to both the points gained and the levels reached. There are three type of badges Gold, Silver and Bronze and they can be achieved both for the degree course or for a specific course. Moreover, the badges can be achieved for each kind of activities performed by the student, thus a student can have a Gold badge for the DC access points (Activity A1) but any badge for SC creating wiki pages (A6) this means

that the student mainly surfs in the e-learning platforms only to download the learning resources or to read news, but s/he is not an active participant to online activities.

Table 1. The XP points gained by the user according to the action performed

Activity type	XP gained
(A1) Access	10
(A2) Read a wiki page	2
(A3) Put a "like" to a post	2
(A4) Publish a post on the dashboard	2
(A5) Comment a post on the dashboard	3
(A6) Create a wiki page	5
(A7) Edit a wiki page	5

4 A Mobile App for VeeU2.0

VeeU2.0 is a learning dashboard developed as plugin for Moodle, the e-learning platform in use in our University. The main goal of VeeU2.0 is to make students and teachers aware of their engagement in e-learning environment. As a matter of fact, teachers and students need to be aware of what kinds of interactions are occurring in the virtual space and how the building up knowledge process happens. The dashboard offers two points of views, one addressed to the teacher, who can visualise the trend of the entire class or of a specific student, and one addressed to the student, who can visualise her/his rate of participation in each activity and can compare her/his data with those of the other students. From the teachers' points of view, the information visualised are useful in order to monitor the level of students' participation and interest in the subject. This information can lead the teacher to change the teaching strategies in order to improve the teaching effectiveness. From the student point of view, the visualised data can help the student's self-assessment that could be pushed to improve her/his efforts in the learning process.

In order to improve the efficacy of VeeU2.0, a mobile app has been developed and the gamification model was applied. The mobile version (the language is Italian) reported here, as well as the web app, offers two points of view. One addressed to the teacher, who can view how many accesses students have done for each course (Fig. 1a), which resources have been downloaded, how many quizzes have been completed and so on. Moreover, the teacher could visualize information about each single student in order to verify how her/his learning process is going on. For each course, the number of access of the student is represented using a histogram together with a line indicating the mean of accesses of the class in the same period (see Fig. 1b).

Gamification techniques has been implemented in the app for the student point of view (Fig. 2). Once the user has selected the degree course, the app shows his/her progress (Fig. 2a): on the top of the screen the course name is shown and below the level reached and the overall XP gained are given ("Livello 3" and "99/600" respectively in the figure). For each course the student can visualise the list of the resources

(a) (b)

Fig. 1. The mobile app from the teacher's point of view showing students' accesses (a) for all courses and (b) for a specific course

(a) (b) (c) (d)

Fig. 2. The mobile app from the students' point of view showing (a) progresses, (b) available resources, (c) badges achieved and (d) the leader board

available in the course and the mean of the students that have visualised each resource (Fig. 2b). The green colour is used for the visualised resources, the red for non-visualised ones.

In the badge section, the user can see how many (and which type) of badges s/he has achieved (Fig. 2c). Every time a new badge has reached, a popup message is shown with details of the badge and how it is possible to increase the number (the value can be shown by clicking on it). Finally, the leader board of the users shows all the users, for the selected university course, with the relative amount of XP gained and the level (Fig. 2d).

5 User Testing

In order to evaluate the usability of the application, we performed a user testing with real end users. The user testing aims at analysing the user behaviour during the interaction with the system. To this aim, we defined a list of 9 tasks that users have had to accomplish. The "Thinking aloud" technique was used in order to better understand the interaction problems. For lack of space, we cannot report further details on the user test performed. The sample was composed of 15 students attending one of the Computer Science degree courses at the University of Bari. All students use regularly the LMS to access the content of the different courses.

Each student used the system alone. A facilitator gave the instructions to the student and an observer annotated all the significant information about student's behavior. During the test the success rate was used as objective measure. The success rate has been calculated as follows: *Success rate = (S + (P * 0,5))/N*. Where: *S* is the number of tasks successfully completed; *P* is the number of tasks partially completed; *N* is the sum of all tasks. The results of the test are shown in Table 2.

Table 2. Results from the user tests with 15 users and 9 tasks (S: success, P: partial, F: failure)

	Task1	Task2	Task3	Task4	Task5	Task6	Task7	Task8	Task9
S1	S	S	S	S	S	S	S	S	S
S2	S	P	S	S	S	S	S	P	S
S3	S	S	S	S	S	S	S	S	S
S4	S	S	S	P	F	S	S	S	S
S5	S	S	S	S	S	S	S	S	S
S6	S	S	S	S	S	S	S	P	S
S7	S	P	S	S	S	S	S	S	S
S8	S	S	S	S	S	S	S	S	S
S9	S	S	S	S	S	S	S	S	S
S10	S	S	S	S	P	S	S	S	S
S11	S	S	S	S	S	S	S	S	S
S12	S	S	S	S	S	S	S	S	S
S13	S	S	S	S	S	S	S	S	S
S14	S	S	S	S	P	S	S	S	S
S15	S	P	S	S	S	S	S	P	S

The success rate of 95% could be considered a positive indication about the usability of the system. Moreover, in order to have a qualitative evaluation of the system, the students were asked to answer to a 5-Likert scale questionnaire about the perceived usefulness of the app during the learning process.

Analysing the results, the system has reached a good level of acceptance. The 85% of the students have appreciated the use of the system and hope that it would be used in the future. Moreover, the student's appreciation is visible also in the Fig. 3.

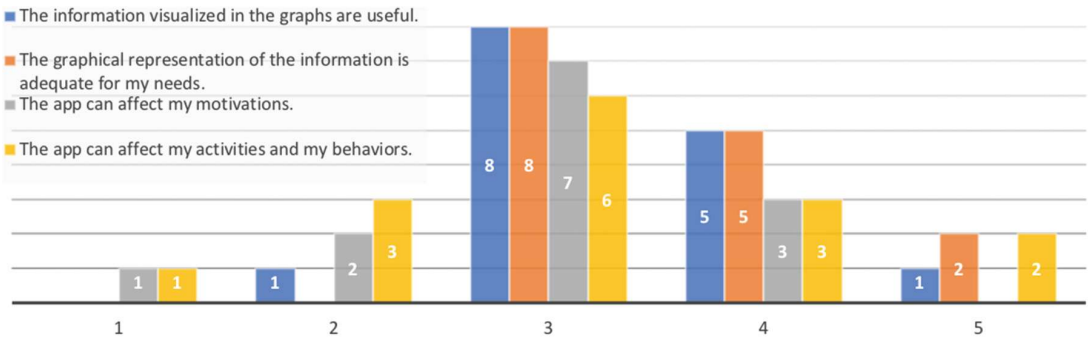

Fig. 3. Results of the students'appreciation: from 5-Likert scale questionnaires administered to the 15 participants of the user test, where "1" means "not at all" and 5 is "definitely"

In particular, to the questions about motivation 10 students out 15 give an evaluation between 3 and 4. For what concerning the engagement in e-learning activities, 5 students out 15 give an evaluation higher than 3 (neutral value). The user testing has revealed also a number of weakness that should be addressed in the next future, but the results are promising, and this can lead the research to further developments.

6 Conclusions

In this paper we have proposed a mobile application, based on the VeeU2.0 Learning Dashboard, that allow university student and teachers to be aware about their engagement, using the gamification technique. The students, using the app and interacting with the system, gain XP points that are used to rise their own level. The application presents for each DC and SC, a leader board about the most proactive students. The teacher can evaluate the ongoing student's engagement through a specific view.

We performed a preliminary evaluation test with 15 users to perform some tasks and then a 5-Likert questionnaire has been administered. The preliminary results show that the proposed app is promising with a good usability and acceptance rate.

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