An Approach to Gamify an Adaptive Questionnaire Environment

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***Abstract*— Studies in gamified e-learning tools lack on clarifying whether Gamification improves the user engagement and therefore the learning experience, or if the success depends on the system itself, independently of the Gamification process. As an attempt to start answering these questions, we present an existing adaptive self-evaluation tool where we have observed low engagement issues by analysing students' behaviour when using it during our previous experiences. Gamification can face those issues while maintain the system essence on dynamic adaptability. With the inclusion of Gamification mechanics in our existing environment, we will be able to measure if Gamification works, or if the system performance keeps as in the not-gamified version.**

Keywords*— *Gamification; adaptive software; e-learning; computerized adaptive tests

I. INTRODUCTION

The term Gamification has become quite popular in multiple fields and can be defined as the use of game elements and mechanics in non-game contexts [1] with the goal of engaging users. It has been used in fields like computer science and engineering [2], business, information studies, human–computer interaction and health [1], and good habit acquisition [3]. Of course, education has not been an exception [4] [5] [6], so that the use of elements such as leader boards, badges, levels, experience points or a narrative story has become a new trend.

Although there is a pretty well established consensus around the positive effects of Gamification in educational environments, the possible negative ones must be also taken into account. Some previous works concluded that Gamification is a trendy phenomenon that, even with careful implementations, probably never will attract all [7]. It has been also established that the addition of the most common Gamification elements (e.g., points, levels, badges) may help in some learning contexts, but harm in others [8]. Comparing empirical studies, Hamari [9] also found that they yielded both positive and negative results in a wide variety of contexts and using multiple design elements.

The question that arises here is how to introduce Gamification in learning activities keeping the positive outcomes and, at the same time, reducing the negative ones? Landers and Landers [10] defend that a key problem is a poor design phase, which is the consequence of not having a good theoretical model to understand how Gamification works on individuals. It has been also suggested that such a model should focus on students' profiles in learning and playing activities in order to analyse which ones will take advantage from the gamified learning activities [11].

Under that perspective, when gamifying an existing environment, does Gamification always improve the user engagement and so the learning experience, or does the success depend on the system? As an attempt to start answering these questions, in this paper we present an existing Adaptive System and how some specific issues we have observed during our previous experiences can be faced with Gamification while maintaining the system essence on dynamic adaptability, i.e. we will present our Adaptive System in which we will try to increase its effectiveness taking advantages from Gamification.

Thus, the rest of the contribution is structured as follows: in section 2, we present a brief introduction to the system as it is implemented at present and show the specific issues we plan to face; in section 3, we introduce a theoretical framework about gamer types and the corresponding Gamification techniques and elements; in section 4 we present how Gamification can be implemented in our Adaptive System and how we expect it to improve users' engagement; and finally, in the last section we will present some conclusions and future work.

II. E-VALUAM AND STUDENTS' ENGAGEMENT

The adaptive system that has been used as starting point for this work is e-valUAM [12]. Since this system has been presented in previous works, only a brief description is given here. e-valUAM performs an assessment process where students are evaluated under certain conditions, being some subjects more important or relevant than others. The numerical model included in the application calculates the different paths that a student can follow depending on the student's answers [13].

In a previous experience, we used e-valUAM with a set of 47 students from the fourth course of the Degree in Early Childhood Education at the Autonomous University of Madrid (UAM). The test was divided into four levels with 10 questions per level (i.e. students had to answer 40 questions). Questions shown to the students were randomly selected from a general repository. The self-evaluation tool was available and accessible to the students since 33 days before the final exam up to one day after it. The number of attempts for all the students and the day they accessed is shown in figure 1. As we

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can see, there are a high number of students that used the application only when the final exam was imminent. Specifically, 15 students used the application only 5 days before the final exam. If we want to improve the engagement of the application, we need to increase the time window of those students.

It is more interesting to analyse the students that used the application from the beginning but did not use it continuously. Those students employed the application but were not engaged, failing continuously. In figure 1 we have marked the relevant gaps. As we can see, most of these students only have few accesses to the application at the beginning and do not use it again until the final exam is approaching.

In figure 2 we show the percentage for the students that use the application continuously, the students that only used it the last 5 days before the final exam, and the students that used the application from the beginning but having relevant gaps in the process. For clarity, we have grouped students into categories depending on the amount of times that they used the application: 10 (21%) students used the application 0-9 times; 21 (45%) students used it 10-19 times; 9 (19%) students used it 20-29 times; 5 (11%) used it 30-39 times, and 2 (4%) used it more than 40 times. We found out that 12 (26%) students showed gap periods in their use of the application. As we can see, those students appear in all the groups but in the last one. This last group only includes 2 students. One of them used the application continuously and the other one only used it along the last 5 days.

Those results imply that the engagement problem is something that is present in many different students that use many different learning strategies. Students that use the application only a few times can be a group that used alternative learning strategies or simply did not study the subject enough. On the other hand, students that used the application many times probably are a group of students that believe that the application is a good tool for studying. The presence of gap regions in all these groups suggests that improving e-valUAM engagement with Gamification or any other strategy will be fruitful. That idea is supported by the

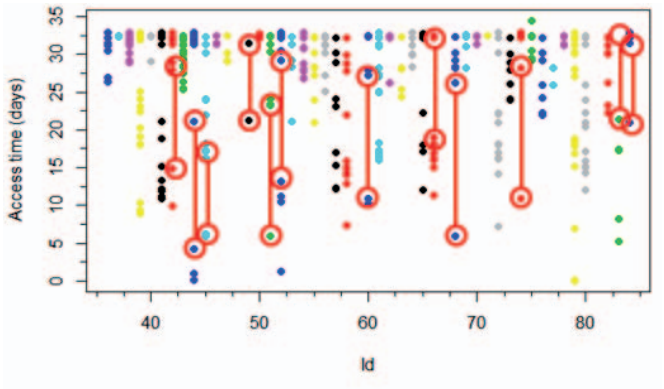

Fig. 2. Access time in days for all the students under study in the experiment. Students are identified by an anonymous identification number (id) in *x*-axis. Students that present significant gaps in the use of the application are marked with red lines, which are presented following the most important gap of every student that shows this characteristic.

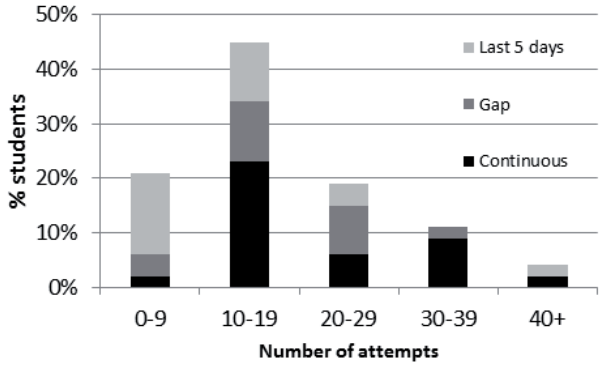

Fig. 1. Percentage of students that used the application a certain number of times. Different grey colors represent students that only used the application along the last five days and students that used it from the beginning but having relevant gaps without any activity.

variety of profiles that are represented by the different groups in figure 2. Even if some of the students' main gamer profiles are not compatible with the Gamification techniques suggested in the following sections, presumably some of them will be receptive and so their engagement will be improved.

III. Gamification and Player Profiles

In order to identify player's profiles, one of the most extended models is the proposed by R. Bartle [14]. Bartle suggested his model after analysing the data obtained from the most experienced players of an online Multi-User Dungeon (MUD). Thus, he identified four main motivations [14]:

1. **Achievement within the game context**, so that players are focused on game-related goals and are motivated to get them.
2. **Exploration of the game**, for those players who enjoy discovery features, knowledge and elements of the virtual world.
3. **Socializing with others**, when the main incentive is to interact with others players.
4. **Imposition upon others**, for those players that use the game to obstruct other players.

According to those motivations, Bartle identified four groups of players, namely: *achievers*, *explorers*, *socializers* and *killers*. Also, Bartle classified those player's profiles according to two dimensions. The first dimension attends to the kind of interaction the player performs within the game, particularly whether the player prefers acting or interacting. The second dimension refers to the player's preferred object of interaction, particularly other players or the world, indicating whether the player interest is focused on the other users or on the environment.

Thus, the four different types of players can be characterized according to the former dimensions: *achievers* are interested in having an influence in the game (acting on the world), *explorers* want to discover all the secrets of the game (interacting with the world), *socializers* look forward to talk or meet new people (interacting with other players) and, finally,

killers are directly interested in influencing or acting on other players.

More recently, Marczewski proposed a new taxonomy, based on Bartle's model, which extends it by including two new profiles: *philanthropists* and *players* [15]. *Philanthropists* are related to Bartle's *socializers*, but differ from them in the fact that *philanthropists* interact with other players aiming to enrich their lives with no expectation of reward. For its part, Marczewski's *players* are related to Bartle's *achievers*, differing from them in the fact that mastering and learning are not goals for *players*. The remaining four Marczewski's profiles are homonymous or more or less equivalent to Bartle's ones: *socializers*, *free spirits* (similar to *explorers*), *achievers* and *disruptors* (similar to *killers*).

Apart from a new taxonomy, Marczewski also proposes some elements, techniques and ideas aimed at increasing gamers' motivation [16], which have also been validated in other works [17]. Some of those motivation techniques are directly associated to gamers' profiles, while others are supposed to be useful for any kind of gamer.

IV. GAMIFYING E-VALUAM

As previously analysed in section 2, the introduction of Gamification techniques in e-valUAM tries to improve students' engagement. For that purpose, our starting point is the Marczewski's taxonomy and the Gamification mechanisms he proposes. Figure 3 depicts the seven sets of Marczewski's proposed Gamification mechanisms[1], as well as its proposed implementation in e-valUAM: the darkest colour, the most feasible implementation in the system environment.

It is worth noting that some e-valUAM features will heavily condition the way we introduce Gamification. For example, e-valUAM is individually oriented and does not offer any communication tool or collaborative service between students. This fact mainly penalizes socializers' mechanisms. However, the system currently gathers all the information about how students interact (from a temporal point of view) with the system, facilitating the introduction of many of the Gamification mechanisms. Thus, the system also needs to be changed in some indirect ways by the introduction of Gamification.

In both former models, Bartle's and Marczewski's, real gamers rarely possess "pure" profiles but a certain percentage of some of them. For example, even the purest players will probably present traits of other behaviours in a certain degree. Therefore, we plan to test students to determine their gamer profile.

Finally, it is worth noting that we are planning those changes with the idea of making the system become part of a blended learning environment or of a complete e-learning experience as long as e-valUAM is complemented with additional tools as a Learning/Content Management System. In the next subsections we will detail the implementation of specific Gamification mechanisms.

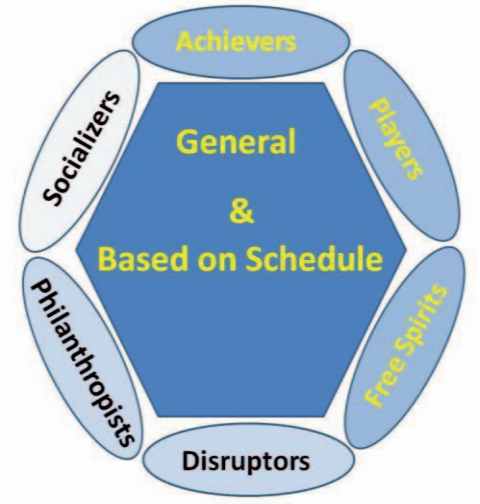

Fig. 3. Gamification mechanisms sets in Marczewski's taxonomy. In yellow, those sets of mechanisms that can be directly introduced in e-valUAM. In black, those that implies deeper changes in the design of our tool.

A. "General & Based on Schedule" proposals

The mechanisms for the "General and Based on Schedule" category are the most feasible to implement in e-valUAM, given that we can tackle the implementation of 5 out of the 11 Gamification mechanisms proposed by Marczewski, namely: *loss aversion*, *progress/feedback*, *time pressure*, *fixed reward schedule* and *time dependent rewards*. The implementation of those mechanisms directly addresses the lack of students' engagement explained in section 2, regardless their gamer profile.

In that sense, we plan to add a *fixed reward schedule* based on gratifications (in the form of collectable badges) for students accomplishing some academic milestones as answering a fixed number of questions across all the tests, completing a number of tests or achieving high scores significantly. A progression timeline can be shown before every test to give *feedback* to the students. In the timeline they should be able to see their past performance, giving them a sense of *progression* and information about how much is still ahead. Also, we can provide *time dependent rewards* with *time pressure* based on the number and time of accesses. Thus, we can present challenges to the students by asking them to access the system at least a number of days per week or to accessing tests before a certain date. These challenges will be translated in showing a badge once it is completed and in the absent of that badge when it is not, to motivate the students to take the challenges using *loss aversion*.

In this category, the Gamification mechanisms we will not tackle by now are: *on-boarding/tutorials*, *signposting*, *theme*, *narrative/story*, *curiosity/mystery box* and *random rewards*.

[1] In Marczewski's proposal, "General" and "Based on Schedule" correspond to two different categories. We treat them together given their transversal mechanism features, which are common to every kind of gamer.

B. Proposals for "Achievers", "Players" and "Free Spirits"

After the common set of Gamification mechanisms that are useful for all kind of gamers' profiles, specific Gamification initiatives for *achievers*, *players* and *free spirits* seem to be the most feasible ones.

For "*achievers*", *challenges* and a sense of *progression through levels* are planned. The *challenges* have been already presented as we plan to use them as the presentation tool for the time dependent rewards. *Progression through levels* can be addressed by adding level marks to the progression timeline already presented, associating each level with collecting a percentage of badges. Some of the other Gamification techniques proposed by Marczewski are natural to the learning process like *learning/new skills* or *boss battles*, usually referred as mid-term and final exams.

There are also interesting Gamification mechanisms we can introduce not to face additional issues, but to test the adaption process itself. In particular, we can check how the adaption procedure proposed by the system differs from the preferred by the students. Some Gamification mechanisms associated to "*free spirit"* users could allow us to test that. Thus, *branching choices* could be introduced in order to benefit "*free spirits*", who will see multiple questions at a time, answering them at their choice. Registering their order of choice, we can compare with the order usually proposed by the system and improve it. The rest of Gamification mechanisms proposed by Marczewski for "*free spirits*" are: *exploration*, *unlockable/rare content*, *creativity tools*, *customization* and *Easter eggs*. *Exploration* is an important part of every learning process, and as such is already present. The rest are not considered in our proposal.

Finally in this group, we can find "*players*", for which we have already discussed the use of *badges* (*achievements)* that we hope will motivate them. Obtaining *physical rewards/prizes* is also a natural part of a learning environment, as the acquired knowledge (or at least the grade) is a tangible reward for students. The rest of the Gamification techniques proposed are, at present, out of the learning scenario we analyse (*experience points*, *leaderboards/ladders*, *virtual economy* and *lottery/game of chance*).

C. Interactive players: "Socializers", "Philanthropists" and "Disruptors"

For different reasons, those three gamer's profiles are the most difficult to gamify within e-valUAM.

Firstly, e-valUAM is individual oriented and does not include collaborative features. Therefore, it presents no possibility of communication among users. So, "socializers" oriented Gamification techniques are out of our scope (*guilds/teams*, *social networks*, *social status*, *social discovery*, *social pressure* and *competition*).

On its part, "*philanthropism"* is against e-valUAM goals: test answers should not be shared. *Sharing knowledge* can be easily addressed outside the system, with the teacher creating groups of study or a way of answering questions performed by other students, but it is not part of the current system. Again, the rest of proposed Gamification techniques proposed for this player type are out of our scope (*meaning/purpose*, *care-taking*, *access to more features*, *collect and trade* and *gifting/sharing*).

Finally, with "*disruptors*" we face a problem similar to the one we find out about "*philanthropists*", because we cannot allow them to go outside the boundaries of the system or provoke not approved changes. But again, *voting/voice* can be part of the experience that teachers create outside the system for them. *Innovation platform*, *development tools*, *anonymity*, *light touch* and *anarchy*, as Gamification techniques, are out of our learning scenario.

Independently, the introduction of these three kinds of gamers' profiles and their corresponding game mechanisms implies that collaborative protocols must be defined and validated previously to the implementation of them within the e-learning environment.

V. Concluding Remarks

Studies in gamified e-learning environments usually show results where it is not clear if gamification better performs the learning experience due to the introduction of game-based mechanisms, or if it depends on the system itself. Under this perspective, we want to build an environment where to perform studies on clarifying whether Gamification improves users' engagement, or if the success depends on the system itself, independently the Gamification process.

Thus, we have presented e-valUAM, an existing adaptive self-evaluation tool where we have observed and analysed low engagement issues. For that purpose, we have shown a study developed with 47 students. That study demonstrated that more than one over four students used the application very intermittently, what implies a low engagement.

Gamification can face these issues while maintain the system essence and so, we will be able to measure if it really works, or if the system performance keeps as in the not-gamified version. Thus, we have analysed in detail each of the specific game mechanisms we can directly or indirectly implement in e-valUAM according to specific gamer's profile.

With all those mechanisms we will get a gamified environment aimed at testing if Gamification really improves users' engagement, and so their learning experience, or if users' achievements can eventually depend on other factors.

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