Gamification in Location-based M-Learning: Students' Perceptions of Game Elements

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1 INTRODUCTION

Games are widely popular nowadays. Given their dissemination and capacity of attracting different audiences, researchers investigate how to apply games elements in different domains, not solely for entertainment. Thus, the phenomenon known as "gamification" arises. It consists of the inclusion of game elements in other software application for non-gaming purposes (Deterding et al., 2011). Gamification is being utilized in a multiplicity of activities and areas, including education (Swacha and Baszuro, 2013; Perry, 2015).

The education process, however, is not exclusive to the school environment. The widespread use of mobile devices, such as smartphones and tablets, provides new opportunities to stimulate learning outside the traditional teaching space, offering the capability for learning in real-life other spaces (Huizenga et al., 2009). That is, through mobile devices in conjunction with GPS (Global Positioning System), it is possible to implement pedagogic characteristics in urban and other scenarios. Associated with gamification, these characteristics may positively impact motivation and engagement in the learning process.

Nevertheless, gamification does not simply entail insertion of game elements from existing systems (games) into an application. It is necessary to follow an adequate process to obtain real benefits (Cheong et al., 2014). The development processes of gamified applications have common steps, such as understanding the target audience and context to insert the game elements accordingly (Aparicio et al., 2012) (Huang and Soman, 2013) (Cheong et al., 2014). In the learning context, comprehending students' perspective about game elements beforehand might improve the motivation and the engagement of participants.

Previous works evaluated gamification in location-based mobile applications (and its variations) and showed positive results about their adoption (for example, see Hutzler et al., 2017 and (Barros et al., 2017)). However, much of the evaluations of previous works focused almost exclusively on objective metrics (such as learning performance (Su and Cheng, 2013) and not on the (potential) player's perspective. Other studies, such

Honório, J., B. Moura, J., Brito, P., Menezes, T. and Barros, M.
Gamification in Location-based M-Learning: Students' Perceptions of Game Elements.
DOI: 10.5220/0006716404890496
In *Proceedings of the 10th International Conference on Computer Supported Education (CSEDU 2018)*, pages 489-496
ISBN: 978-989-758-291-2

as the one made by Cheong et al. (2014), evaluated the user's perspective about game elements for gamification of applications. However, the literature on academic evaluation studies of game elements of location-based applications in the field of education is still scanty. This paper adds to this specialized literature.

To better understand users' perspective of educational, location-based, mobile applications (m-Learning), an investigation into students' perceptions of which game elements might bring an overall improvement in their engagement and learning is being carried out at the Federal University of Campina Grande (UFCG), Brazil.

So far, the investigation considered students from public middle (junior high) schools in two states in Northeastern Brazil. Preliminary results offer indication as to the perception of the effectiveness of game elements for educational purposes. As such, they might lead to a better understanding of the use of gamification in educational location-based applications.

The remainder of this paper is structured as follows: section 2 highlights basic concepts for the discussion and it reviews related work. Section 3 discusses the methodology and models used in the investigation and describes the design of associated experiment. Section 4 brings results and analyses and explores them for possible cause-effect relations. Finally, section 5 presents conclusions and discusses future work.

2 BACKGROUND AND RELATED WORK

This section describes: (1) the use of gamification in the learning process; (2) game elements and their definitions; and, (3) location-based learning.

2.1 Gamification in Education

In education, gamification has the potential to engage people, motivate actions, promote learning, and help in problem-solving (Kapp, 2012). Implementation of gamification, however, is a complex process. To be effective, it requires a careful application of the elements of games (Kapp, 2012).

Several works sought to understand the perspectives of users regarding the elements of games used in learning environments. One of them is Cheong et al. (2014) that evaluated the perception of undergraduate IT students about six game elements that could make the teaching process more engaging.

Another study, carried out by Peixoto and Silva (2017), carried out a systematic mapping to obtain an overview of the elements of gamification in education and evaluating them according to their priorities. In addition, the study sought to evaluate the elements found according to the types of the users. Their assessment has been made by specialized participants such as researchers and members of companies, leaving out (the perspective of) non-specialist members such as children - who, by the way, are an important and large target audience for educational and gambling applications.

Other works, such as the one by Monterrat, Lavoué and George (2014), have studied adaptive gamification to create personalized experiences for each user type in game-based learning systems.

Although gamers' expectations do not seem to directly enhance the effectiveness of the gamified protocol, the study of expectation elements may be useful in guiding new studies and developers during the gamification-implementation process. This work, besides dealing with different audiences and different contexts of the cited works, aims to evaluate the expectations related to twelve of the most important elements identified by Werbach and Hunter (2012). This document can thus be seen as complementing and broadening the works briefly reviewed above.

2.2 Game Elements

Game elements are characteristics pertaining to games that might be implemented during or for gamification (Werbach and Hunter, 2012). These elements present some level of abstraction, which might be complex because they are not necessarily concrete aspects as found normally in games - e.g., emblems, points, ranking systems, etc (Cheong et al., 2014).

Werbach and Hunter (2012) identified three game elements hierarchical categories that might be applied during gamification: dynamics (top level in the hierarchy), mechanics (middle level) and components (bottom). These categories are described and organized according to their level of abstraction. Each mechanics might have a link with one or more dynamics; and, each component be linked with one or more mechanics - that is, each element has a link to their superior levels, except for the dynamic, which represents the highest level (Werbach and Hunter, 2012).

The dynamics are aspects in which a gamified

system evolves and is represented at the highest level of abstraction for the game elements. Dynamics are not inserted directly into a gamified piece of software, but must be managed (Werbach and Hunter, 2012). According to these authors, there are different types of dynamics, of which the most important ones are: restrictions (e.g., limitations), emotions (e.g., curiosity, competitivity), narrative (e.g., storyline), progressions (e.g., growth within the game) and relationships (e.g., social interactions with other players, cooperation).

The mechanics are the next level down of abstraction, being responsible for the basic process of involving the user in the essential processes and is utilized to achieve one or more dynamics (Werbach and Hunter, 2012). In other words, the mechanics provide the specific means to designate how the dynamics will really be performed (Teh et al., 2013). Among the ten most important levels of mechanics identified by Werbach and Hunter (2012), there are: cooperation (e.g., teamwork), rewards (e.g., gratification for certain actions), competition (e.g., friendly competitions between users), acquisition of resources (e.g., collectibles items).

In the most concrete level for game elements, one finds the components. Components are practical game elements that might be visualized directly in the application (Werbach and Hunter, 2012). Despite that direct visualization, the player's experience might be affected by some previously presented aspects.

In trying to offer a good experience with a gamified m-Learning app, this paper aims to elicit the app users' (i.e., its potential or actual players') perceptions on the importance of the following components identified by Werbach and Hunter (2012):

Virtual Goods: acquisitions that the players can make and utilize within the game itself. These acquisitions are commonly done with the use of virtual currency acquired by successfully realizing activities within the game;

Quests or missions: proposed activities that guide the user in what should be done. In an educational context, missions can be utilized to teach a specific topic to the player, and then guide her or him into putting the newly acquired knowledge into practice. Missions, upon their successful conclusions, will reward the users with, for example, scores or points. This component is linked to the challenge and emotion mechanics;

Teams: the teams are made up by groups carrying out the same activity, which can be executed by students from the same school, people from the same neighborhood, etc.;

Leader boards: a list that ranks players according to criteria such as their scores or collections;

Collections: collectible rewards commonly in the form of medals or emblems that a player usually wins when s/he concludes certain activities;

Points: usually related to levels and are basically, rewards that are given to users when they realize certain actions. In addition, points can be used as feedback about the game itself, informing whether an action was carried out adequately;

Boss Fights: challenges with progressive difficulty faced at the end of a level, stage, etc.;

Levels: represent the player's evolution in the application. New levels are usually unlocked by acquired points after the success of some game activity;

Social Graphs: ability to interact with players within the game;

Combat: a dispute between two or more players in search of rewards;

Avatar: virtual representation of a user (player) within the context of the game (e.g., a character);

Content Unlocking: resources made available to the player when s/he meets certain criteria such as attaining certain levels, points, medals, etc.

It is worth mentioning that Werbach and Hunter (2012) describe 15 game elements; 3 of them, are not considered here because apprehending abstractions (achievements), are either included in other elements (badges) or were not properly grasped by the participants of the study (for instance, gifting).

2.3 Location-based Learning

With each passing day, students tend to use more smartphones, tablets and other mobile devices. In this scenario, it is possible to combine training and connectivity to create new opportunities in the learning process. The dissemination of mobile devices, in conjunction with the use of GPS (Global Positioning System) and game-based strategies, can provide a way to motivate and involve students in the learning process in new environments. For example, a student can learn about a historical monument through school material, or be in the monument's location to see it, learn directly about its characteristics and the history behind it. In this way, location-based applications can allow new experiences, extending the acquisition of knowledge to the physical and virtual worlds.

Some works incorporate gamification into the learning process in location-based applications. Hutzler et al. (2017) designed, evaluated and identified risks qualitatively in an application used for

sharing and learning of historical information about specific places, e.g., historical sites.

Another gamified application that utilizes the user's location is AquaGuardians (Barros et al., 2017). This application promotes awareness about water usage through missions, many of which take place in real locations, provided by the local water management agency and by (mini-)games embedded in the application. Moreover, it involves events related to information about the economy and water recycling, making use of the human vision as a sensor for a system of collection of data regarding water leakage and contamination.

By mapping which game elements users perceive as causes for a better experience, this paper contributes to the support of decisions on requirements of these and other m-Learning apps which are to be implement for their creation or evolution.

3 METHODOLOGY

Gathering information on users' perceptions of game-elements in m-Learning applications was made here through questionnaires. Questionnaire development followed a methodology based on the proposal by Shaughnessy and Zechmeister (2011).

The methodology has six stages. In the first stage, the data that were to be collected were defined together with how and when the questionnaire would be applied. After that, a questionnaire sketch was developed, and it was further revised by other researchers. A preliminary test of the questionnaire was executed with 3 subjects who were not part of the intended sample, but with similar characteristics (11 to 18 years-old students from the middle school system in North-eastern Brazil). The last stage defines the procedures that were to be followed when applying the questionnaire.

The final questionnaire was divided into three sections. In the first section, the questions focused on demographic characteristics, like educational level, age and gender. The second section elicited information on the participant's familiarity with mobile devices, gamified applications and location-based systems. In the third and last section, the interviewee was asked to evaluate the gamification components identified by Werbach and Hunter (2012), giving him questions with the Likert scale for answers, each with 7 levels ranging from 1 (I strongly disagree) to 7 (I fully agree). The questions served as a basis for assessing participants' perceptions of their existing experiences of using game components to make the learning process and learning assessment activities more appealing. Note that because of such subjectivity and the small number of participants (53), results should be taken as preliminary.

Before receiving the questionnaire, the participants were given a presentation and explanations on the addressed issue. And to facilitate their understanding of the issue and objective of the questionnaire, formal language and jargons regarding gamification were avoided in the making of the questions that better represented the game elements at hand.

4 RESULTS AND DISCUSSION

This section presents results on (potential) users' expectations about gamification of location-based, educational applications for mobile devices (m-Learning) and their perception of which game elements might make these applications more appealing.

Sixty-two participants answered the questionnaire initially. Of these, 9 were excluded from statistical analysis due to incomplete data or unintelligible answers. Thus, the complete data set consists of 53 responses, resulting in 85.48% of usable data for the research. The 53 responding students came from the public network of schools of the city of Campina Grande – Paraíba state, Brazil (10 males and 14 females of average age = 13.83 and standard deviation = 1.80, with a minimum of 11 years-old and a maximum of 17) and Santa Cruz do Capibaribe – Pernambuco state (14 males and 15 females with average age = 14.10, SD = 1.11, Min.=12, Max.=18). Students were from the 6th to the 9th grade of the middle school system. All actual respondents were selected at random and had their participation made willingly.

4.1 Experience and Expectation with Gamified M-Learning Applications

The initial interest here is on gathering information on experiences and expectations of middle level students with gamified applications in general, not necessarily gamified educational apps, for mobile devices. For that, the frequency in which they use mobile devices for gaming was first established.

It was observed that 31 (58.49%) of the participants, consisting of 17 male and 14 female students, made daily use of mobile phones or tablets for playing games. Only 3 male and 3 female students, for a total of 6 participants (11.32%), made

weekly use of these devices for gaming. 10 females and 4 males, tor a total of 14 (26.42%) participants, said that they rarely played on these devices. Finally, only 1 (1.8%) participant said that he never used a mobile device to play. The above information can be visualized in Figure 1.

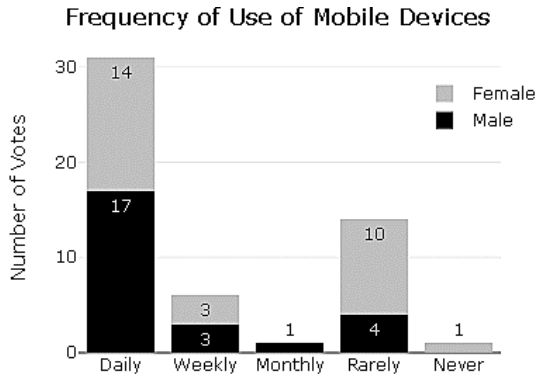

Figure 1: Frequency of use of mobile devices for games.

The questions regarding the experience with location-based applications, as well as gamified applications, highlighted that 41 participants (77.3%) reacted positively to the adoption of gamified applications. In regard to the use of location-based applications, 31 (45.28%) of the participants said that they had already used applications with similar characteristics.

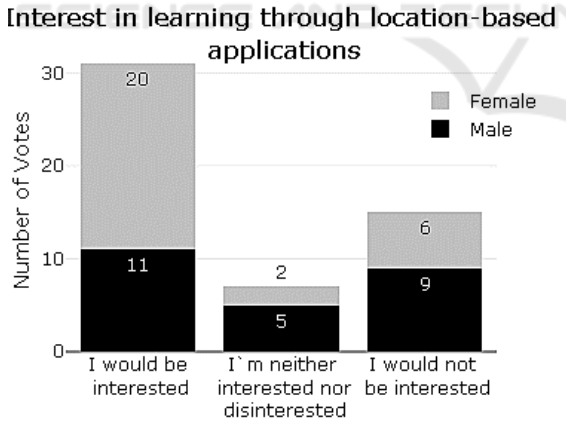

Figure 2: Interest in learning through location-based applications.

As to their interests and expectations regarding location-based educational applications, Figure 2 shows that 31 (58.49%) of the interviewees, 20 females, and 11 males, favour the utilization of location-based applications in the learning process. Only 5 males and 2 females, for a total of 7 people (13.21%), are indifferent and 15 (28.30%), 9 males and 6 females, are not interested in learning through this approach. When it comes to the expectations of the participants, 36 people, comprising 22 females and 12 males, informed that they had interest in learning and putting into practice their acquired knowledge outside of the classroom. 22 participants (10 males and 12 females) expect to socialize with other students. Lastly, 10 participants (5 males and 5 females) hope to see and understand the subject in their current location, and only 10 (6 males and 4 female) do not have interest or show any other expectation.

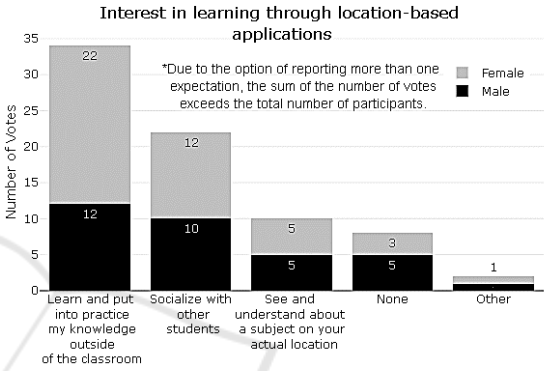

Figure 3: Expectations for using location-based applications for learning.

The results found in this subsection refer to the users' behaviour towards the usage of mobile devices, interest in and expectations with the gamification and usage of location-based applications in education. Overall, most of the students already had contact with gamified apps, games in particular, and a significant part of them had some notion or already utilized location-based applications. The students also showed interest in participating in educational approaches based on location - the female respondents being the most interested in this approach. Ultimately, the participants showed more interest in learning outside of the classroom and socializing with other students through mobile apps.

4.2 Perception of Game Elements

The game components used here are part of the main components proposed by Werbach and Hunter (2012): virtual goods, quests, teams, leaderboards, points, boss fights, levels, social graphs, combat, avatar, collections and content unlocking. The questionnaire had questions for all these 12 elements. Associated answers offered options covering seven levels of agreement with the presence of each element

in a gamified m-Learning app. The respondent could choose from: 1 (I strongly disagree) to 7 (I strongly agree). Each respondent was requested to indicate his/her perception concerning the components in the questionnaire. Components were described without presenting specific examples of them in any game or app; this way, respondents were more likely to evaluate the items according to their experiences with less bias that could be caused by examples.

The analyses of results are done here in three distinct parts. The first presents overall results for the average scores of the components. Next, results are sorted out according to participant's gender. And lastly, the results are examined according to the respondents' gaming regularity using mobile devices.

The overall results show that the majority of the students evaluate a significant portion of the components in a positive way as actual promoter of engagement in the learning process (as shown in Figure 4). The leaderboard component appears as a possible exception. In fact, it is the only component to have a median below 5 (as shown in Table 1).

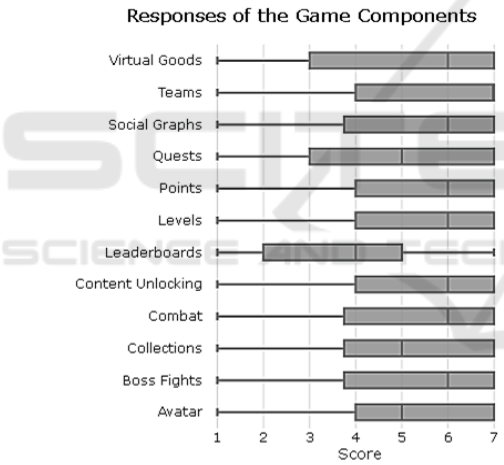

Figure 4: Responses to the question on game components. (1 is the minimum and 7 is the maximum score in the adopted Likert scale).

To statistically estimate the difference between the evaluations of the 12 game components, the nonparametric Kruskal-Wallis and the post-hoc Mann-Whitney tests were used, since the resulting data do not follow a normal distribution. Tests indicate that at least one game component exists with a significant difference in its evaluation (Kruskal-Wallis test, $p<0.001$): the evaluation of the leaderboard component is significantly different from other components (Mann-Whitney test, $p<0.05$).

Table 1: Statistical Summary of Sample (Min. is the minimum and Max. is the maximum score in the sample; SD is the standard deviation).

Components	Mean	Median	Min.	Max.	SD
Virtual Goods	4.92	6	1	7	2.27
Quests	4.64	5	1	7	2.24
Teams	5.60	7	1	7	1.85
Leaderboards	3.81	4	1	7	1.93
Points	5.32	6	1	7	1.99
Boss Fights	4.90	6	1	7	2.15
Levels	5.28	6	1	7	2.06
Social Graphs	5.20	6	1	7	2.06
Combat	5.05	6	1	7	1.99
Avatar	5.11	5	1	7	1.78
Collections	5.03	5	1	7	1.97
Content Unlocking	5.15	6	1	7	1.97

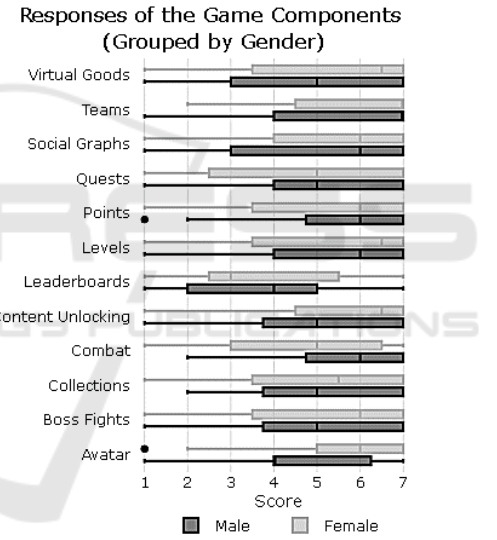

Figure 5: Responses to the question on game components grouped by gender (1 is the minimum and 7 is the maximum score in the adopted Likert scale).

The perception according to the participant's gender is shown in Figure 5. Results indicate that there is no significant difference among game components evaluated by male respondents (Kruskal-Wallis test, $p<0.10$). In contrast, there is a significant difference among game components evaluated by female participants (Kruskal-Wallis test, $p<0.03$), with the leader board component being significantly different from other components (Mann-Whitney test, $p<0.05$).

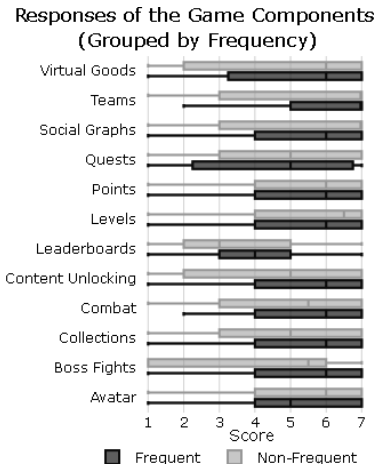

Figure 6: Response to the questions about game components grouped by frequency of use of mobile devices for games (1 is the minimum and 7 is the maximum score in the adopted Likert scale).

Preference for game components according to frequency of gaming on mobile devices is shown in Figure 6. Participants were put into two categories: frequent players (that use mobile devices daily for gaming), and non-frequent users (that uses mobile devices for gaming weekly, monthly or rarely). No significant difference among evaluations by non-frequent users (Kruskal-Wallis test, $p<0.10$) was found. In contrast, there is a significant difference between the evaluations of game components by frequent players (Kruskal-Wallis test, $p<0.03$). Again, the evaluation of the leader board component significantly differs from those of other components (Mann-Whitney, $p<0.05$).

4.3 Discussion

Some results seem worth of further observations, comments and attempts to explore cause-effect relations:

1. The overlapping intervals in Figure 1 preclude definite conclusions – statistically speaking there could be equally favored by respondents – except perhaps, for leader boards. The apparent "distaste" for leader boards could stem from the negative psychological impact of being exposed when one is not very well ranked.
2. Females were observed to come out stronger in favour of gamification of m-Learning applications. Further, their perceptions of the contribution of game elements differ from those of their male counterparts. Although additional research is needed to ascertain these observations and identify their causes, they could lead to customizable m-Learning apps according to gender for better user experiences.
3. Results in Table 1 suggest a uniform distribution – i.e., all 12 game elements appear equally important for the success of m-Learning apps. It is important to note that a similar observation may be made for the results in (Cheong et al., 2014) but for respondents with a different profile (university students). This may be caused by the "give me the works" syndrome of avid and/or frequent players.
4. Bias from frequent players seems not to be the case here: Figure 8 shows that although players with different gaming and mobile usage profiles have somewhat different perceptions most game elements end up with very similar ratings.

All four points above suggest further research to clarify matters or open new research opportunities. In this direction, one might envisage a contribution of the paper in the sense that it opens new paths for further research on gamification of m-Learning apps.

In short, the general results found in this subsection indicate that there is no consensus among the participants regarding the key elements that might contribute to the educational process, However, there is evidence that the leader board component is less "effective" for the analysed profile of potential players.

5 CONCLUSIONS AND FUTURE WORK

Gamification is being used in different contexts. In education, the usage of game elements has the potential of engaging people, motivate actions, promote learning and help in problem solving situations (Kapp, 2012). However, to obtain the true potential of gamified m-Learning apps it is necessary to use adequate gamification processes, understand the characteristics and perspectives of students about their motivation and engagement in the learning process (Cheong et al., 2014).

This paper offered preliminary results of research on the perspective of location-based mobile applications users. Potential users of interest here were children (11 to 18 years-old) of the middle level of schooling. The results provide a descriptive study of game elements that affect students' perceptions in terms of overall improvement of the learning process caused by the characteristics of those elements. The study indicated that, in general, there is no consensus among the questionnaire respondents regarding the

key elements that might contribute to the educational process. This indication is aligned to the results by Cheong et al. (2014), although their work considered another "class" of (potential) users – i.e., university students. On the other hand, the study here yielded evidence that the leader board component appears to be less effective. This research might serve as a basis for other works on the evolution of gamified m-Learning applications.

As future work, one could consider other user profiles for the evaluation of the game elements. One could also consider a qualitative research through semi-structured interviews. It is of further interest to explore gamification in the process of pedagogic evaluation of students. Since false information is likely to be produced by cheating users for underserved gains, one will need intervention to detect and root out cheaters. Conventional manual evaluation approaches (by teachers, tutors or specially appointed agents, etc.) to catch false information lack scalability. That is, as the quantity of users/students rises, the number of evaluators may not increase proportionally. Therefore, interventions are necessary to meet such increase and motivate users towards this type of activity – which is typical of a trust evaluation system. Gamification of such systems may prove efficient. One would need, however, to identify which game elements would be of most assistance in this case and thus set development priorities.

ACKNOWLEDGEMENTS

This work is being carried out with support from the Brazilian Agency for the Improvement of Higher Education Personnel (CAPES).

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