

# Gamification of an Exercise Tool of a Virtual Learning Environment

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**Keywords:** Gamification, Web Social, Inquiry based Learning.

**Abstract:** Gamification uses game design elements in non-playful contexts, such as educational environments, to achieve motivation, interaction, and performance benefits. This paper presents the gamification of an exercise tool of a Virtual Learning Environment to induce students to increase their participation through creating new questions in the tool and answering the questions of their peers. The development of the gamification process and the experiment with students are detailed, and as result, we can find gamification can be an ally as a motivation tool for students.

## 1 INTRODUCTION

The use of technology supports education in many aspects, such as the dissemination of teaching, the easy search for teaching materials, or even distance learning. One of these technologies that are being increasingly disseminated are the virtual learning environments, which have the characteristic of taking learning in an interactive way, such as multimedia classes and learning materials repositories, it can remove barriers in transmission of knowledge, allowing collaboration between individuals, enabling the exchange of experiences, making knowledge available to everyone (Ashraf et al., 2009).

However, a problem that still persists is related to the motivation and engagement of students (Atkin, 2012). In the traditional education system, students' lack of motivation is the result of different aspects, such as students' difficulty in seeing the benefits of going to school, lack of confidence, fear, fatigue, etc. (Atkin, 2012). In virtual learning environments the situation is no different, even with the mediation of technology for more effective learning, students end up facing some of the same problems they face in the traditional education system.

Several initiatives have been analyzed to increase motivation and the engagement of students. Among them, gamification is an approach that stands out, the term gamification originated in the digital media industry and can be generically defined by the thought process and game mechanics to engage users to solve

problems (Zichermann and Cunningham, 2011).

The area of education has been using gamification to motivate and engage students, and thus improve their learning. According to Lee and Hammer (2011), the use of gamification can influence three major areas related to the student:

- **Cognitive:** The use of game techniques can change students' perspective on relation to learning;
- **Emotional:** In a game, or in a gamified environment, the player normally experience a large number of emotions, such as by example, curiosity, pleasure, pride and optimism;
- **Social:** Through gamification students can be recognized for its academic achievements, and the system, with the possibility of online interaction between students through gamification techniques result in a more social environment than the classroom.

Another approach that can help the teaching and learning process in virtual learning environments is the social web, as it aims work on sociability aspects among users. The social web is in the classes of applications that are web-based and allow interaction and sharing data among its users, in addition to being technology that enable communication between groups of people (Machado and Tijiboy, 2005). Thinking about the use of the social web as an educational support tool, in the student's view, it can enhance the construction of autonomy and boost col-

laborative learning and paradigm shifts educational, as collaborative technologies can create new ways of interaction (Junior et al., 2012)

Bringing together concepts of social web and inquiry based learning, the research of (Pimentel et al., 2021) developed the COEXA model, a model of question that was applied in the AdaptWeb environment in the form of a tool for creating exercises that are fed by the students themselves, in order to increase the engagement of students with the environment and also assist in the process of teaching and learning.

This work improves the tool of the COEXA model by means of the gamification supported of the honeycomb framework, which is a social web framework, for assess student satisfaction when using the exercise system. This paper is organized as follows: section 2 presents the concepts of this research, specially related to gamification, inquiry based learning, and social web. Section 3 details the project. Section 4 explain the development of the tool. Section 5 presents the experiment with students. Section 6 shows the results. Finally, section 7 presents the conclusions of the paper.

## 2 CONCEPTS

This section presents the concepts used in this research: Gamification, Inquiry Based Learning and Social Web.

### 2.1 Gamification

Gamification corresponds to the use of goal-oriented game mechanisms to solve practical problems or to awaken engagement among a specific audience (Vianna et al., 2013). Gamification is also defined as the use of game design elements in non-game related contexts (Deterding et al., 2011). The essential concepts that justify the application of gamification are engagement, persuasion and motivation (Deterding et al., 2011).

Engagement is a persistent and rewarding state of mind in which individuals voluntarily invest energy, concentration, and dedication to accomplish tasks that are linked to human work (Schaufeli and Bakker, 2004). Persuasion is the intentional effort to influence the mental state of other individuals through communication, in situations where the persuaded have some freedom of choice (O'Keefe, 2015). Motivation, on the other hand, consists of a set of mechanisms biological and psychological whose objective is to guide an individual to constantly perform certain behaviors until a goal is reached (Lieury, 2000).

#### 2.1.1 Gamification Elements

The presence of certain elements can make games more engaging and transforming them into experiences in which the player feels the will to remain involved, therefore, in terms of learning, when thinking about gamification, one seeks to produce engaging experiences that keep players (students) focused to learn something that positively impacts their performance (Alves, 2015). Such elements can be divided according to the Mechanics, Dynamics and Components (MDC) model. In this model, Dynamics are managed aspects that do not directly belong to the game, Mechanics are processes that stimulate action and player engagement, and Components are specific instances of one or more mechanics or dynamics (Werbach and Hunter, 2012).

#### 2.1.2 5W2H Framework

The 5W2H Framework is a generic and flexible framework to assist design and implementation of gamification in Virtual Learning Environments have seven main dimensions (Klock, 2017):

- Who?: identify users who are part of the target audience and what are the characteristics of these individuals that interfere with gamification.
- What?: aims to identify the behaviors that must be performed by the target audience during the interaction with the system in order to assist in the learning process.
- Why?: identifies the stimuli to be generated in the audience target for them to perform the desired behaviors in order to assist in the learning process.
- When?: identify the most appropriate situations to encourage the target audience to perform the desired behaviors.
- How?: aims to design gamification so that it encourage the desired behaviors in the target audience in certain situations.
- Where?: after designing gamification to stimulate the desired behaviors in the target audience in certain situations, the process of implementing the elements of games on the system.
- How Much?: the assessment of how much gamification in system was able to stimulate the desired behaviors in the target audience in certain situations.

### 2.2 Inquiry based Learning

Considered a great innovation within the pedagogical practices, Inquiry-Based Learning aims to make stu-

dents active subjects of the teaching/learning process, instigating them to assume an investigative role and explore their real world. In performing this real-world exploration, the students will ask questions about a given topic, will collect data to be able to answer the questions previously raised, and will finally test their findings to confirm their new understanding. Inquiry-Based Learning involves the act of researching, evaluating different viewpoints and situations, gaining new knowledge through discoveries made during the process, and walking a path from the simple to the more complex (Morán, 2015). In the paper Short (2009), proposes The Inquiry Cycle, which explains the steps for the effectiveness of the process of Inquiry-Based Learning. Figure 2 presents de Inquiry Cycle proposed by Short (2009);



Figure 1: The Inquiry Cycle adapted from (Short, 2009).

The first step is the connection, where the student will connect the topic being worked on in class with his/her life outside of school. The second step is the invitation, where the teacher will need to look for ways that will make the student want to participate and engage in the established process to expand their knowledge. The third step is the tension, where the student will be provoked with all the questioning already done in the connection process to promote interest and engagement of the students, instigating them to investigate and make new discoveries. The fourth step is the investigation, where the student assumes the role of investigator and engages in research on the topic, here the students will look for ways to solve their questions and solve their doubts. The fifth step is the demonstration step, where the teacher comes into action to assess means, develop strategies and look for tools to help the student in the process. The teacher will answer any questions that arise during this process. The sixth step will be the re-vision phase, where the students will re-measure the investigative process, recalling all the questions and what their new dis-

coveries are. The seventh step is the representation, where the student will gather all the materials, knowledge and information that he/she obtained during the process and will share it with the rest of the classmates. The eighth step is valorization, in this step students will reflect on what the value of all their new learning is. And finally, the ninth step will be action, in this step students will think about what they will do with their new discoveries and how they can take their learning outside the classroom. It is important to highlight that in all this process the student will be an active subject of the teaching/learning process, the goal of Inquiry-Based Learning is to make the student the main center of the teaching and knowledge construction process.

## 2.3 Social Web

Advances in the use of technology in education have been placed on the potential of social software for accessing information and knowledge, as well as the ability to work and learn with others in creative global collaboration, demanding a new ecology of learning (Bragado, 2012).

Among the main features of the social web, we can mention the need for a chain of users and content produced by them. The users interact, communicate, create, share and organize content, demonstrating the "strength of the collective", the opportunities and knowledge that can be generated by working together and by mass interaction (Baranauskas et al., 2010).

In the research of Smith (2007), it was proposed a framework that well exemplifies the features sought in a social software called Honeycomb Framework.

### 2.3.1 Honeycomb Framework

In the (Smith, 2007) framework is composed of elements that were identified by researchers and professionals interested in the design and evaluation of social software. Accordingly with its creators, social software has a set of common elements that are combined and implemented to produce distinct environments. The honeycomb framework has seven combs that represent the functional aspects of a social software, they are: identity, presence, relationship, reputation, groups, conversation and sharing.

- Identity: something that uniquely represents that user, and even at which point this user reveals his identity within the system.
- Presence: refers to a user's ability to know if others users are available. This includes knowing where other users

- **Relationship:** refer to how people are connected on a social platform. In some social software it is possible to identify family members and make notes about mutual friends among users.
- **Reputation:** it is understood as the users' ability to identify the position of others within a system. For example, on social networks users can usually like certain content and comment on it. A post with lots of likes and comments tends to increase the popularity and reputation of users.
- **Groups:** refer to the ability of users to form communities and subcommunities. When users of a social software like the same brand, subject, celebrity and among others, they form a social community, and interaction is very important for creating user-generated content, because when creating content, users can connect with others, experience a sense of community and feel important.
- **Conversation:** the honeycomb of the framework's conversation a level of communication on a social web platform with other users which can also be regularity of posts. One of the main implications of this comb is the speed of the conversation and the risks of initiating and joining one.
- **Sharing:** sharing refers to the sending and receiving of content between users of the same social platform, such as photos, comments, news and videos. In addition to "likes" and "comments", the metrics of a social software must comprise the number of shares.

### 3 DESIGN

This work continues the research of (Pimentel et al., 2021). In our research group we continue to discuss proposals and improvements for the COEXA model with the main objective of increasing user interaction with the AdaptWeb exercise system.

Some premises were defined so that it would be possible to proceed with this research:

- **Merge with current AdaptWeb gamification:** Various gamification elements have been applied to the environment, from experience points and redeemable points to badges and gifts. Obtaining these elements consists of tasks performed by the student within the environment. Because of that, the proposed gamification project of the exercise system based on the COEXA model should neither overlap nor develop as a second gamification tool, but, it should coexist harmoniously

with what has already been implemented, making the two projects into one gamification design for AdaptWeb.

- **Focus on the reputation comb of social honeycomb framework:** after an analysis of popular educational environments, it was noticed that most of them focus on the reputation comb. It was also noted that educational environments that are gamified often use points, levels, badges, rewards and rankings to engage students, components that relate strongly to the reputation comb.
- **Develop other combs of social honeycomb framework:** Although it was decided that the focus of the research would be in the exploration of the comb of reputation, in the long term the objective is to reach all combs of the of social honeycomb framework.
- **Use strategies for continuous use of the system:** Keeping a student interested in maintaining daily access is critical to the success of an exercise tool. Then, a search for strategies that can contribute to the student's motivation to access AdaptWeb daily was proposed.

To define which gamification strategies will be applied in the environment, we must first define what behaviors are expected from students.

Desired behavior	Frequency	Importance
Access the system	Daily	Very high
Create new questions	Daily	Very high
Solve questions	Daily	High
Interagir socialmente	Daily	Average
Report questions	When existing	High

Figure 2: Desirable behaviors and the levels of importance.

Figure 2 shows what is expected from student when taking a course using the exercise system. Student access to the system is essential, and as the initially proposed objective was to encourage daily access, its importance was defined as "Very high". Another behavior that was defined as "Very High" was the act of creating new exercises in the system. For the flow of the exercise system to work, there must be exercises created, without that, there is nothing to interact with. The resolution of exercises created by other students also has a great impact on the system and especially on learning. The process of reporting issues that do not serve the learning purpose or that have some structural error also deserves considerable importance, as it requires the student to know the content to assess a possible error. Finally, the possible social interactions in the exercises are also important and characteristic of some combs from the Honeycomb Framework, but they are not essential, so they

are classified as “Average”.

With the game elements grounded in the MDC and defined for use in the project, it was possible to numerically measure the rewards for desired behavior based on their degree of importance to the AdaptWeb exercise system. These metrics were defined as follows:

- Experience points: served as the basis of gamification. It was used as a measure for the gradual escalation of levels and as a unit of measure to classify the positions in the ranking. It is important to emphasize that the numbers were based on the values previously defined in the research by (Klock, 2017);
- Redeemable points: Inserted in the research of (Klock, 2017) in the form of coins, it is used to buy consumer goods within the system. These consumables range from being able to re-answer a question the student missed or increasing experience points gained for a specified time.

The scoring definitions for each action performed in the exercise system can be seen in Figure 3.

Action	Points	Coins
Create new question	100	50
Solve questions	50	50
Get "Like" on a created question	15	-
Report question	50	-

Figure 3: Punctuation definition.

If the student creates a question that is later reported by another student, and excluded by the teacher, the points obtained by creating the question are removed. When a student reports a question which is then deleted or edited by the teacher, this student receives a bonus of 50 experience points.

Other gamification approaches that were applied in the system to increase student engagement were Offensive Days and Badges.

- Offensive days: This is a strategy chosen to increase student interest in accessing the environment on a daily basis during the course period. This initiative works as follows: the experience points received for creating new questions and for answering questions created by other students are multiplied by the number of offensive days the student has.
- Badges: The badges are rewardful that the system gives to the student when he fulfills certain tasks previously established.

Figure 4 show how students can get each badges when an action is performed on the system in a certain number of times, that is, the student has the possibility of winning a different badges.

Challenge to earn the medal	Quantity
Create new question	5 - 10 - 15 - 20
Solve questions	5 - 10 - 15 - 20
Get "Like" on a created question	10 - 20
Offensive days	2 - 5

Figure 4: Badges challenges for the exercise system.

Twelve new badges were designed to the exercise system. Seeking a strategy to make these badges even more attractive and somewhat fun for the students, it was decided to use *memes* in the reward images. In the research (Jablonka, 2012) is explained the meaning of *memes*, as an improvement of emoticons, they are born with the purpose of expressing emotions in situations in which non-verbal means are lacking. The *memes* initially from entertainment and humor is increasingly being used in education. For teachers, these internet expressions (*memes*) can be explored in the classroom both as a didactic tool and for approach students (Pavanelli-Zubler et al., 2017).

Regarding the loss of points in case of a reported question, excluded by the professor, the badges also have the same type of control. If a student receives the medal for example from create ten new questions, and one of these questions is deleted by the teacher, the student loses the medal gained.

In the next section gamification developed in the exercise system is presented.

## 4 DEVELOPMENT

A strategy was used to always show on the user's screen the rewards he/she is receiving for each action performed in the exercise system. This was done with the intention of making gamification more present, and not letting it fall into oblivion by the students. In Figure 5, the student has just answered correctly a question created by another student, it is also noticed that the system sends a message together of incentive for the student to continue using the features of the environment. When the student earn a badge after completing a challenge, he/she is also notified, as shown in Figure 6.

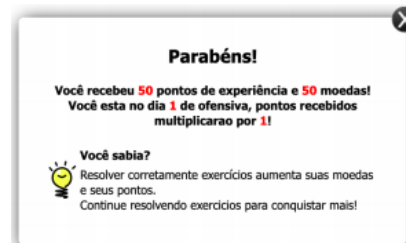


Figure 5: Question correctly answered by the student (system message in portuguese).

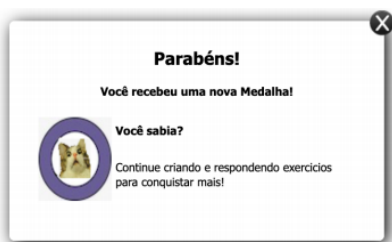


Figure 6: Student just earned a new badge (system message in portuguese).

Offensive days also appear in student interactions with the exercise system, in addition to showing how many days the student has been on the offensive. The message shows by how much your points are being multiplied, and the total points obtained with this multiplication performed.

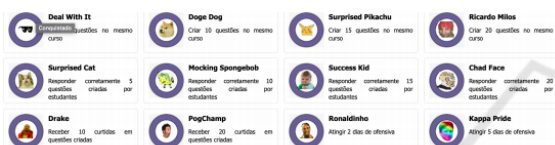


Figure 7: Exercise system badges achieved.

Badges only appear in color, like in the Figure 7, when the student has already earned it. Otherwise, the student can only view the outline of each badge, as if it were a sticker album. This type of visualization conveys a feeling of incomplete goal until all the "cards" are acquired.

Finally, regarding the visualization of experience points, levels and ranking, the gamification present in the exercise system merged with the gamification that already exists in AdaptWeb as it was initially proposed. Those parameters are added to the user profile, located in the gamification tab, as can be seen in the Figure 8.



Figure 8: User gamification tab.

Thus, all the elements of gamification that are within the system of exercises operate together with elements outside the exercise system in the rest of

the environment. Therefore, the premise of creating a unique gamification system for AdaptWeb.

## 5 EXPERIMENT

Since the research happened in the COVID pandemic period there was certain difficult to implement a large experiment. Then we used a convenience sample, were students from the department and their friends from other university were invited to be part of the short course on Programming Algorithms. Students were invited via e-mail and instant messaging system on 08/02/2021.

The experiment started on 08/02/2021 until noon on 08/06/2021. A few hours before the start of the experiment, they were created and distributed twenty-six accesses previously registered in the subject of the Programming Algorithms short course. Along with that, a document explaining how to use AdaptWeb and what tests would the users should do to enjoy as much of the features as possible implemented.

In order to keep users motivated to access the system, every day interactions were made via email and instant messaging. Of the 26 students who had access to the environment and were invited to the experiment, only 16 actually accessed the system and interacted with the exercise system.

Despite the low number of users using AdaptWeb, the number of interactions with the exercise system was quite impressive. Were created a total of 44 new questions, these questions were answered 108 times. Social interactions were not left behind either, they were distributed 62 likes on the questions created, and 4 exercises were reported, and analyzing these reports, they are considered correct because the enunciation of these questions they had nothing to do with the content of the short course. Many badges were acquired by students during the experiment, of the 16 users who participated, 11 of them earned at least one. The maximum number of badges a student obtained was 5 badges.

The point multipliers provided by the functionality of the offensive days were enjoyed by a total of 5 students, and the maximum offensive obtained was 3 days, which was achieved by the students received who ended up with the highest number of points earned. On the last day of the experiment, users were sent a questionnaire of satisfaction where it made it possible for students to share their opinions about the features that have been implemented. This questionnaire was answered by 14 students, and with that, it was possible to carry out the analysis of the results.

## 6 RESULTS

The first question referred to the effective use of the exercise system, if the student created or answered at least one question, it is a question important to be able to validate the next questions related to gamification, because if the student even performed these actions once then he/she would not have basis to answer the rest of the questionnaire. As a result, 100% of the students created or answered a question created by another student at least once.

The second question aimed to assess whether the approach chosen of the constant visualization of gains related to gamification were important in the experiment process, maintaining the student's perception of that all those actions he/she did in the environment were being rewarded outputs somehow. Again, 100% of students found the chosen strategy important.

The third and fourth questions were aimed at knowing about the badges available and obtained in the exercise system. The questions were aimed at knowing precisely whether students think the tasks that had to be performed in order to arrive at the reward were fair. User responses were positive and some of them can be seen in Figure 9. Another question was about theme chosen for the badges. A total of 78.6% of students claimed that the more humorous theme of the *memes* influenced them positively in the goal of winning badges, highlighting in a way the effectiveness of the chosen approach.

What did you think about earning medals for tasks performed? Were the tasks fair? Did you like the theme?
I liked the way it worked, it was easy to win the first medals, but there were several others that required more effort which made the tool well level and fair. The theme of medals being memes made them very current and funny
The system of earning medals for tasks performed is very interesting to encourage study. Medals and "reward" points give a competitive feeling that escalates over time. The medal theme was essential for relax and approach the student's reality
I felt encouraged to use the system, to earn more medals. The theme of medals pleased me a lot

Figure 9: Users comments about badges.

The fifth and sixth questions raised questions about the effectiveness of the offensive days strategy. Feedback from students was positive and unanimous: 100% of users liked the functionality of the days of offensive, and again, 100% of users considered it a strategy that helps motivate the student to access the environment more often.

The seventh question wanted to know if the use of gamification and strategies chosen motivated the user to use the AdaptWeb exercise system. The feedback from users was excellent, 100% considered it motivating.

The last question asked the students for their final opinion on the experiment, requesting comments,

opinions, criticisms and suggestions for improvement. That question is very important because it is precisely through the user that it is possible to see possible improvements that end up making the system even better. Thus, Figure 10 follows some of these comments.

Leave a comment/opinion/criticism about your experience in this experiment
"I found the use of gamification and the way in which it was implemented for the interaction of students with the proposed exercises to be of great value to the teaching-learning process, without being just a matter of grades. Also, I got a good experience using the new feature. PS: if I click submit the question without having answered, it counts as an error. I believe it could have a confirmation."
"I found it very interesting that the achievements are already explicit, the labels explaining what to do and what they would win. I think it's interesting to do surprise labels too, where I don't know what I have to do to achieve, but I know I can earn. I thought it was all very nice."
"Overall it was a pleasant, intuitive and stimulating experience with every right answer to find out if I was going to pass the level and what kind of prize would win."
"Gamification certainly made the environment more interesting and encourages students to contribute and consequently, learn more."
"I really liked the tool, the idea of creating questions about the subjects encouraged me to better understand the matter in order to create a good question. A criticism would be regarding the graphic quality of the images used as medals, a better image resolution would feel better to win that medal."

Figure 10: Final users comments about the system.

## 7 CONCLUSIONS

Currently, there are several strategies and approaches that can be used in order to make the use of a virtual learning environment more satisfying and attractive to students. So defining this, as the main objective of this work, we initially tried to find such approaches that if applied correctly could bring these results.

The paradigm of the Social Web was studied, which aims to establish connections, enabling interactions of a social nature between users. To support this paradigm there are several tools, the one studied in this work is the Honeycomb Framework that effectively categorizes in its combs the social relationships often required in environments that interconnect users.

Another approach that has shown potential in increasing student interaction and satisfaction in virtual learning environments was gamification, which has the potential to main feature the inclusion of game elements in non-playful environments. The main purpose of gamification is to increase engagement among users. However, applying gamification in a system is not a trivial process, for this, the 5W2H framework was studied, which defines seven main dimensions that serve as an aid for gamification design.

In the development stage the proposed solutions were actually implemented in AdaptWeb, and a small

experiment was carried out to validate the solutions. At the end of the experiment the students were invited to answer a 9-question questionnaire in order to verify if the previously stipulated objectives were achieved. The results were satisfactory, showing that the chosen and implemented approaches increased student satisfaction in using the exercise system, and also, according to the students, that gamification proves to be effective in helping the teaching and learning process.

From this work on, there are several future works, as in addition to the reputation comb, there are still other six combs that can be better explored through gamification elements. Some ideas were raised, such as creating a second ranking, this one weekly, and unlocking content, in this case, avatars.

In conclusion, the use of gamification linked to the Honeycomb Framework has great potential in making an exercise system of a virtual learning environment even more attractive and seeking to keep the student's interest.

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