# Gamification with Lego in Higher Education: Experience in the Course of Logistic Distribution

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**Abstract.** The universities have already taken gamification to the classroom, seeking to inspire students, to innovate in activities and to raise student participation in a greater way. It may seem easy, but teaching inspiring lessons which join content, creativity, time management, and good dynamics is not an easy task, especially when introducing a gamification activity. Observing this scenario, in the course of Logistic Distribution, classes using gamification were introduced. This research presented a case study. The research had a qualitative and quantitative approach. This case allows the deepening of knowledge and brings new dynamics to the classroom. Based on the concept of gamification it is possible to apply the subjects studied in academic activities in the areas of Administration, Logistic, Economics, Accounting Sciences, Psychology, Human Resources Management, Foreign Trade and the various engineering areas. The gamification also makes possible a collaborative approach and the use of technology in Education. The use of technologies within gamification will make the game even more attractive. The result was very positive because the students were able to understand that it is possible to associate theory and practice in a pleasurable activity.

**Keywords:** Gamification · Higher education · Lego

## 1 Introduction

Different studies indicate the use of gamification in higher education as a practice for socializing, relaxing, competing and having fun [1]. The universities have already taken gamification to the classroom, seeking to inspire students, to innovate in activities and to raise student participation in a greater way. It may seem easy, but teaching inspiring lessons which join content, creativity, time management, and good dynamics is not an easy task, especially when introducing a gamification activity. It takes organization, interest, student cooperation and creativity.

Gamification can occur in several spaces such as face-to-face classrooms and in distance learning. The Horizon Report 2016 [2] cites that we have leaders who believe that new forms of teaching and learning require new classroom configurations. In this sense, the universities have been making available such new physical structures to give support to pedagogical strategies. In addition, there are different applications and online spaces that can be used to mediate game practices. Observing this scenario, in the

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course of logistic distribution, classes using gamification were introduced. This experience allows the deepening of knowledge and brings new dynamics to the classroom. Based on the concept of gamification it is possible to apply the subjects studied in academic activities in the areas of Administration, Logistic, Economics, Accounting Sciences, Psychology, Human Resources Management, Foreign Trade and the various engineering areas.

This article is organized as follows: in Sect. 2 we present a reflection about games and gamification in educational settings. In Sect. 3, we present the research path, describing the game and presenting the results and the discussion. We finish the paper by presenting the findings and making recommendations for future research.

## 2 Games and Gamification in Educational Settings

According to Pimenta and Anastasiou [3], education has the mission of inserting children and young people into the advancement of civilization, through knowledge, reflection, analysis, understanding, contextualization, skills development and attitudes. This results in the appropriation of scientific, technical and technological, political, social and economic knowledge, generating the capacity of thinking and coming up with solutions. In this sense, games are being introduced in the classrooms by educators and according to Mcgonigal [4] for a game to happen, be it digital or non-digital, some concepts such as goals, rules, feedback system and voluntary participation are necessary. Mcgonigal [4] informs that goals provide a sense of purpose. The rules are meant to impose limits. The feedback system tells players how close they are from reaching the goal and finally, the player must consciously and voluntarily accept the goals, the rules and the feedback, establishing a common purpose.

In order to have a game in a teaching context it is necessary, according to Schmitz et al. [5], to have the following elements: character, competition, and rules of the game. The authors say that the character is directly related to the student; the competition stimulates the attention and the focus of the student; and finally there are the rules of the game, which stimulate the student's immersion into the learning context.

But what motivates people to participate in a game in a classroom? For Zichermann and Cunningham [1] people play for four reasons. The first is to compete and gain competence, that is, to win; the second reason is to relax or relieve stress; the third is to have fun and seek entertainment; and finally as a way to socialize.

The gamification debate within the classroom and its collaboration for the teaching and learning process has been developing among leading educators around the world. Its goal is simple and clear: to make the act of learning more enjoyable for all those involved. For this to happen inside the universities, the use of gamification has been increasing intensively.

For Avellar [6] gamification can be understood as the application of game dynamics to everyday situations. Collaborating to the study of this concept, authors such as Domínguez et al. [7] claim that games can promote playful and fictional contexts to favor the learning process.

In order to bring gamification into a classroom, one has to prepare a series of previous steps. The construction of the idea, the assembling and the planning of the game. Then it is

necessary the motivation and collaboration of the students at the time of applying this game. Playing does not occur if there is no involvement. Piaget [8] highlights the importance of the subject's action, attributing to him the responsibility for the learning process. He also treats knowledge as a construction based on the action of the subject in an interaction with the object of knowledge, and teaches us (in 1967) that knowledge rests on the interaction between the subject and the objects, in all levels.

The concept of gamification for authors like Zichermann and Linder [9] uses the mechanics of games, the style of games and the thought of games in a non-game context. This is done with the purpose of engaging the students involved and also in solving the problems included therein. The whole process to be developed clearly goes through the understanding and participation of the subject. Without this collaboration, the whole process of teaching/learning might not reach its goal.

From this perspective, Simões et al. [10] understand that in an educational context, aspects of games such as repetition of experiments, rapid response cycles, increasing levels of difficulty, different possibilities of paths, recognition and reward, are extremely significant for learning.

The gamification also makes possible a collaborative approach and the use of technology in Education. Through the collaborative approach, students exchange ideas, develop new strategies and organize actions within games. According Loos and Crosby [11] the use of gamification to promote student engagement embodies an evolving approach to learning in higher education.

The use of technologies within gamification will make the game even more attractive. According Kearney et al. [12] education is one of the areas mostly impacted by the technological society.

## 3 Methodology

This research presented a case study which occurred in the course called International Logistic Distribution at Unisinos University.

The research had a qualitative and quantitative approach. In this gamification the student acts frequently and his decisions interfere with the results. According to Gil [13] a case study consists of a deep and exhausting study of one or a few objects in a way that allows its broad and detailed knowledge.

### 3.1 The Game

This article presents the dynamic developed in November, 2017. The activity occurred during a class in the course of International Logistic Distribution and had the purpose of identifying logistic bottlenecks and of showing the steps for assembling the operating costs in international trade. It also aimed to identify the role of purchasing areas, distribution centers, logistic, production, costs and quality. The course integrates the syllabus of the Foreign Trade course. In this dynamic, 37 students were involved and worked alone, in pairs, or in groups, each of them having a specific role. The game simulated the production line for building a toy, with the objective of, at the end, delivering one final product by using LEGO pieces.

The activity was created to make the game as close as possible to a real organization. In this gamification the students had the opportunity to understand the support areas such as purchasing, government tax collection, distribution centers, logistic, and quality control At the end of the process, the final product is a car assembled with LEGO parts.

### 3.2 The Objective

The general objective of this gamification was to understand the main activities of organizations that act in the international market. The specific objectives were to understand the role of the government in supervising the payment of all taxes; the importance of working as a team; and the need to carry out financial control and logistic planning. By the end of the production the students should deliver a car assembled with LEGO parts without flaws. Figure 1 shows the layout of the classroom.

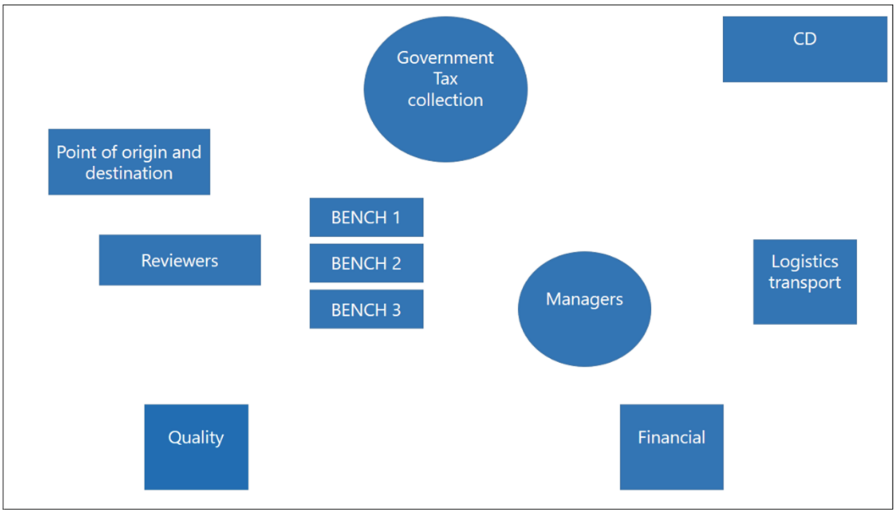



**Fig. 1.** Classroom layout (Source: Created by author)

### 3.3 The Steps for Building the Game

To facilitate the game the students were divided into two groups, and each group had the following functions:

(a) Point of origin and destination;
(b) Production Line;
(c) CD- Distribution Center;
(d) Government tax collection;
(e) Quality;
(f) Logistic;
(g) Financial department;
(h) Managers;
(i) Reviewers.

(a) Point of origin and destination:

Students were responsible for "point of origin and destination". The game starts and ends in this position. All the LEGO pieces were separated and ready to be moved. Figures 2 and 3 shows the bench "point of origin and destination".

**Fig. 2.** Point of origin and destination (Source: author's database)

**Fig. 3.** Point of origin and destination (Source: author's database)

(b) Production Line:

Students were responsible for building a car using LEGO pieces and responsible for the construction of a part of the toy, with the help of an instruction manual which describes all the steps of the assembling process. Three structures/benches (benches 1, 2, and 3) were created in each group that simulated a production line. Figure 4 shows the benches "production line".

(c) CD- Distribution Center:

Students were responsible for the support desk called "CD-distribution center". One structure/benche was created that simulated a Distribution Center. Students were

**Fig. 4.** Production line (Source: author's database)

**Fig. 5.** CD- Distribution Center (Source: author's database)

responsible for receiving and keeping the LEGO pieces. Figure 5 shows the bench "CD-distribution center".

(d) Government tax collection:

Students were responsible for the support table called "government tax collection". The support table was made available to students who were in charge of collecting government taxes. Figure 6 shows the student checking the "government tax collection". The students used an Excel spreadsheet to identify all taxes. Figure 7 shows this bench.

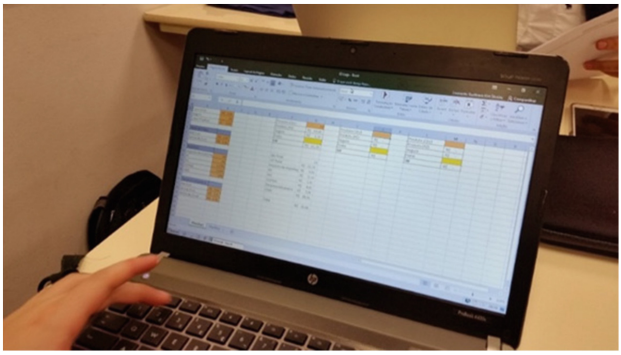


**Fig. 6.** Government tax collection (Source: author's database)

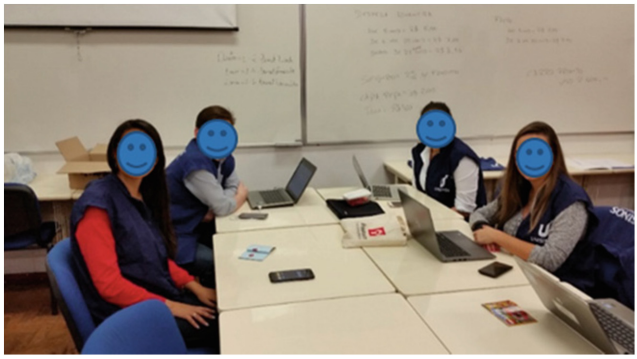


**Fig. 7.** Government tax collection (Source: author's database)

(e) Quality:

A student was responsible for quality - that is, to verify and analyze the finished car at the end of the last structure/bench. This was the student who informed if the car was correctly constructed and was in perfect conditions to be sold and shipped to the "origin/destination sector".

Figure 8 shows the manual and cars at the "point of origin and destination". These cars have already passed through "quality" function.

(f) Logistic:

Students were responsible for transportation and are therefore called "transport/logistic". The transport/logistic had the task of transporting the pieces from the "origin/destination" point to "government tax collection" and from "government tax collection" to "CD-distribution center" and next, from the "CD-distribution center" to the frames/benches (1 to 3). Other responsible for the students were for moving the car from the structure/bench number 3 to the "point of origin and destination", and they were also responsible for transporting, between the benches, the assembled pieces (1 to 3).

**Fig. 8.** The manual and cars (Source: author´s database)

Figure 9 shows the delivery of the pieces at the function "CD-distribution center" by the function "transport/logistic".

**Fig. 9.** The delivery of the pieces at the function "CD-distribution center" (Source: author´s database)

(g) Financial department:

Students were responsible for the "financial department", therefore called "financial". They authorized the costs. The decision of where to spend the resources were made by the managers.

(h) Managers:

The "managers" were responsible for all the decisions. When to buy, how many pieces to buy and where to send the pieces to, were some of the decisions made by them.

(i) Reviewers:

They were responsible for monitoring the students in charge of the transportation time. They were also responsible for monitoring the students who did the calculation and payment of the taxes.

**Table 1.** Categories and questions (Source: Created by author)

| Category | Question |
|---|---|
| Category 1 Character | Rate from 1 to 7 the function with the highest workload in the activity of gamification, being grade (1) the highest and (7) the lowest<br>() Government Tax Collection<br>() Logistics/transports<br>() Reviewers<br>() Financial sector<br>() Production<br>() Quality control<br>() Management |
| Category 2 Competition | Can you see the relationship between the gamification "playing with Lego" and the practices used in organizations?<br>() I totally agree<br>() I partially agree<br>() I do not agree nor disagree<br>() I partially disagree<br>() I strongly disagree |
| | As for your participation in the gamification:<br>() I fully participated<br>() I partially participated<br>() I did not participate |
| | Would you participate in another round of this game, analyzing and applying theoretical strategies?<br>() Yes<br>() No<br>() I don´t know |
| Category 3 Rules of the Game | Rate from 1 to 9 the difficulties faced during the activity of gamification, being grade (1) the highest and (9) the lowest<br>() Understanding the rules of the game<br>() Assembly of toys<br>() Organization of the group and the relationship between its participants<br>() Negotiation of the group with the transport/logistic<br>() Federal Revenue Service<br>() Time for moving the pieces<br>() The amount of parts moved by the carriers/logistic<br>() The calculation of the taxes<br>() The monitoring of the time applied in moving the pieces by the carriers/logistic |
| | Which other process would you include in this game? Do you have any suggestion (s)? Which one (s)? |

After the game, a questionnaire was applied in order to collected information. The questionnaire was organized into three (03) categories.

These categories follow the elements in a game which were indicated by Schmitz et al. [5]. The first category is called "character", the second category is called "competition" and the last one is called "rules of the game". In Table 1 it is possible to identify the category and its respective question.

## 4 Results and Discussion

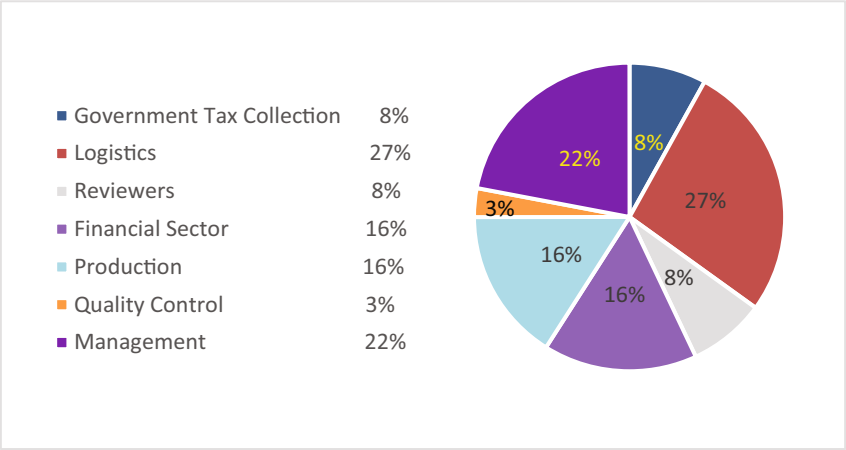
The game began when the "managers" determined the amount of pieces that should be purchased from the table "point of origin/destination". Next, the "financial" made available the resources for the "transport" to remove the pieces to "government tax collection". At this bench, taxes were paid and parts could legally be moved on. After the customs clearance, the "transport" took the pieces to the "CD-distribution center". There the pieces were separated, organized, and later distributed between the three (03) structures/production benches. It is important to highlight that there was a determined amount of pieces to be transported in a specific period of time. All the moves were required by "managers" and paid by "financial".

The first students who were in each of the structures/benches that simulated a production line had the same objective (to assemble LEGO pieces), but performed different steps in the construction of the car. The goal was to reach the end of the bench number 03 with the car finished. As the car has 30 steps for construction, these steps were divided as follows: the student in the first structure/bench was responsible for assembling steps 1 to 10; the student in the second structure/bench was responsible for assembling steps 11 to 20; the third student had the responsibility of assembling steps 21 to 30. When the student of the first structure/bench finished assembling, the "transport" was activated to move these assembled pieces to the structure/bench of number 2. As soon as the student of this structure/bench put together his pieces, the "transport" was activated to take the product to the structure/bench 3. Whenever a student finished assembling his pieces he communicated to the "managers", who asked to the "financial" and to the "transport" to pay and move the piece to the next structure/bench. All the movements were authorized by the "managers". The "financial" payed all expenses with the money made available by the professor in the beginning of the game.

The game also involved the use of technologies. Computers and smartphones were used. Each group had a computer for calculating the taxes. Smartphones were used to take notes of the code numbers of the pieces to be bought using whatsapp and notepad. The students in the "government tax collection" function also had a computer to check the taxes collected.

### 4.1 Category 1: Character

Regarding the first category we identify a number of (09) nine characters. The Graphic 1 shows the percentage of workload found in each of the functions performed by the students throughout the process.

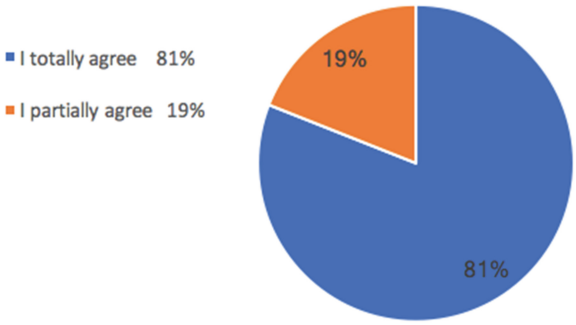



**Graphic 1.** Characters (Source: Created by author)

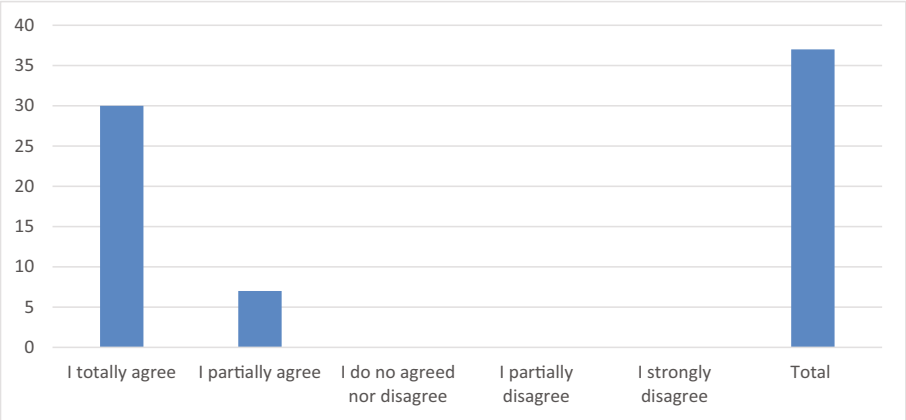
We have in this category "character" several functions, as indicated by Schmitz, Klemke and Specht [5]. According to the results of the questionnaire, the function "logistic" had 27% of the workload.

### 4.2 Category 2: Competition

Three questions support the category "competition" (Table 1). The first question shows that 81% of the students totally agreed that this gamification is related to the practices used in organization (as seen on Graphic 2). Graphic 3 shows that 30 students totally agreed with this question, while only seven (07) students partially agreed.

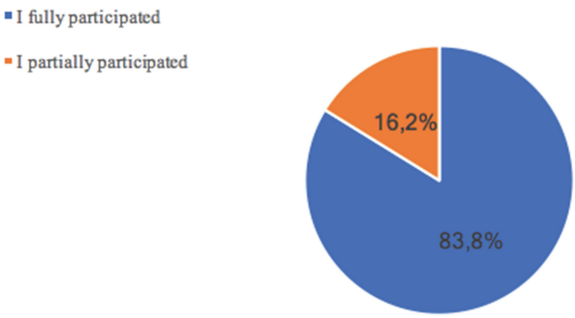



**Graphic 2.** The gamification and the practices used in organizations (Source: Created by author)




**Graphic 3.** The gamification and the practices used in organizations - number of students (Source: Created by author)

The next question is about participation. The results show thirty one students (31) indicated "I fully participated". Only 6 (six) students indicated "I partially participated". The Graphic 4 shows that most students (83,8%) indicated that they participated fully in the proposed activity.

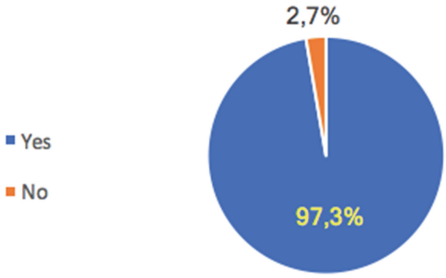



**Graphic 4.** Fully or partially participation (Source: Created by author)

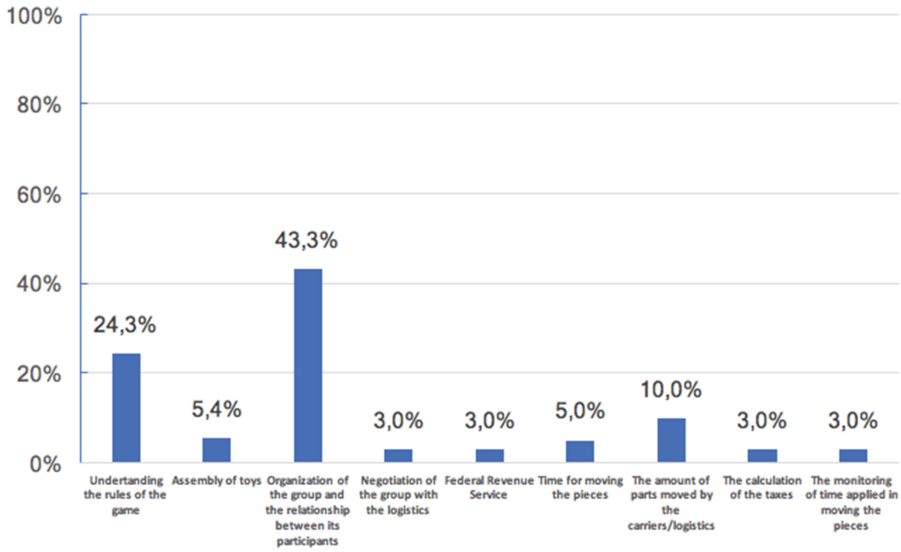
The final question in this category asked if the students accepted to participate in a new round of this gamification with a focus on theoretical strategies of purchase and logistic. The Graphic 5 shows that only one student did not accept to participate in a new round. The result shows 97,3% accepted to participate in a new round.

### 4.3 Category 3: Rules of the Game

Two questions support the category "rules of the game". The first question is about the difficulties faced during the activity of gamification. The result shows 43,3% identify the "organization of the group and the relationship between its participants" as the most difficult in the game (Graphic 6).




**Graphic 5.** Willingness to participate in a new round with a focus on theoretical strategies of(in) purchase and logistic (Source: Created by author)




**Graphic 6.** The difficulties faced during the activity of gamification (Source: Created by author)

The last question is about suggestions and five students gave feedback. The first student suggested the introduction of a storage area. The second one said the game should be related to the activities of an export company. The third student said that the rules of the game should became clear in the first class. The fourth one suggested that all the students should go through all the functions of the game. And the last student said that the "quality control" area could have more tasks to be performed.

## 5 Conclusions

The main concern of the students was to understand the rules of the game. They thoroughly engaged in the game and followed the proposed rules, participating in a collaborative way. The responsibility for the process was accepted by all of them.

Four difficulties were identified along the game. First, they had difficulty in the calculation of the brazilian taxes (Import tax, IPI, PIS, COFINS and ICMS). The second was in assembling the cars correctly, the third the organization of the group and the relationship between its participants, and the last difficulty was the handling of the pieces of LEGO because they are very small.

The result was very positive because the students were able to understand that it is possible to associate theory and practice in a pleasurable activity. Another positive point was the use of technologies, such as Excel spreadsheet for calculating taxes and the use of the smartphones apps, such as notepad and whatsapp, to write the code numbers of the pieces to be bought.

Suggestions for future studies are: (a) to apply this gamification in different courses; (b) to identify and analyze the introduction of different digital technologies (apps) to monitor costs and times; (c) to improve the gamification to study foreign trade strategies.

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