

# Gamification in the Classroom: Motivating Higher Education Students Using Digital Badges

Lydia Velázquez-García<sup>1</sup>, María D. P. Longar-Blanco<sup>1</sup>, Antonio Cedillo-Hernández<sup>2,\*</sup>,  
and Eduardo Bustos-Farías<sup>1</sup>

<sup>1</sup> CIECAS, Instituto Politécnico Nacional, Ciudad de México, Mexico

<sup>2</sup> Escuela de Ingeniería y Ciencias, Tecnológico de Monterrey, Monterrey, Nuevo León, Mexico  
Email: lvelazquezg@ipn.mx (L.V.-G.); mlongar@ipn.mx (M.D.P.L.-B.); acedillo@tec.mx (A.C.-H.);  
ebustosf@ipn.mx (E.B.-F.)

\*Corresponding author

**Abstract**—Nowadays, one of the most crucial challenges for higher education teachers is to improve student motivation and engagement. Educational gamification, i.e., the addition of game techniques and models in non-game contexts arises as a support to avoid students' distraction and get interested in the course content. Digital badges are a gamification tool that has witnessed a growing application in recent times. Digital badges are tokens employed to officially record or validate achievements in the realm of academia or any other domain. In this paper, we analyze the impact of the use of digital badges, as a strategy of educational gamification. We conduct a study involving 150 higher education students, specifically in the subject of database workshop, to whom the digital badges have been applied as a part of the system to accredit learning. The obtained results were analyzed through objective and subjective measurements indicating that the application of digital badges seemed to have a positive impact on student learning.

**Keywords**—gamification, digital badges, higher education, educational innovation

## I. INTRODUCTION

At present, educational institutions must adapt to the new socio-educational realities of their students because of the enormous economic, technological, cultural, political, and social changes that are currently taking place [1]. Higher Education Institutions (HEIs) confront problems due to the current academic community environment. One of the biggest problems for HEIs is transitioning from a traditional teaching style, in which students play a passive role, to an environment in which students more actively participate in the teaching-learning process, resulting in greater dedication and motivation from their acquired knowledge [2]. This is crucial in higher education, where the use of master classes and expository lectures is frequently overused, and methods or events that directly involve students are few and far between [3]. Faced with this scenario, teachers must adopt cutting-edge teaching-learning practices, use technology to promote education,

and implement innovative strategies to put students at the center of the teaching-learning process [4].

Gamification is a modern educational strategy that satisfies students' evolving learning needs. Gamification is the use of game techniques and models in non-game contexts to avoid students' distraction and change their behavior by creating a fun environment that encourages engagement and enjoyment [5]. Students' attention and loyalty might be attracted when gamification is used in the classroom since they are aware of a mechanism that makes it easier for them to understand the academic topics covered in class [6]. Gamification has gained popularity in the teaching-learning process recently, largely due to its ability to affect students' behavior and attitudes [7], engage them in their studies [8], make them protagonists of their academic training by engaging them in enjoyable activities that promote meaningful learning [9], and boost their motivation and self-esteem [10].

Digital badges are a type of gamification technique that has been increasingly applied in recent years [11]. Digital badges are irreplaceable tokens utilized for the purpose of documenting or certifying accomplishments in the academic world or any other field. In addition to serving as evidence of accomplishment, digital badges hold significance in higher education as effective motivators for students and learners at large, inspiring them to actively pursue specific objectives and develop well-defined competencies [12]. In this regard, digital badges can be seamlessly incorporated into learning management systems, operating as a component of informal learning efforts. Digital badges have the potential to promote active participation of students, recognize achievement, and enhance visibility [13].

Several recent investigations have reported the benefits of employing digital badges in the classroom [14–20]. However, there are still some challenges to resolve with respect to this type of implementation. The effective student involvement depends largely on the design and implementation of learning activities that provide digital badges as incentives. In other words, the context of application is very relevant since it may introduce variations in cultural, social, and economic factors, which requires an exhaustive analysis. Also, it is important to

contemplate the different academic levels and evaluate the impact of academic content on the adoption of innovative educational approaches [21].

Considering the above, this study evaluates the impact of educational gamification on the teaching-learning process by using digital badges as a part of the accredited learning system. The research includes 150 undergraduate students who were participants in the database workshop course of the second semester of the bachelor's degree educational program in Business Relations. Subsequent sections of this document provide a full description of the structure and characteristics of the implemented digital badges system. The obtained results were examined using both objective and subjective metrics. An important aspect in the teaching-learning process is the degree to which students acquire knowledge and skills, which is evidenced by the performance of their evaluations. Consequently, academic outcomes, such as dropout rates and grades earned during the course, are examined as objective metrics. To assess the students' perspectives on their learning experience and identify the aspects they consider valuable; we conducted an analysis utilizing an online questionnaire. The questionnaire was structured into three dimensions, with items evaluated by applying a Likert scale. The reliability of the instrument was proven through the calculation of Cronbach's alpha coefficient. The results indicate that the students held a favorable perception of the utilization of digital badges to enhance the teaching-learning process.

## II. BACKGROUND

Typically, we are familiar with awarding insignia such as medals, banners, and stars to individuals to display or recognize their accomplishments, ranks, or merits in a particular skill. In recent years, there has been a notable emergence of organizations using digital platforms to issue and allocate digital badges to acknowledge the attainment of specific skills or accomplishments.

Digital badges are visual elements in electronic format, such as photos, or icons, that serve as representations of achievements or goals. These badges may also include information that facilitates the acknowledgment of the accomplishment [22]. In the realm of education, the incorporation of digital badges has emerged as an innovative approach to acknowledge and validate accomplishments and expertise. Digital badges operate as a system of incentives granted to students upon the attainment of specific objectives or completion of training activities. In other words, digital badges serve as tangible representations of performance levels, talents, or knowledge that substantiate an individual's active engagement in each task [23].

Digital badges have the potential to serve as motivational incentives that guide students' actions to certain objectives. Typically, digital badges include three main components: a picture, metadata containing relevant information, and a web page that serves as a repository for the evidence, criteria, and issuer's information [24]. The metadata of digital badges is considered the most significant aspect, as it contributes to their overall value.

This metadata encompasses many details, such as the entity responsible for awarding the badge, the recipient of the badge, the date of acquisition, and the specific criteria that were fulfilled to receive it [25]. In addition to its intrinsic worth, the aesthetic depiction of the badge aims to captivate the student. This image should serve the purpose of conveying pertinent information pertaining to the specific region or subject matter being discussed, as well as providing details about the institution, the level of training, or a full description of the insignia.

Digital badges can serve functions such as the recognition, evaluation, and motivation of learning (Fig. 1). One benefit of digital badges is their ability to accredit informal learning [26]. Regarding evaluation, digital badges benefit summative evaluation by verifying the occurrence of learning, formative evaluation by finding improvement areas, and transformation evaluation by encouraging changes to the student's identity [27]. Moreover, digital badges can enhance students' interest in specific topics and guide them in completing academic activities, assisting them to recognize the necessary processes to achieve learning objectives.

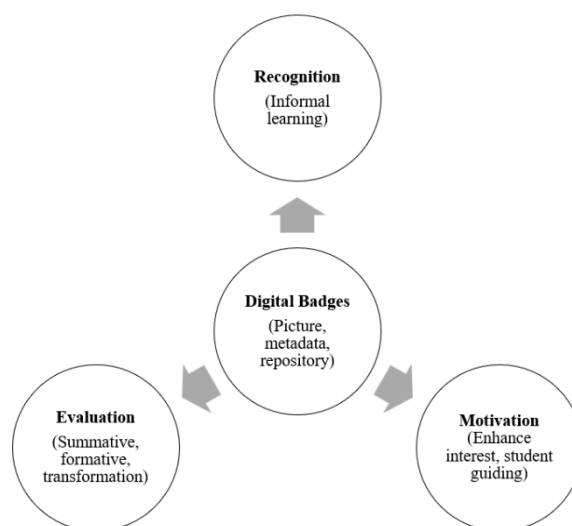


Fig. 1. Digital badges main elements and functions.

However, it is important to recognize that there is currently a lack of clarity regarding the real impact of digital badges on student motivation [28]. To explain the functioning of digital badges, we can turn to the theory of motivational goals, which proposes three orientations that can be found in any educational situation: Outcome, avoidance, and learning orientation [29]. Current research shows that, within the same orientation, different goals can be in play simultaneously. It is assumed that, for the learner to seek to achieve a given badge, the reward associated with the badge must align with the learner's motivational orientation; otherwise, there is a low probability that the learner will make efforts to achieve any digital badge.

The functioning of digital badges can also be explained from behavioral learning; from operant conditioning [30]; this consists of the contingent presentation of a stimulus to a certain response, generating an increase in the occurrence of this behavior. Precisely, one of the techniques derived

from this learning principle is the token economy. In this technique, tokens are only a set of neutral stimuli that, when presented repeatedly and contingently to the reinforcing stimulus, become reinforcing entities in themselves.

### III. METHODOLOGY

This section describes how the experience was carried out, the research methodology used as well as the methods used for data analysis and resource design.

#### A. Context and Sample of Study

This research evaluates the academic results obtained in the database workshop course of the second semester of the bachelor's degree learning program in Business Relations, at the Instituto Politecnico Nacional (IPN) in Mexico City. The study involved four groups of students, which were divided into two sets. Two of them did not have gamification methods applied into their lessons (control group), while the other two groups had digital badges integrated as part of their learning approval system. The assessed data ranges between the years 2021 and 2022. It is important to note that no modifications were made to the study plans of the subject over the research time. In this way, the learning subjects remained consistent in the implementation of both techniques.

The overall sample size comprises of a total of  $N = 150$  students. The provided sample is partitioned into two distinct data sets. The initial set  $G1 = 75$  represents the control group, whereas the subsequent set  $G2 = 75$  concerns to the students that incorporate gamification through the utilization of digital badges in their learning activities. The allocation of students to both groups was conducted using a pairing technique [31], which aims to set equivalence between the groups based on a specified variable. In this case, the independent variable employed for student matching was the degree of overall academic performance during their initial semester of enrollment. Specifically, students were selected based on achieving a score exceeding 8 on a 10-point scale. In relation to the control group, a total of 49 male and 26 female students were involved, whereas the experimental group consisted of 45 male participants and 30 female participants (Table I).

TABLE I. PARTICIPANTS IN THE SAMPLE ( $N = 150$ )

Group	Gender			Average academic performance
	Male	Female	Total	
G1	49	26	75	8.71
G2	45	30	75	8.54

#### B. Design of the Investigation

The scope of the present study is explanatory, while the design utilized was quasi-experimental, with a post-test and control group. The levels of the dependent variables in both groups are so tested after the independent factors have been altered.

#### C. Data Collection

The evaluation of the study's findings encompasses both objective and subjective metrics. In relation to the

pursuit of objective measurement, two variables have been established: 1) The Non-dropout Rate (NDR) refers to the proportion of students who persist in a course from its commencement to its completion. It is quantified by dividing the number of students who take the final examination of the subject by the initial enrollment count, and 2) The Average Grade (AGR) in each scholar period that is obtained by considering students who take the final exam, regardless of whether they pass the course or not.

Regarding the subjective metrics, we use an electronic questionnaire applied to students at the conclusion of each academic year to determine their assessment of the teaching and learning experience. The instrument is divided into three sections, each containing two questions, with the objective of assessing the students' perceived levels of satisfaction, motivation, and utility. Each item in the survey has a rating system ranging from 5 to 10, where 5 is the minimum level of evaluation and 10 represents the maximum level. Table II presents the elements comprising the evaluation instrument proposed for this study.

TABLE II. VARIABLES OF THE DATA COLLECTION INSTRUMENT





Variable	Question ID	Description
Satisfaction	S1	In terms of how was evaluated, the course was:
	S2	In terms of the assistance obtained, the course was:
Motivation	M1	In terms of the learning guidance, the course was:
	M2	In terms of my own learning motivation, the course was:
Utility	U1	In terms of conceptual comprehension, the course was:
	U2	In terms of intellectual challenge, the course was:

#### D. Procedure

Initially, the method for awarding badges within the course was designed, followed by its configuration within Canvas LMS with the Badge program. The selection of the student sample was facilitated using data provided by the scholar department of the bachelor's degree program in Business Relations. This course was selected because of its notable consistency in terms of student attendance when compared to other courses. The students were thereafter assigned to both the control group and the experimental group through random pairing, taking into consideration their average achievement attained in the first semester.

The research evaluates data obtained from two academic periods between 2020 and 2021, with an average duration of 20 weeks each. During each academic term, the subject matter was instructed into two distinct groups, so establishing a control group and an experimental group for each period. It is important to note that during the course development process, data associated with students' activity inside the LMS was collected in a centralized manner, facilitated by the technical assistance provided by the institution's personnel. The teacher follows a set of criteria pertaining to the utilization of the LMS for all groups. These guidelines included the dissemination of notices, monitoring of students, and a forum for requests.

TABLE III. WEEKLY ACTIVITIES AND DIGITAL BADGE DISTRIBUTION

Academic period	Learning topics	Digital badge designation
Term 1 (Weeks 1–4)	1. Database Basics and Design	 <b>PRINCIPIANTE</b> TALLER DE BASE DE DATOS
	1.1 Basic concepts	
	1.2 Relational database design	
	1.3 Database objects	
Term 2 (Weeks 5–7)	1.4 Design process	 <b>INTERMEDIO</b> TALLER DE BASE DE DATOS
	2. Database Utilities in Excel	
	2.1 Excel Basics	
	2.2 Excel formulas	
Term 3 (Weeks 8–14)	2.3 Excel data tables	 <b>AVANZADO</b> TALLER DE BASE DE DATOS
	2.4 Graphic presentation of data	
	3. Data analysis in Excel	
	3.1 Advanced functions in Excel	
Term 4 (Weeks 15–20)	3.2 Additional functions in Excel	 <b>EXPERTO</b> TALLER DE BASE DE DATOS
	3.3 Pivot tables and charts in Excel	
	3.4 Macros in Excel	
	4. Databases in Access	
	4.1 Creation and modification of databases	
	4.2 Records, tables, and forms	
	4.3 Reports and queries	
	4.4 Data import and export	

In courses that incorporated the use of digital badges, upon meeting the commanded criteria, students were granted a digital badge that could be accessed within the LMS. Each of the digital badges required the completion of all activities and evaluations relating to the themes linked with a learning unit, as outlined in Table III. Upon receiving a digital badge, the system granted users the ability to get started on the activities of the subsequent learning unit to attain the subsequent digital badge.

The teacher published announcements to students through the LMS, including a congratulatory message to students who achieved any of the badges and a reminder of those badges pending to be obtained.

#### IV. RESULTS AND DISCUSSION

The percentage of students who finish the course is defined as the Non-dropout Rate (NDR), which is given by dividing the number of students who take the final test by the total number of students who enrolled in the course. It should be kept in mind that during the first six weeks of the course, students have the chance to drop or withdraw from any subjects they feel are not convenient for them.

In the past, it has been observed that students often choose to drop out of subjects to relieve heavy academic workload, or when they lack enthusiasm or do not observe significant challenges in their learning experience. The difference in the Non-dropout Rate (NDR) between the two study groups is minimal, nevertheless, it indicates a positive advancement of G2 in comparison to G1 (Fig. 3). In the year 2021, a non-dropout rate of 92% was documented for G1, indicating that only three students were absent from the final examination of the subject.

During the same period, it was seen that two students from G2 decided to discontinue their participation in the subject, resulting in a dropout rate of 95% for this group. In contrast, there existed a disparity of four percentage

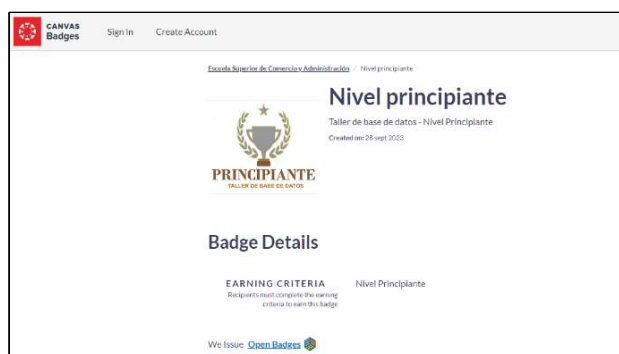


Fig. 2. Configuration of digital badges within LMS Canvas.

The acquisition of the whole digital badges serves as a means of verifying that the student has successfully fulfilled all the evaluations of each module, thereby indicating their comprehensive mastery of the topics included within the study plan. In Fig. 2, we can see an example of a digital badge within the LMS platform.

points in the year 2022, as seen by the respective dropout rates of 94% and 98% for G1 and G2.

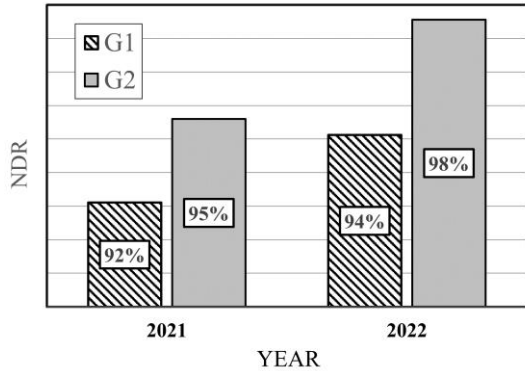


Fig. 3. Non-dropout Rate (NDR) for the years 2021–2022

Then, the average of the grades of each academic period is calculated. This data can be utilized to determine the level of knowledge acquired by students. Fig. 4 shows the results of the average grades during each academic period (AGR). In this figure, we can observe that the results for G1 and G2 in 2021 are very similar, while the differences become more noticeable in 2022. It is important to know that grade point averages cover the performance of all students, including those who do not complete the course. To assess the students’ perception of the teaching-learning process, it is needed to compare the outcomes of both groups by analyzing the responses to the questionnaire applied to the students upon completion of the course.

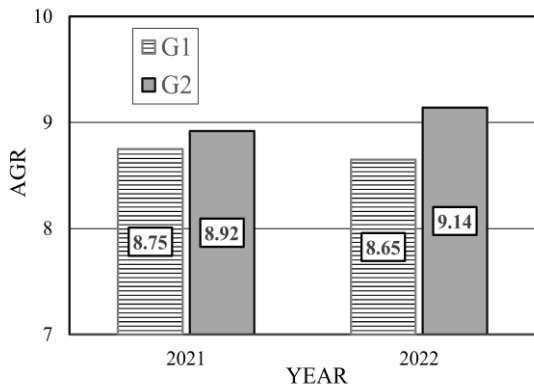


Fig. 4. Grade Average (AGR) for the years 2021–2022.

It should be highlighted that the questionnaire defines the answers to each aspect that is relevant to the students, but it does not directly establish the value of the research variables. For example, the questionnaire returns the answers to the S1 and S2 questions, but they must be merged to calculate the SATISFACTION variable.

$$\bar{X}_c = \frac{n_1\bar{X}_1 + n_2\bar{X}_2}{n_1 + n_2}, \tag{1}$$

where  $n_1$  and  $n_2$  are the total number of samples in the first and second populations, respectively. The outcome denoted as  $\bar{X}_c$  corresponds to the average value found by combining the means of both groups. Eq. (2) denotes the procedure that is used in the case of standard deviation:

$$Sd_c = \sqrt{\frac{Q_c - (n_1 + n_2) \times \bar{X}_c^2}{n_1 + n_2 - 1}}, \tag{2}$$

The variable  $\bar{X}_c$  denotes the aggregate mean obtained by utilizing Eq. (1), while  $Q_c$  denotes the cumulative sampling variations used to compute the standard deviation ( $Sd_c$ ) of combined samples. The calculation of  $Q_c$  is as follows:

$$Q_c = Q_1 + Q_2$$

$$Q_i = (n_i - 1) \times (Sd_i)^2 + n_i \times \bar{X}_i^2. \tag{3}$$

In this context,  $n_i$  denotes the overall sample size,  $\bar{X}_i$  denotes the mean, and  $Sd_i$  denotes the standard deviation of population  $i$ . After merging the mean and standard deviation values of two questions, these values correspond to a research variable.

TABLE IV. RESULTS OF EACH STUDY GROUP

Variable	Total	M	S
<b>G1</b>			
Satisfaction	75	8.967	0.802
Motivation		9.012	1.214
Utility		9.122	1.003
<b>G2</b>			
Satisfaction	75	9.441	0.421
Motivation		9.872	0.379
Utility		9.389	0.732

The results are depicted in Table IV, where the values of each variable for each study group can be observed. In this case, the mean (M) and standard deviation (S) of the students’ opinions are consolidated. According to the data in Table IV, it can be observed that G2 shows significantly superior outcomes across the three research variables in comparison to G1. The variable exhibiting the most substantial disparity in this analysis is motivation. The difference in motivation resulting from the implementation of gamification methods is significant when comparing the respective values of both variables. Although both study groups studied the same thematic material, the inclusion of digital badges resulted in increased levels of student motivation. This data displays a potential correlation between motivation and academic outcomes, specifically to NDR and AGR. It suggests that higher motivation can lead to improved learning outcomes.

With respect to the variable utility, the results suggest that students possess a comprehension of the significance of employing educational tools in their academic pursuits. The implementation of gamification strategies enables students to enhance their knowledge retention by engaging in a state of flow facilitated by gamification tools. The variable utility exhibits the least difference between G1 and G2, compared to the other research variables.

Regarding the research variable of satisfaction, this variable serves as an indicator of the level of well-being that students perceive in relation to their academic expectations at the beginning of the course. In this case, the findings indicate that the application of gamification activities has a favorable effect on students’ compliance to

the course expectations, as evidenced by the fact that G2 achieved higher results than G1.

The collected data of each research variable were subjected to statistical analysis using the student's t-test. This was done to formalize the research findings and ascertain the presence of statistically significant differences. The student's t-test is employed as a statistical tool for assessing the average value of one or two groups via hypothesis testing. The value derived from this test conceptually indicates the difference in means between the two groups being assessed, measured in standard units. When doing the calculation for the student's t-test, it is assumed that the data being analyzed is continuous, exhibits homogeneity of variance, and follows a normal distribution. The statistical significance threshold used for conducting the student's t-test was  $p < 0.05$ . This analysis was performed using the Minitab® version 21.3 software designed for the Windows® operating system.

TABLE V. RESULTS OF THE STUDENT'S TEST

Variable	gl	t	p
Satisfaction	148	4.53	0.002
Motivation	148	5.85	0.001
Utility	148	1.86	0.032

The results of the student's t-test are presented in Table V. We can observe that there is a statistically significant distinction among all the research variables, as the initial criterion of  $p < 0.05$  is satisfied in each instance.

## V. CONCLUSION

Innovation in higher education implies an improvement in the teaching-learning process through promoting very positive changes in academic resources, didactics, and procedures. The objective is to promote the utilization of enhanced academic resources, so that they may perceive that their value expectations are fulfilled. In this context, we examine the impact of gamification techniques in the classroom as part of educational innovation in the database workshop subject of the Bachelor of Business Relations educational career at the Instituto Politecnico Nacional.

Digital badges are progressively gaining recognition and esteem among prestigious educational institutions, thereby establishing themselves as a means for accrediting learning experiences while also ensuring their assessment. The results of this study indicate that using digital badges has a positive impact on the average grades received by students, indicating a higher degree of accomplishment and acquired skills. In relation to learning objectives, the study reveals that students seemed to have exhibited a strong inclination towards acquiring new knowledge. Furthermore, the prospect of earning badges seemed to act as a motivating factor, hence establishing task completion as a formidable undertaking.

Also, this research reveals that students consider the teaching-learning process enhanced by the implementation of gamification methods as a more motivating and useful model that aligns more effectively with their expectations. Students hold a favorable perception of their learning

experience and experiment higher levels of satisfaction in the context of this sort of educational setting.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## AUTHOR CONTRIBUTIONS

Lydia Velázquez-García led the execution of the entire research project and wrote the first version of the paper; María D. P. Longar-Blanco conducted the research and was involved in collecting and managing the data; Eduardo Bustos-Farias accomplish the data analysis, contributed some ideas and a section on the manuscript, and complete the review process; Antonio Cedillo-Hernandez directed the research orientation, supervise the learning outcomes and finalized the paper as to the required format. All authors had approved the final version.

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