Gamification and ubiquitous learning in higher education: applying learning styles

Gamificación y aprendizaje ubicuo en la educación superior: aplicando estilos de aprendizaje

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Keywords
Distance education; higher education; team teaching; teaching method; learning method

ABSTRACT

Education has gained increasing importance in the current context. Both teachers and students face difficulties due to the lack of knowledge in the use of technological tools and good practices of this type of learning. With the aim of improving academic performance and motivation in the learning process, an investigation was carried out to evaluate the effectiveness of gamification and ubiquitous learning in higher education, taking into account the learning styles of students. The methodology used was Design-Based Research, using a quantitative approach and a convenience sample made up of several faculties of the Autonomous University of Queretaro, Mexico. Likert scale surveys were conducted before and after implementing gamification and ubiquitous learning practices. Subsequently, an analysis was performed using the T test for paired samples. The results showed a significant difference before and after the implementation of these practices, which supports the idea that students improved their academic performance and motivation in the teachinglearning process. The research concluded that the effectiveness of gamification and ubiquitous learning in higher education was due to the fact that a predominant learning style was considered in each group, thereby enabling the formulation of strategies to enhance students' academic performance and motivation in the learning process.

Palabras clave
Educación a distancia; enseñanza superior; enseñanza en equipo; método de enseñanza; método de aprendizaje

RESUMEN

La educación ha adquirido una importancia creciente en el contexto actual. Tanto los docentes como los estudiantes enfrentan dificultades por la falta de conocimiento en el uso de herramientas tecnológicas y en la aplicación de buenas prácticas con este tipo de aprendizaje. Con el objetivo de mejorar el rendimiento académico y la motivación en el aprendizaje, se evaluó la efectividad de la gamificación y el aprendizaje ubicuo en la educación superior, considerando los estilos de aprendizaje de los estudiantes. Se utilizó la investigación basada en el diseño como metodología, con un enfoque cuantitativo y una muestra por conveniencia conformada por varias facultades de la Universidad Autónoma de Querétaro, México. Se aplicaron encuestas con escala Likert antes y después de implementar las prácticas de gamificación y aprendizaje ubicuo. Posteriormente, se realizó un análisis con el uso de la prueba T para muestras pareadas. Se encontró una diferencia significativa antes y después de la implementación de estas prácticas, lo cual confirma que los estudiantes mejoraron su rendimiento académico y motivación en el proceso de enseñanza-aprendizaje. La investigación concluyó que la efectividad de la gamificación y el aprendizaje ubicuo en la educación superior se debió a que en cada grupo se consideró un estilo de aprendizaje predominante y se plantearon las estrategias para mejorar el rendimiento académico y la motivación en el proceso de aprendizaje de los estudiantes.

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INTRODUCTION

Both virtual and face-to-face education have become increasingly relevant in the current context; however, teachers and students face difficulties due to their lack of knowledge of technological tools and good practices. One of the alternatives that has emerged to face this problem is ubiquitous learning or u-learning, which can be carried out anywhere and at any time, allowing learning to be a different experience. In this way, time and space are not obstacles for students, since the teacher acts as a facilitator of learning at any time and place (Burbules, 2014).

Currently, some education centers have opted to migrate to the digital world with the use of mobile devices both in the classroom and at home. Various studies indicate that the use of smartphones, tablets and other touchscreen technologies provide physical interaction and contingent feedback, which promotes learning. In this way, students can transfer learning from the games or applications they use inside the classroom to a real context (Pila *et al.*, 2022).

The above leads to consider that today the conventional teaching-learning process is influenced by mobile devices and educational technologies, which can enhance education through a model, as well as novel rules, strategies and tools for students to learn anywhere and anytime (Amez *et al.*, 2022).

BACKGROUND

Ubiquitous learning has been made possible by the emergence of new pervasive technologies, i.e., they have been integrated into our environment with greater intensity. This favors continuous access to information and the creation of relational and social structures, allowing continuity between physical and virtual spaces. It is important to highlight that ubiquitous learning modifies the paradigm of traditional learning in the classroom, since new knowledge is constantly being built due to all available resources, such as the internet, social networks, mobile devices, among others (IETIC-EVEA Research Group, 2014).

Ubiquitous learning is related to the culture of participation in the educational environment, referring to the support provided to students to collaborate and create together. This culture encourages problem solving, task completion, and knowledge acquisition through the contribution of all team members, where the importance of all contributions is recognized, as each member experiences a social connection with others (Cruz & Garay, 2019).

Digital literacy is fundamental in today's society due to the omnipresence of information and communication technologies (ICT). There are two important strands to this issue. The first is technical literacy, which focuses on developing basic skills to improve the use of ICTs (Maruri-Orellana *et al.*, 2021). This concept focuses on teaching people how to use different digital tools, such as office software, social networks and e-mail. The second strand is critical literacy, which seeks not only to teach basic technical skills, but also to encourage reflection on the use of ICTs and their application in the personal and collective development of students (Salado *et al.*, 2019).

The use of technologies plays an essential role in today's education, because students show more interest in learning and are more motivated when using technological tools. This in turn leads to increased concentration and focus in the learning process. Through gamification, the teaching process becomes more attractive, autonomous, stimulating and effective, resulting in a positive experience for students when acquiring knowledge (Medel-San Elías and Moreno-Beltrán, 2021).

The concept of gamification has recently emerged with the purpose of employing game elements to transform educational content and make it more motivating for students. Gamification not only seeks to generate fun, but also to establish a connection with the needs generated in the people involved at that moment (Revuelta-Domínguez *et al.*, 2022).

Gamification is carried out by using games based on rules, where its dynamics or mechanics depend on the purpose at the time of teaching, which makes the objectives are diverse, such as improving concentration or seeking the implementation of specific skills to generate knowledge (Medel-San Elías *et al.*, 2022).

Because of the implementation of numerous practices in educational environments to increase motivation and encourage student participation, gamification has found application in almost all stages of education in recent years. This methodology gives real value to the personal development of individuals in a fun way by incorporating elements such as emotions, progress, game mechanics, rewards, feedback and challenges (González-Fernández *et al.*, 2022).

According to a study by Morschheuser and Hamari (2019), gamification has been shown to improve students' academic performance and increase their interest and engagement in learning. Likewise, research by Londoño *et al.* (2020) found that this learning technique can also improve problem-solving skills and creativity among students.

To talk about learning styles, the Honey and Mumford model (based on Kolb's questionnaires) will be used, where learning is considered as a circular process divided into four stages, highlighting the importance of

learning through experience; however, this model seeks to detail the descriptions of learning styles and base them on the action of the subjects. Based on the description made by Honey and Mumford, Alonso *et al*. (2016) created the Honey-Alonso questionnaire of learning styles (CHAEA), which consists of 80 items and considers only four learning styles: active, reflective, theoretical and pragmatic (Olivo, 2020).

Learning styles have contributed to the students' improved academic performance, since teachers have a clearer idea of the specific strategies they can apply within the classroom (Román & Ruiz, 2018). It should be noted that the success of the use of the virtual modality along with learning styles lies in correctly choosing the media and resources to be used for the delivery of classes within the classroom (Prado-Bailón and Corral-Joza, 2021).

The objective of this research was to evaluate the effectiveness of gamification and ubiquitous learning in higher education by considering students' learning styles to improve academic performance and motivation in the learning process. The research hypothesis was: if the effectiveness of gamification and ubiquitous learning in higher education is evaluated by considering students' learning styles, then academic performance and motivation in the learning process will be improved.

DESIGN AND METHODOLOGY

A convenience sample of 103 students from different faculties of the Escuela de Bachilleres of the Universidad Autónoma de Querétaro, Mexico, was used. The sample was distributed as follows: seven undergraduate students in the area of Networks from the Faculty of Computer Science, fourteen undergraduate students in the basic area from the Faculty of Political and Social Sciences, and 82 second semester high school students from the Escuela de Bachilleres Plantel Norte, divided into two groups of 40 and 42 students respectively, who were taking the subject of Computer Science II. The following criteria were taken into account for the selection of the participants: to be an active student of the Universidad Autónoma de Querétaro during semester 2022-2, to be enrolled in the subject assigned to the professor for that academic period, to be taking said subject for the first time according to the corresponding faculty or high school, and to use mobile devices both for educational purposes and in their daily lives.

The methodology applied was design-based research (DBR), since the objective was to analyze specific problems in the educational and technological field. This methodology offers the possibility of obtaining feasible solutions that allow the researcher to test and refine learning

environments and obtain an innovative design (Valverde-Berrocoso *et al.*, 2020; De Benito and Salinas, 2016).

In conjunction with the IBD, a quantitative approach was used to guarantee the rigor of the research, avoid omitting some steps and ensure consistency throughout the stages of the study. It should be noted that, although it is possible to redefine the processes between the different phases, the quantitative approach usually begins with the formulation of general ideas that are then broken down into more specific aspects. Figure 1 shows the combination of the quantitative approach with the IBD methodology.

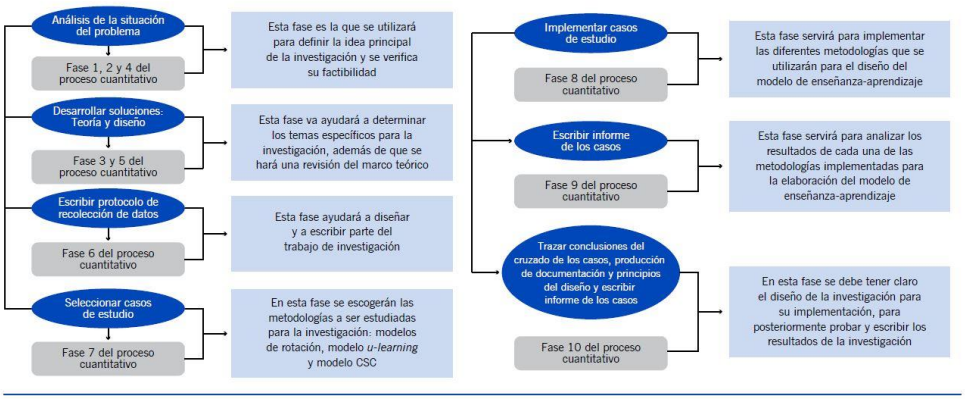

Figure 1. Research methodology

Instruments

To obtain the results of this research, Likert-type surveys were conducted before and after implementing gamification and ubiquitous learning practices. The questionnaires consisted of 30 questions divided into two main categories: ubiquitous learning and gamification. The ubiquitous learning category considered items such as spatial ubiquity, portability, interconnectedness, cross-curricular ubiquity, temporality and globalized knowledge. The gamification category included elements such as dynamics, mechanics and game components. Cronbach's Alpha coefficient was used to validate these instruments, as it is a simple way to measure the internal consistency of a unidimensional instrument (Oviedo and Campo-Arias, 2005).

An analysis was performed using the paired samples t-test to assess the significance of student learning. Since the previous surveys did not directly assess the improvement in learning, it was decided to administer a test before and after the implementation of the ubiquitous learning and gamification practices. This allowed having two variables in the study: one

before and one after, which is necessary to perform the statistical test and measure the impact of the elements applied in the research.

The Honey-Alonso questionnaire for learning styles (CHAEA) was used to measure the variable, 1 with which the predominant learning style for each sample group was identified both individually and as a group. In this way, relevant strategies were applied to improve students' motivation and learning in the classroom, regardless of whether they were in a virtual or face-to-face environment.

In addition, a methodology was developed that consisted of three fundamental phases: in the first, the objective was for the teacher to identify the predominant learning style in each sample group; in the second, the aim was to determine the most appropriate gamification tools for the predominant learning style in each group; finally, in the third phase, all the content was transformed into material accessible at any time and place, in order to comply with the principle of ubiquitous learning. In this way, we sought to ensure that the educational resources were available in a flexible manner and could be adapted to the learning time of each student.

During the first phase, the CHAEA questionnaire was applied, which comprises four learning styles: the first is the active style, in which the student seeks to learn through practical experience; in contrast, the second style is the reflective, where the main objective is reflection and critical analysis; the third style is the theoretical, which focuses on generalization and the development of hypotheses from abstract concepts; finally, the pragmatic style focuses on the application of knowledge in real and practical situations (Rodriguez, 2018).

The CHAEA is a tool consisting of 80 questions, 20 for each of the four learning styles. These are answered using an agree or disagree scale. To identify the learning style of each individual, the questions are grouped into blocks: block I corresponds to active learning, block II to reflective, block III to theoretical and block IV to pragmatic (Alonso *et al.*, 2016).

To obtain the scores for each block, the Abbreviated General Scale of Learning Style Preferences is used, which provides a clear guide on the scores to be considered to determine an individual's learning style and, subsequently, to evaluate it. This simplified scale facilitates the analysis and interpretation of the results, allowing individuals to more accurately understand their predominant learning style and adjust their learning process to make the most of their strengths. In short, the use of this scale contributes to a better understanding and adaptation of the personalized learning approach.

The interpretation of the CHAEA involves considering the relativity of the scores for each learning style. According to the recommendations of

Alonso *et al.* (2016), the scores have been grouped into categories based on the percentage of the assessed population. A very high preference is assigned when the score is in the top 10%, a high preference in the top 20%, a moderate preference in the middle 40%, a low preference in the bottom 20%, and a very low preference in the bottom 10%.

Once the predominant learning style of the group of students was identified, the most appropriate learning strategies were designed for them. These were divided into three distinct moments: the first consisted of understanding the task at hand; the second focused on defining the capabilities, attitudes and interests of the students; and the last focused on determining the strategy approach. Consequently, the following learning strategies were proposed during the class sessions, with the aim of optimizing the learning process of the students of the Faculty of Computer Science.

First, it was considered that the students' attention decreases after approximately 45 minutes of theory, therefore, it was sought that the theoretical explanation did not exceed this time. Subsequently, a guided practice was carried out using the Packet Tracer simulation software, selected for its specific characteristics in the field of networks. This allowed the students to experience in a practical way the concepts learned during the session. The practice not only provided them with a more meaningful and concrete experience, but also allowed them to perform tasks and keep track of their progress and learning.

The Quizizz tool was also used, which offers the possibility of competition among students to determine who is the best. One of the features of this application is that it provides the opportunity to answer a question again if it has been answered incorrectly. In addition, it awards achievement badges to the first three places, thus providing the main elements of a gamified environment: dynamics, mechanics and components.

The learning strategies implemented in the Political and Social Sciences group were similar to those used in the previous group. The first consisted of combining theory and practice in the classroom through the resolution of exercises during the classes.

At the same time, practical exercises were used as part of the summative evaluations, with the objective of providing immediate feedback to the students. For the partial evaluations, students were asked to apply the topics studied in class to solve real problems. This was intended to foster a deeper understanding of the concepts, enable students to make rational decisions and defend their arguments. Finally, we sought to present the project in an attractive way so that students would find motivation in its development.

To gamify the learning process in this group, the Educaplay platform was used. This web tool offers the possibility of creating various activities and scenarios that allow students to reinforce their knowledge. In this case, the platform facilitated the creation of activities that fostered competition among students by presenting challenges at the end of each class. As a reward for the winning students, they were awarded everything from extra tenths in their grades to exemptions in the time for handing in homework.

At the Escuela de Bachilleres, students were asked to complete a project: to create a web page with applicability in a real-world context. The objective was for them to understand the usefulness of creating and selling a web page to a specific audience, thus promoting a reflective learning style.

For the evaluation, a section was included in which students received comments and perspectives from both their peers and the teacher; the purpose of this constructive criticism was to improve the students' work and foster their growth through constructive feedback.

In addition to in-class activities, the integration of digital platforms such as Classkick and Kahoot provided students with the opportunity to interact with the content in a dynamic and enriching way. For example, using Classkick, students completed online activities and received immediate feedback from the teacher, which allowed them to improve their understanding of the material and correct errors instantly.

Kahoot, on the other hand, provided a more playful experience by allowing students to compete in quiz games. This not only increased their motivation to learn, but also helped them to consolidate the knowledge acquired in a fun and enjoyable way.

Table 1 shows the types of learning, their main characteristics, the activities that best suit each style and which platform is best suited to each type of learning.

In this way, we sought to ensure that the platforms used were the right ones for each learning style and would enhance student learning.

Table 1. Platforms for each type of learning

Learning type	Characteristics	Activities	Platforms
Asset	• Animator • Improviser • Discoverer • Risky • Spontaneous	• Activities must present a challenge • Short activities with immediate results • Competition between group members (emotion, drama and crisis)	Kahoot Quizizz
Thoughtful	• Observer • Responsive • Analytical • Exhaustive • Retailer	• Observer posture • Activities must offer an analysis of the situation • Activities where the objective is to think before acting	Classkick
Pragmatic	• Experimenter • Practical • Straight • Effective • Realistic	• Activities that relate theory and practice • Team activities • Immediate activities after the topic studied	Quizizz Educaplay
Theoretical	• Methodical • Logical • Critical • Structured • Aim	• Activities must present a challenge • Students must have the opportunity to ask questions and inquire in the activities	Educaplay Classkick

RESULTS

As previously mentioned, two Likert-type scale instruments were used, one before implementing the gamification and ubiquitous learning practices, and the other after their implementation. The results obtained for the reliability of these instruments showed a Cronbach's Alpha coefficient of 0.890 for the first instrument and 0.834 for the second. These values indicate that the instruments are reliable and allow obtaining accurate and consistent results.

The data from the first instrument show that the practices and customs of each academic unit vary, indicating that some faculties can adapt more easily to digital platforms than others. Regarding ubiquitous learning, in the Faculty of Computer Science students expressed a clear dissatisfaction with the contents displayed on digital platforms, while in the rest a neutral or satisfied opinion predominated. Regarding the use of digital tools and mobile devices as academic support, students in all faculties expressed general satisfaction; however, when consulted about the effectiveness of these strategies, in all faculties the response was negative.

In relation to the gamification variable, it was observed that students from the Faculty of Computer Science showed a preference for games that included rewards, rankings and categories, as well as achievement through complex challenges. Students from the School of Political and Social Sciences seemed to opt for games that encouraged collaboration and communication among players, and the resolution of complex challenges. As for the students from the Bachelor's School, they mostly presented a preference for winning over their peers in order to obtain rewards or be recognized among other students.

In the instrument applied after the gamification and ubiquitous learning practices, the following results were obtained: when analyzing the ubiquitous learning category, it was observed that in all the groups to which the previously explained methodology was applied, there was an improvement in the assimilation of the contents presented in the digital platforms, which allowed students to obtain their knowledge asynchronously. In addition, the use of mobile devices and digital tools in the classroom increased in all groups.

According to the gamification variable, favorable satisfaction was obtained in all faculties at the time of developing games adapted to the learning styles of each of the groups studied. Likewise, the groups expressed satisfaction when participating in an environment that allowed them to apply their experiences and knowledge while learning different lessons. It was observed that the Escuela de Bachilleres was one of the groups that experienced a significant impact, since, being at a higher intermediate level, the classes adopted a different dynamic. This led to greater participation on the part of the students in the completion of their work

because they were motivated to obtain the rewards proposed for each lesson.

To determine the predominant learning style in each study group, the general scale was used as a reference, which is presented in Table 2. It should be noted that the scores used as reference values are identical for all groups, since their function is merely indicative.

Table 2. Abbreviated general scale

Learning style/preference	10% Very low	20% Low	40% Moderate	20% High	10% Very high
Asset	0-6	7-8	9-12	13-14	15-20
Thoughtful	0-10	11-13	14-17	18-19	20
Theoretical	0-6	7-9	10-13	14-15	16-20

Source: taken from Alonso *et al.* (2016).

It is important to note that each group is unique, so the individual scores of each student were categorized into groups according to the faculty to which they belonged. From these individual scores, percentage scores were calculated. The learning style was considered predominant when it presented a percentage equal to or higher than 50% and was placed in the columns of high or very high predominance.

All the results of the predominant learning styles for each study group divided by faculty are shown below.

The most common learning style among the Computer Science Faculty is active, as 60% of the individual scores are in the very high predominance of this style (see Table 3). Students with this learning style are committed, open to new situations and like to experiment without prejudice. They are enthusiastic, like to improvise, are willing to take risks, have a high daily activity and get bored with prolonged tasks that do not provide them with

knowledge. These students enjoy solving problems and testing their knowledge.

Table 3. Result of the Faculty of Informatics group

Style	Very low	Low	Moderate	High	Very high
Asset	0%	20%	20%	0%	60%
Thoughtful	20%	40%	20%	20%	0%
Theoretical	20%	0%	60%	20%	0%
Pragmatic	0%	0%	80%	20%	0%

The next group considered was the students enrolled in the Descriptive Statistics class at the School of Political and Social Sciences. As in the previous study, the general scale was used to obtain the results on the predominant style of this group (see Table 4).

Table 4. Results of the group from the Faculty of Political and Social Sciences

Style	Very low	Low	Moderate	High	Very high
Asset	12.5%	12.5%	37.5%	25%	12.5%
Thoughtful	0%	12.5%	75%	12.5%	0%
Theoretical	0%	12.5%	62.5%	25%	0%
Pragmatic	0%	0%	12.5%	75%	12.5%

The pragmatic learning style stands out in most of the students of the Faculty of Political and Social Sciences, with 75% of the scores corresponding to this category, which indicates a high predominance. These students have an orientation towards action and practical application of knowledge and prefer to learn through direct experience. They are practical, realistic and tend to put theoretical knowledge into practice immediately. The pragmatic style is beneficial for students interested in political and social sciences, as it allows them to quickly apply the concepts and theories they study and gain an in-depth understanding of them.

Finally, the group of students taking the Computer Science II class at the Escuela de Bachilleres was analyzed. Similarly, the scores of the general scale were taken as a reference to subsequently obtain the predominant score at the group level. Table 5 shows the percentage results.

No predominant learning style was found in this group of students, since none of the percentages obtained met the eligibility criteria. Although the reflective style is the most common, with 49% of the scores, it is considered a moderate preference and not predominant. The pragmatic style is closer to the criteria, with 45% of the scores, indicating that students prefer to acquire theoretical knowledge first and then apply it through experimentation.

Table 5. High School Results

Style	Very low	Low	Moderate	High	Very high
Asset	0%	0%	39%	32%	29%
Thoughtful	7%	32%	49%	13%	0%
Theoretical	0%	10%	42%	32%	16%
Pragmatic	0%	7%	32%	16%	45%

For the Escuela de Bachilleres it is normal that there is no predominant learning style and that there are only complementary percentages, since students are still in a transformation process where they take advantage of the best of each learning channel according to the type of information they are acquiring; however, it is possible to apply strategies to enhance those percentages that are higher, such as pragmatic learning (45%) and reflective learning (49%).

A paired samples t-test was used in each study group to evaluate the improvement in learning. Two tests were administered, before and after implementing gamification and ubiquitous learning practices, with fifteen questions each, through the Quizizz platform. The test reports were downloaded and analyzed with SPSS statistical software. In addition, normality tests (Kolmogorov- Smirnov and Shapiro-Wilk) were performed on the reports generated by the platform and all indicated a satisfactory normal distribution.

The first group to be analyzed was the Faculty of Computer Science, where the aim was to obtain a significance of less than 0.05, since a reliability level of 95% was being used for the sample used. The results obtained were satisfactory, since at the time of applying the T-test for paired samples it was found that the significance obtained was 0.00, which indicates that the average of the scores obtained in the second exam was significantly higher than in the first one, that is, the proposed methodology had a positive impact on the learning of the students of this faculty (see Figure 2).

Prueba de muestras emparejadas

		Diferencias emparejadas							
					95% de intervalo de confianza de la diferencia				
		Media	Desv. Desviación	Desv. Error promedio	Inferior	Superior	t	gl	Sig. (bilateral)
Par 1	CAL_1 - CAL_2	-17.28571	5.05682	1.91130	-21.96249	-12.60894	-9.044	6	.000

Figure 2. Significance of learning in the Faculty of Informatics

The second group evaluated was the Faculty of Political and Social Sciences. As in the Faculty of Computer Science, a significant difference was observed in the grades obtained by the students in the second exam. The significance obtained was .000, which confirms that the learning was significant and had a positive impact on the students' performance on the applied tests. This result demonstrated the effectiveness of the methodology in the group of students of the Faculty of Political and Social Sciences (see Figure 3).

Prueba de muestras emparejadas

		Diferencias emparejadas							
					95% de intervalo de confianza de la diferencia				
		Media	Desv. Desviación	Desv. Error promedio	Inferior	Superior	t	gl	Sig. (bilateral)
Par 1	Cal_ini - Cal_fin	-.81429	.31344	.08377	-.99526	-.63331	-9.721	13	.000

Figure 3. Significance of learning in the Faculty of Political and Social Sciences.

Finally, the groups corresponding to the Bachelor's School were analyzed, where the results obtained indicated a relevant statistical significance, which confirms that the students achieved significant learning through the proposed methodology, since the result obtained was .000. This result demonstrated the improvement in learning thanks to the gamified environment.

Prueba de muestras emparejadas

		Diferencias emparejadas							
					95% de intervalo de confianza de la diferencia				
		Media	Desv. Desviación	Desv. Error promedio	Inferior	Superior	t	gl	Sig. (bilateral)
Par 1	CAL_1BACH - CAL_2BACH	-15.03659	4.56353	.50396	-16.03930	-14.03387	-29.837	81	.000

Figure 4. Significance of learning at the Plantel Norte High School School

DISCUSSION

In order to carry out an adequate evaluation of the results obtained; it is essential to consider the limitations that arose during the present investigation. The main one was the small sample of students with whom we worked in each faculty or high school. A larger sample would have allowed a validation with a higher degree of accuracy and reliability of the effectiveness of the proposed methodology in terms of ubiquitous learning, gamification and learning styles. Therefore, it is important to recognize that the results obtained may not be generalizable to all student populations and that further research should be conducted to explore the effectiveness of this methodology with a larger sample of students.

What can be generalized is the process of identifying a predominant learning style in each group of students. This allows teachers to find the appropriate strategies to implement a gamified environment that fits the needs of their students.

It is important to consider the dynamics, mechanics and components of the game to be implemented. Regarding ubiquitous learning, this strategy can be used for students to learn in any environment, whether formal or informal.

The results show similarities with previous research that has focused on ubiquitous learning, such as the study by Aguas *et al.* (2023), who mention the relevant indicators to evaluate ubiquitous learning and achieve an improvement in student performance. On the contrary, a difference is noticed with the study by Vinagre (2017), which sought to determine the direct influence of a learning style on student performance, without finding it.

From the perspective of this research, it is considered that there is a particular influence, but not only through learning styles, as these are only one way in which students can develop their knowledge. Instead, this study presented additional features, such as the implementation of gamification and ubiquitous learning, which could have an impact on student performance.

Medel-San Elías *et al.* (2022) mention the importance of being able to gamify, at what times and for whom this content is suitable. In addition, their study is similar to the learning styles, since, although it does not handle a style to perform gamification, it does have a type of player to which certain characteristics are given in order to know which dynamics can be applied to each group of students.

Finally, the hypothesis raised at the beginning of this research is confirmed, since it was possible to evaluate the effectiveness of gamification and ubiquitous learning in higher education through the questionnaires conducted before and after applying the methodology. Additionally, by considering the learning styles of the students, relevant strategies were proposed to improve their academic performance and motivation in the learning process.

CONCLUSIONS

The effectiveness of gamification and ubiquitous learning in higher education was due to the fact that in each study group a predominant learning style was considered so that, in this way, relevant strategies could be proposed to improve academic performance and motivation in the learning process of students.

This research has yielded conclusions that support the idea that the integration of ubiquitous learning, gamification and learning styles in the educational process can have a positive impact on student learning. The

results obtained indicate that adopting ubiquitous learning allows students to learn in any context thanks to the implementation of mobile devices and digital tools inside and outside the classroom. Similarly, gamification involves playful and motivational elements, and promotes a more participatory and engaging learning environment.

Likewise, the consideration of individual and group learning styles of students within this approach allows adapting teaching strategies and educational resources in a more personalized way. By recognizing the learning preferences and characteristics of each group, a more effective and meaningful learning experience can be provided, focused on their specific strengths and needs.

In relation to the students who participated in this research, it was only possible to collaborate with them during the period 2022-2 due to the variable dynamics of the semesters, where subjects and professors change. However, the intention is to implement these practices in future groups in order to obtain better results and continue with the optimization of this methodology.

The importance of maintaining continuity and iteration in the application of these pedagogical strategies is recognized, as it allows them to be perfected and further adapted to the needs of the students.

The objective is to continue learning from the experiences and take advantage of the lessons learned in this research to optimize the teaching-learning process in future student groups.

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