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EDITED BY
Guillermo M. Chans,
Department of Science, School of Engineering and Sciences, Monterrey Institute of Technology and Higher Education (ITESM), Mexico

REVIEWED BY
Milan Kubiatko,
J. E. Purkyne University, Czechia
Vanessa Camilleri,
University of Malta, Malta

*CORRESPONDENCE
David Escobar-Castillejos
✉ descobarc@up.edu.mx

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Designing a gamified approach for digital design education aligned with Education 4.0

Francisco Cal Y. Mayor-Peña[1], Ari Y. Barrera-Animas[1], Daisy Escobar-Castillejos[2], Julieta Noguez[3] and David Escobar-Castillejos[1]*

[1]Facultad de Ingeniería, Universidad Panamericana, Ciudad de México, Mexico, [2]Faculta de Ingeniería, Universidad Autónoma de Chiapas, Tuxtla Gutiérrez, Chiapas, Mexico, [3]School of Engineering and Science, Tecnologico de Monterrey, Ciudad de México, Mexico

Introduction: Gamification integrates game-like elements, such as points, badges, and leaderboards, into the educational process. This study examines the influence of a gamified approach on improving graphic design education. By implementing this methodology, we aim to create a more dynamic learning environment that could lead to better academic outcomes.

Methods: A quasi-experimental design was employed to compare students' average grades and academic achievements using the gamified technique with those taught using conventional methods. Thirty-two students participated in the study, with these students enrolled in three different terms. Data collection involved tracking students' grades, participation, and completion rates of gamified activities.

Results: Participants in the August—December 2023 semester (Experimental 2 group) who experienced the gamified approach with the proposed platform showed significant improvement, with a *p-value* of 0.033, compared to those in the August—December 2022 semester (Control group), which used only conventional approaches. Furthermore, better learning outcomes were obtained when the Experimental 2 group was compared with the January-May 2023 semester (Experimental 1 group), which used only the gamification methodology ($p\text{-value} = 0.025$). Additionally, out of 15 students in the Experimental 2 group, 10 achieved certification in Adobe Illustrator and 13 in Photoshop, suggesting that gamification elements applied through a digital platform can improve academic performance and enhance students' practical skills and readiness for professional challenges in graphic design.

Discussion: Results indicate that the gamified methodology can improve learning outcomes. Nevertheless, the proposed approach also has limitations and areas for improvement. Manual data capture, integration with external tools, the amount of teachers applying the approach, and the sample size of participants are limitations of the study that could have affected the accuracy of the results. Future work will focus on developing a proprietary platform that integrates course content and automates the tracking system to improve efficiency and accuracy. Moreover, a subsequent study will include a larger sample of students and professors to validate the present study's findings.

KEYWORDS

digital design, STEAM education, technology-enhanced learning, digital fluency, gamification, educational innovation, higher education

1 Introduction

As society progresses, the necessities of the labor market have also advanced. This has also affected education by providing it with new types of resources. The emergence of technological tools and digital materials has been pivotal in shaping this transformation, leading to the establishment and global use of the term Education 4.0 (Miranda et al., 2021). According to The UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training, this learning paradigm emphasizes using technology to transform the learning process, contributing to the generation of innovative teaching methods (UNESCO-UNEVOC, 2024).

Graphic design is an evolving discipline within STEAM (Science, Technology, Engineering, Arts, and Mathematics) education. This field focuses on the visual transmission of information through typography, photography, iconography, and illustration (Lupton and Phillips, 2015). Graphic designers produce visual and impactful content that can efficiently communicate messages across several forms of media. Thanks to the evolution of technology, graphic design has integrated concepts like web design, user interface (UI) design, animations, and user experience (UX) design into its curricula (Hardy, 2022).

Incorporating technology has significantly expanded the variety of outcomes professionals in this area can produce. Nevertheless, to effectively engage students and ensure they adopt new concepts and techniques, teaching methods should be adapted to Education 4.0 alongside these advancements. Consequently, future skills such as critical thinking, storytelling, mental flexibility, self-management, digital learning, and digital fluency are becoming relevant in graphic design (World Economic Forum, 2020). One possible approach for incorporating these future skills could be game-base learning and gamification. These strategies are based on integrating game-like elements into educational resources, and it could make learning more dynamic (Pacheco-Velázquez et al., 2023).

This study presents the design of a gamified approach aimed at examining the influence of game-like elements on improving graphic design education. The study focuses on assessing the educational efficacy of gamification and promoting its use to complement the concepts taught in a graphic design undergraduate course. To facilitate this approach, a digital platform was designed to support the implementation of gamified activities. Through the online platform, students can track their grades and access modules that allow them to engage in gaming activities to test their acquired knowledge and check the points obtained by completing these tasks. Hence, the primary hypothesis to be demonstrated in this study is as follows:

1. Implementing a gamified methodology with a digital platform enhances academic performance compared to conventional teaching methodologies in a graphic design course.

2 Background

Nowadays, the challenge of effectively instructing undergraduate students revolves around attracting their attention to ensure that the information shared is assimilated and absorbed (Kember et al., 2008). This issue arises because students typically take at least five courses each semester, leaving them with minimal time for studying outside of class and difficulty absorbing new information (Thornby et al., 2023). Adhering to the principle that students should spend equal time studying after classes can help with this challenge. However, students frequently do not follow this methodology, and the educational community can confirm this by observing their performance in subsequent exercises or evaluations (Walck-Shannon et al., 2021).

Homework and classroom activities, meanwhile, play a key role in stimulating intellectual engagement and reinforcing understanding of the material (Fernández-Alonso and Muñiz, 2020). If an assignment is challenging for the students, they can conduct further research on the topic with the teacher's support or with different tools such as the Internet. This would ensure a better absorption of what they have covered in the classroom. Nevertheless, students often struggle to fully engage with or benefit from these due to various distractions (Dontre, 2021).

One of the most significant distractions students face today is video games. Gómez-Gonzalvo et al. point out that extended periods spent playing video games can negatively affect academic performance, sometimes leading to course failures (Gómez-Gonzalvo et al., 2020). This raises an important question: what is it about video games that makes them so appealing, drawing students to invest significant time in them? The psychology of games is, in essence, the feeling of obtaining skills and the recognition that they can reach a goal (Boyle et al., 2011; Chanel et al., 2011). Consequently, the integration of game-design elements and principles in education, commonly referred to as gamification, has emerged as a prominent area of study in recent years (Boskic and Hu, 2015; Chans and Portuguez Castro, 2021).

Gamification in education refers to the application of game mechanics—such as points, leaderboards, and progress tracking—to non-game environments with the aim of increasing engagement, motivation, and persistence (Christopoulos and Mystakidis, 2023). When these elements are aligned with pedagogical objectives, they can create a more engaging and motivating learning environment. Torres notes that certain game elements are crucial for a satisfying gamified learning experience, emphasizing the need for educators to set clear goals for the competencies students should develop while engaging in games (Torres, 2022). Furthermore, incorporating various types of games to accommodate diverse learning preferences is essential in ensuring that gamification is effective across different student groups.

On the other hand, game-based learning transforms the entire learning experience into a game, where activities and lessons are structured as interactive game-based tasks designed to promote engagement and learning (Liu et al., 2020). Kellinger outlines guidelines for designing curricular games, noting that games can improve learning outcomes when the connection between video game mechanics and established pedagogical strategies is well-structured (Kellinger, 2016). Moreover, in educational contexts, Kellinger suggested that progress bars can serve as an example of game mechanics that help students monitor their performance, providing a visual indicator of their grade advancements throughout the course. This allows students to set incremental goals, fostering a sense of accomplishment as they achieve each one.

In addition to progress tracking, reward systems play a significant role in maintaining student engagement. According to Chou, rewards such as points provide immediate feedback and foster a sense of accomplishment, key factors in sustaining students' efforts over time (Chou, 2019). The ability to accumulate points and exchange them for rewards encourages students to persist in their studies, tying effort to tangible outcomes. Likewise, Sheldon advocates for the use of leaderboards, which can stimulate competition by ranking participants in a way that motivates them to strive for excellence (Sheldon, 2020). When used effectively, leaderboards can enhance students' confidence and commitment to their academic pursuits, promoting a culture of self-improvement and goal achievement (Butgereit, 2016).

Lastly, as technology progresses, digital platforms could enable the seamless integration of gamified elements, allowing for real-time tracking of progress and personalized feedback (Zhukova et al., 2023). Harvey Arce and Cuadros Valdivia developed an online learning platform that integrated competitive and gamified elements (Arce and Valdivia, 2020). This platform encouraged students to take a more active role in their educational process, fostering motivation and sustained interest in course activities. Digital tools have the potential to set dynamic and engaging learning environments that mirror the intrinsic motivation students often experience in gaming, and educators can provide students with a more immersive and interactive learning experience, which not only holds their attention but also encourages sustained engagement over time.

3 Methods

This study's main objective is to examine the influence of gamification and game-based learning on creating a more dynamic learning environment in graphic design education. By implementing a quasi-experimental process, the study aims to determine whether these approaches can lead to improved academic outcomes.

3.1 Case study: Advanced Representation Techniques course

The Advanced Representation Techniques course (*Técnicas Avanzadas de Representación*, *TAR* for its acronym in Spanish) at Universidad Panamericana is part of the curriculum for the B.E. in Innovation and Design. The course was planned to provide students with the skills to design realistic and innovative representations using digital techniques and software. It focuses on teaching students how to produce perspective representations and manipulate both hand-drawn sketches and digital models to effectively express design principles and innovation. A key component of the course is extensive training in various techniques, including professional-level projects. Consequently, the syllabus incorporates the use of vectorizable software and other visual tools to enhance students' design capabilities. Adobe Suite©, specifically Illustrator© and Photoshop©, is one of the software used to provide students with experience in one of the world's most widely used design platforms.

The course begins with an introduction to color theory, covering the nature of color, the physics behind it, the wavelengths that produce different colors, and the relationship between light and shadow. Students then explore the differences between real and digital colors, such as RGB, CMYK, RYB, HEX, and Pantone, and the relationships and conversions between these color spaces. Once students have a foundational understanding of color, they learn about vectorization and its key principles. As the course progresses, students delve into composition, focusing on arranging objects in various art pieces like keynotes, flyers, photographs, and more. This section also includes an introduction to typography theory. Toward the end of the course, students will learn how to edit digital images using techniques such as blend modes, clipping masks, digital effects, and texturing. This knowledge will then be applied to create output files for different purposes, such as printing, cutting, and 3D modeling, to achieve the desired visual impact or prototype object.

One of the main objectives of the course is to provide students with tools relevant to the job market and expose them to real and everyday problems faced by design engineers. These problems include printing postcards, creating designs with clear and understandable graphic communication, and producing objects based on market needs to fulfill specific requirements. As part of this, in the course's final project, students must identify companies with particular needs they can address. Three milestones are set throughout the semester to ensure continuity and allow for feedback, helping students meet these needs effectively. Through this process, students will not only complete tasks that reinforce the knowledge gained in the classroom but also practice these skills in a professional setting and see the impact of their knowledge reflected in a tangible product.

3.2 Design of the gamified approach

3.2.1 Game-based learning implementation

The initial phase of the study involved integrating game-based learning into the course, allowing students to participate in structured learning activities through games. One of the students' first activities is to design a profile image based on a Funko POP!© figure (Funko, 2024). First, they create their customized Funko avatar using the official Funko "POP! Yourself" website (Figure 1). Upon obtaining their avatar, they employ Adobe© Illustrator© to vectorize and color it (Figure 2).

The resulting avatar promotes a deep sense of ownership in students since they have produced a deliverable that can be used on media platforms such as Facebook©, Instagram©, and gaming websites. Moreover, this activity serves as their first practical experience, offering an immediate evaluation of the skills they have gained up to this point.

The course was structured to include game-based learning; consequently, the *TAR Points* system was introduced to motivate students throughout the course (Figure 3, left). *TAR Points* were awarded as incentives for achievement during interactive activities. These games were selected to measure and reinforce knowledge related to the course content. This approach

FIGURE 1
Designing of a virtual avatar employing the "POP! Yourself" platform by Funko.

FIGURE 2
Use of Adobe© Illustrator© for designing the student's virtual avatars as part of the course activities.

FIGURE 3
Visual representation of the *TAR Points*: Original version designed by the professor **(left)** and a replacement version created by a student **(right)** in case students misplace their physical *TAR Points*.

ensured TAR Points could be accumulated throughout different classroom phases.

Firstly, various activities were implemented to ascertain knowledge retention from previous classes (Figure 4). At the outset of each session, one of the following options was selected:

- Kahoot Questions (Kahoot!, 2024): These questions, derived from the content of the previous class, were designed to identify any concepts that students may not have fully understood. This interactive approach promoted a friendly and non-critical environment for students to assess their understanding. The student with the highest score earned one *TAR Point*.
- Jeopardy (Solis Creative LLC, 2024): This online game included questions categorized according to topics such as "From the Last Class," "Color Theory," and "Learned So Far." These categories were tailored to the specific point in the course, covering topics such as Illustrator©, Photoshop©, color theory, light and shadow theory, and composition. Up to five students were randomly selected to begin the activity. Instructions on how to play were provided, and the player on the right started the game. Questions could be "stolen" by the

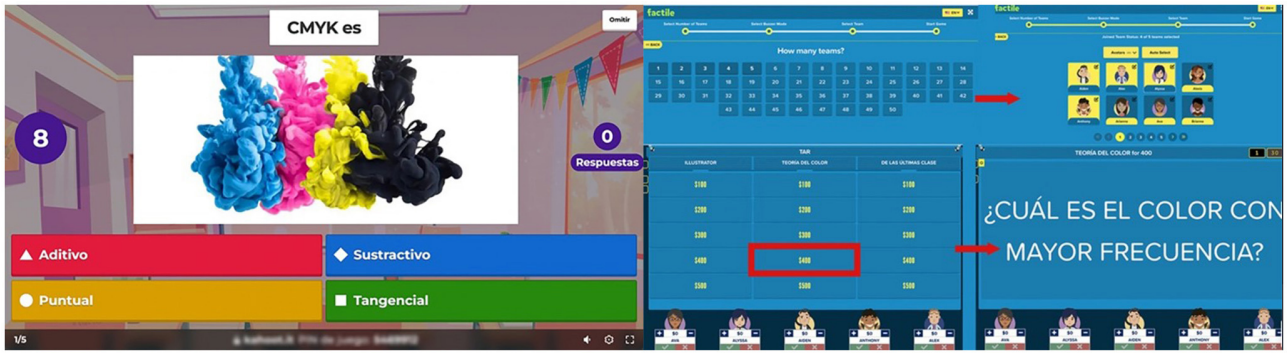

FIGURE 4
Activities selected for the first classroom phase: Kahoot questions **(left)** and Jeopardy **(right)**.

first person to press the answer button; however, if the person who stole the question failed to answer correctly, points for the question were deducted. Each question had a 30-s duration, which could be adjusted. The correct answer was provided if no student answered satisfactorily within the time limit. The student with the highest score at the end of Jeopardy was awarded one *TAR Point*.

- 1 V.S. 1: Students were divided into two teams, with one representative from each team selected to compete in a question-and-answer game. Participants had to press the answer button to respond. Correct answers allowed participants to continue, while incorrect responses resulted in elimination. This competitive format encouraged active participation, with the winner earning one *TAR Point*.

Subsequent activities were selected to reinforce knowledge acquisition and skill improvement while addressing any lingering conceptual gaps. These activities, implemented when the group demonstrated a similar level of comprehension, fostered healthy competition among students. Each activity could award one *TAR Point* to all students or only to those who excelled. The chosen activities were:

- The Bézier Game (MacKay, 2024b): This interactive game was designed to teach students how to use the pen tool, aiming to complete tasks with the fewest anchor points possible (Figure 5).
- The Boolean Game (MacKay, 2024a): This game reinforces knowledge about the Boolean tool, focusing on its application in design programs to create organic objects using tools such as Pathfinder or Shape Builder (Figure 6).
- Can't Unsee (2024): This interactive game teaches students on interface design and user experience rules, corresponding to the subject's composition topic (Figure 7).
- HEX invaders (352 Inc., 2024): This game provides an interactive way to learn about the HEX color system, addressing aspects of color theory and the conversion of color spaces (Figure 8).

Similarly, mini-challenges related to the current topic were introduced during class time. These challenges were designed to enhance students' understanding of the subject matter and identify areas that required further reinforcement. Successful completion of these mini-challenges was rewarded with two *TAR Points*. It is important to note that the objective of these interactive activities was to provide continuous feedback, either direct or indirect, on concepts students may have struggled to grasp fully, thereby allowing them to strengthen their understanding.

Lastly, homework assignments and tasks completed in class could also earn students points. Students who submitted their assignments before the deadline were awarded one *TAR Point*, while assignments of exceptional quality earned an additional *TAR Point*.

3.2.2 Gamification of evaluation and badges

The second phase introduced a gamification approach with the *TAR Points* system. It operated under specific rules to ensure fair use and maintain its integrity. Acting as a form of printed currency, *TAR Points* allowed students to purchase "power-up" badges during theoretical and practical assessments (Figure 9). Consequently, a record of *TAR Points* was maintained to ensure transparency and accountability. If students misplaced their physical *TAR Points* (e.g., by losing them during transit or leaving them elsewhere), the professor verified the balance using the official record. If the discrepancy was confirmed, students had to replace the lost points by designing and creating new ones using their resources, promoting additional creativity and responsibility (Figure 3, right).

The "power-up" badges were physically designed with unique designs to represent the type of support they offered during evaluations. The actions and costs associated with each badge were as follows:

A) Lifesaver (lifeline question) = 15 *TAR Points* each (max. two available per evaluation).
B) 5 mins of internet = 30 *TAR Points* each (max. of two available per evaluation).
C) Kali call (support in examination) = 20 *TAR Points*.
D) Theory track = 10 *TAR Points* each (max. of three available per evaluation).
E) Practical track = 10 *TAR Points* each (max. of three available per evaluation).

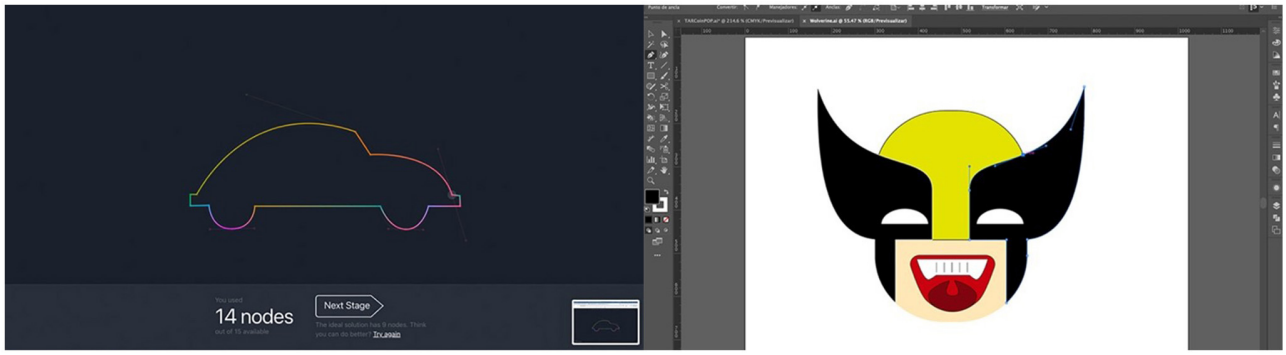

FIGURE 5
The Bézier Game interface **(left)** and a representation of using the pen tool **(right)**.

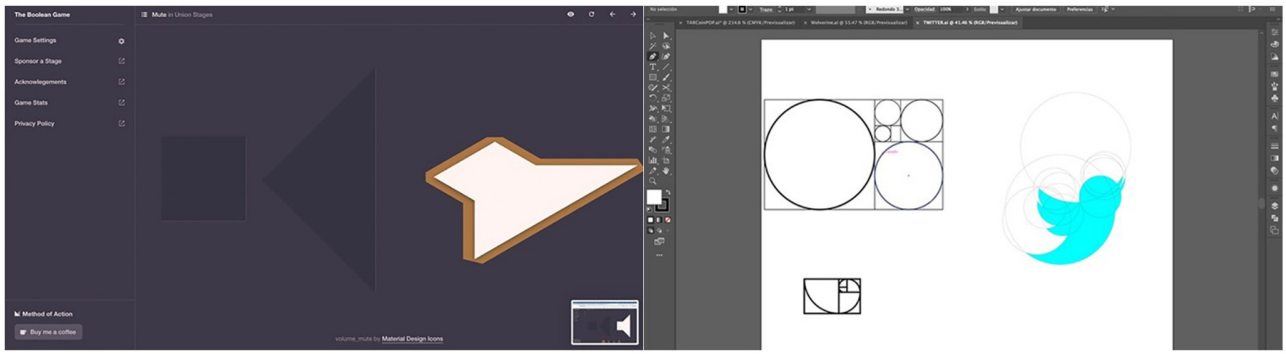

FIGURE 6
The Boolean Game interface **(left)** and a representation of using boolean tools to make the Twitter© logo **(right)**.

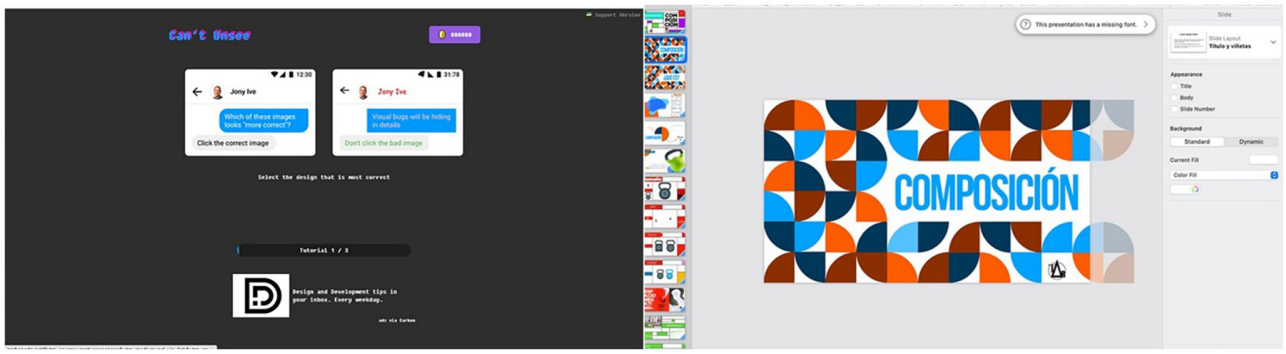

FIGURE 7
The Can't Unsee Game interface **(left)** and a representation of the course content that is used to teach composition concepts **(right)**.

F) Use notes = 40 *TAR Points* each (max. of four available per evaluation).
G) Calculator = 5 *TAR Points* each (max. of six available per evaluation).

Before assessments, students could exchange their *TAR Points* for "power-up" badges. Each student was allowed to purchase only one badge of the same type and a maximum of three badges overall. Since each badge type had a limited number available per evaluation, once sold out, no further badges could be acquired.

TAR Points could not be transferred, reused, or saved for future assessments, promoting individual accountability and active participation. Consequently, students were required to hand in their *TAR Points* when purchasing badges, and any unused points had to be returned to the professor during the examination session.

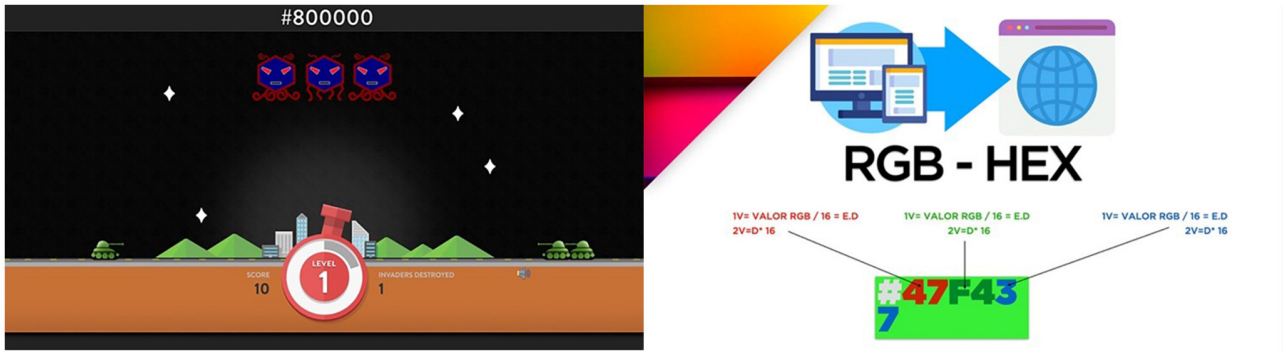

FIGURE 8
The HEX invaders Game interface **(left)** and a representation of the course content that is used to teach conversion from RGB to HEX presentation **(right)**.

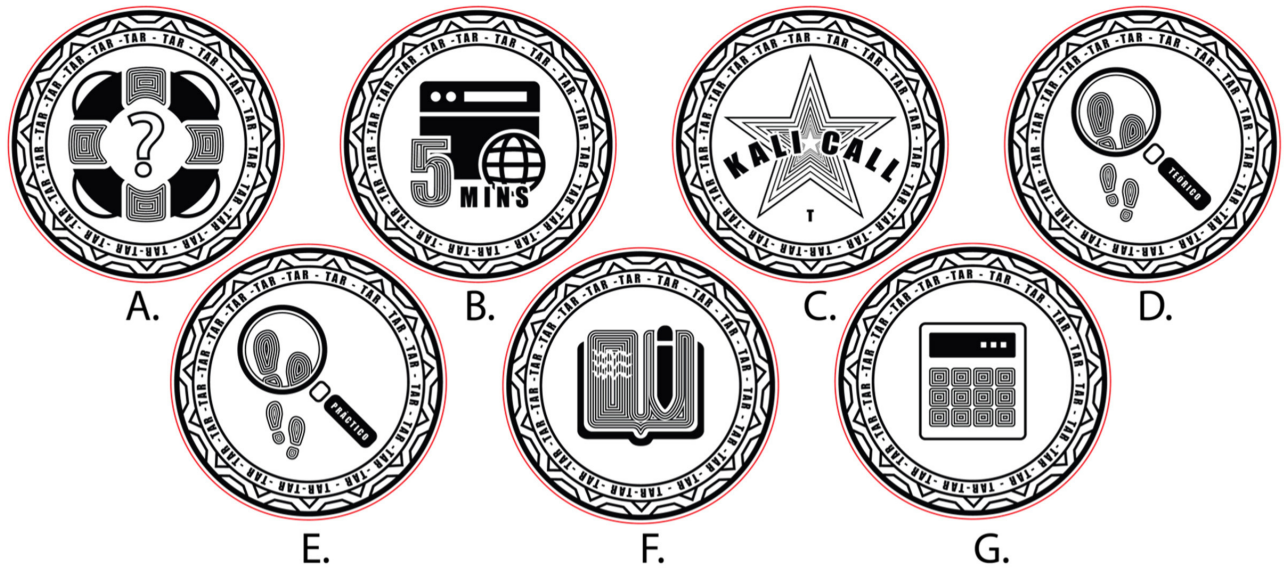

FIGURE 9
Visual representation of the "power-up" badges that can be acquired with *TAR Points*. **(A)** Lifesaver badge, **(B)** 5 mins of internet badge, **(C)** Kali call (support in examination) badge, **(D)** Theory track badge, **(E)** Practical track badge, **(F)** Use notes badge, and **(G)** Calculator badge.

Failure to do so would have resulted in disqualification from earning *TAR Points* in future assessments.

Finally, a PDF leaderboard was regularly uploaded to the Moodle platform for the course, showing each student's current standing based on their accumulated *TAR Points*. Although the points were consumed during evaluations, the leaderboard provided a real-time snapshot of student performance throughout the course. This transparency aimed to encourage continuous participation, foster healthy competition, and motivate students to actively track their progress.

3.3 Design of the platform and certification

In the third phase of the study, a platform was developed using Google's AppSheet to simplify student access to course modules. Students logged in with their institutional accounts, ensuring a smooth and secure connection. Once logged in, they could access a dashboard that allowed them to review their course grades, access links to educational games, and track their accumulated *TAR Points* (Figure 10). The platform centralized all relevant information from the gamified experience, enabling users to monitor their progress in one place, including real-time status on their current point balance. Additionally, each student's virtual avatar, submitted to the course instructor, was linked to their platform profile, fostering a sense of ownership as students saw their creations displayed. The platform also served as the primary medium for instructor feedback and student progress tracking throughout the course.

Finally, an additional resource was introduced at this phase: the option for students to enroll in Adobe© certification exams for Photoshop© and Illustrator© through Certiport, a Pearson VUE provider specializing in certification exams. This initiative aimed

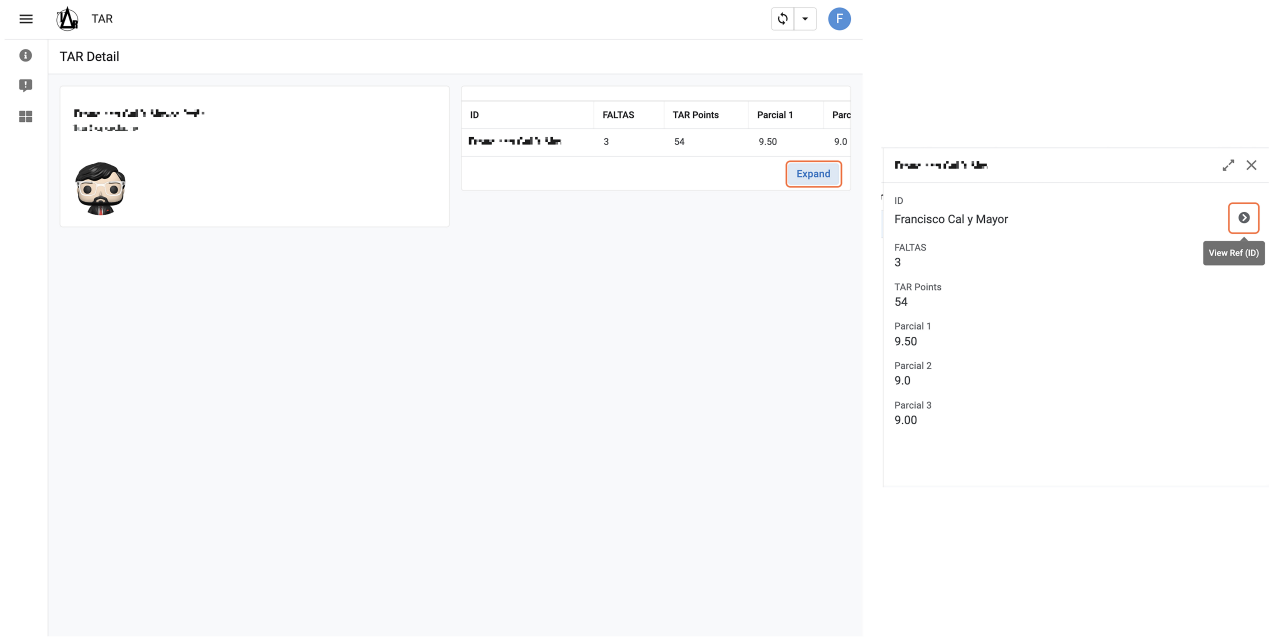

FIGURE 10
Dashboard's view: the student can see his course progress and the amount of "TAR coins" acquired at the moment of access.

to motivate students to validate the knowledge gained from the gamified activities. Additionally, approving the exam could earn students extra points toward their final grades. By undergoing formal certification, students not only assessed their skills but also could enhance their resumes and professional profiles, such as on LinkedIn©, further motivating them. This added an extra layer of assessment to the effectiveness of the gamified methodology, potentially improving students' professional qualifications and job prospects.

3.4 Participants

The study followed a quasi-experimental design to reflect a natural classroom setting and avoid influencing student behavior toward the teaching methodology. It included a cohort of 32 undergraduate students from Universidad Panamericana enrolled in the Advanced Representation Technigues course across three semesters: August–December 2022, January–May 2023, and August–December 2023. The selection process followed the university's self-enrollment method, allowing students to register for the course according to their individual academic plans. This resulted in varying group sizes: 11 students in the first semester (control group), 6 in the second semester (experimental group 1), and 15 in the third semester (experimental group 2).

3.5 Procedure

All students participated for only one semester, and the same teacher facilitated all three groups. At the beginning of the course, students in the January–May 2023 term were introduced to the gamified methodology, while those in the August–December 2023 term were introduced to the gamified approach, the digital platform, and the certification exam. Both groups expressed curiosity and enthusiasm about the gamified elements of the course. The teacher ensured that students followed instructions carefully to maximize learning and avoid technical issues during the activities. Students provided informed consent, understanding the use of gamification and game-based learning in the study.

Throughout their respective courses, students participated in the activities outlined in Section 3.2.1, accumulating *TAR Points* by completing in-class interactive exercises. The course is structured with two midterms and one final exam per semester. Students are able to use their *TAR Points* to purchase "power-up" badges during the midterms. In addition to in-class participation, gamified assignments were given as homework, and students were required to submit screenshots of completed tasks via Moodle. This ongoing evaluation aimed to encourage active engagement and help students stay organized in their interaction with the gamified material.

The teacher made minor adjustments to the evaluation plan across the different groups. In the control group semester (August–December 2022), students were taught using traditional methods. In the semester for experimental group 1 (January–May 2023), students were introduced to gamified methodology (game-based learning and gamification). Lastly, in the semester for experimental group 2 (August–December 2023), students used the current version of the digital platform, had the option to register for the certification examination, and used the gamified approach. If a student registered for the certification exam, they could earn up to 3 extra points for completing it, and these extra points were added to their final grade.

TABLE 1 Participant distribution and group types across study groups.

Term	Group type	N
Aug–Dec 2022	Control	11
Jan–May 2023	Experimental 1	6
Aug–Dec 2023	Experimental 2	15
Total		**32**

4 Results

The data presented in Table 1 shows the distribution of participants across different semesters and their respective group types.

The null hypothesis was:

$$H_0 : \mu_{exp} - \mu_{control} = 0$$

and the condition to reject it was:

$$H_1 : \mu_{exp} - \mu_{control} > 0$$

A t-test was used to assess the significance of increase in academic performance. The results of the t-test for comparing means are presented in Table 2, where independent samples with unequal and unknown variances were assumed. The Aspin-Welch t-test was used since it does not assume equal variances between populations. Table 2 presents the final average grades obtained by each group and the significance of the learning gains.

For the comparison between the Control group and Experimental 1 group (gamified methodology), the null hypothesis could not be rejected, with a p-value of 0.411, indicating no significant learning gain. However, when comparing the Experimental 1 group with the Experimental 2 group (gamified approach, platform, and certification), a p-value of 0.025 was obtained, which is below the threshold of $p = 0.05$. This result shows a significant increase in learning gains in the Experimental 2 group compared to Experimental 1. Additionally, comparing the Control group with the Experimental 2 group obtained a p-value of 0.033, further confirming significant improvements in learning with the addition of the digital platform and the certification.

5 Discussion

The results of this study highlight that integrating game-based learning and gamification, with a digital platform and application of an official certification, can significantly enhance student performance in graphic design education. The Aspin-Welch t-test provides statistical evidence of these improvements. While the gamified approach alone (Experimental 1) showed a slight, statistically improvement over traditional methods (Control), the combination of the gamified approach, the digital platform, and the certification (Experimental 2) led to statistically significant gains in learning outcomes.

Additionally, 10 out of 15 students in the Experimental 2 group passed the Adobe© Illustrator© certification, and 13 approved the Photoshop© certification. This demonstrates the efficacy of the gamified methodology in preparing students for industry-standard qualifications.

5.1 Comparison with current studies in the field

The design of our gamified approach differs from other studies in several key aspects. While many studies focus on point systems and leaderboards, the proposed approach integrates professional certification as a reward mechanism, linking game-base learning and gamification directly to industry standards. This prepares students for professional challenges. Moreover, our approach includes multiple phases of gamified activities, starting with simple activities and progressing to complex tasks integrated with digital platforms. This phased approach ensures that students gradually build their skills.

5.2 Limitations

Although the study offered favorable results, it had four important limitations. One limitation was the small number of participants per term. The small sample size limits this study's ability to generalize the results. Without a diagnostic test at the beginning of the course, learning gains were inferred from final grades rather than pre-post comparisons. Future studies could address this limitation by incorporating pre-course diagnostic assessments.

The second limitation was that only one teacher applied the methodology, which could affect its general efficacy. Teaching styles may influence the effectiveness of the gamified approach, so future research should involve multiple instructors to provide a more diverse experience and better assess the methodology's adaptability across different teaching styles.

The third limitation was the manual recording of students' performance and accumulated *TAR Points*, which proved to be both time-consuming and error-prone. This highlights the need for an automated system. Implementing such a solution would streamline the process, provide real-time scores and point tracking, and significantly enhance the efficiency of monitoring student progress.

The fourth limitation was that only academic performance was evaluated in this study. Since engagement and motivation are key components of game-based methodologies, future studies should incorporate validated instruments to assess these aspects alongside academic performance to provide a more comprehensive evaluation of the methodology's effectiveness.

6 Conclusion

This study demonstrates that the application of a gamified methodology, particularly when combined with digital platforms and professional assessments, could improve student performance in graphic design education. Students that participated in the gamified approach, used the digital platform, and were tested with the Adobe certification showed significant improvements in

TABLE 2 Final average grades and statistical significance of academic performance across study groups.

Group	N	Final average grade	Mean standard error	Difference of means	t-test $H_0 : \mu_{exp} - \mu_{control} = 0$ $H_1 : \mu_{exp} - \mu_{control} > 0$	
Control	11	6.96	0.073	–0.66	T-value	p-value
Experimental 1	6	7.63	0.28	–0.66	–0.85	0.411
Experimental 2	15	8.90	0.46	–1.33	–2.49	0.025
Control-Experimental 2				–2.01	–2.01	0.033

learning outcomes compared to those instructed by traditional methods. The success of students who obtained the certification highlights the efficacy of this methodology in enhancing academic performance and providing students with practical skills for professional challenges.

Nevertheless, several limitations should be addressed to improve the approach. The study was constrained by its limited sample size, absence of diagnostic assessments for pre-post comparisons, and the fact that only one teacher applied the methodology, which may have influenced the results. Furthermore, the study focused solely on academic performance, without directly assessing student engagement and motivation, which are necessary in gamified learning environments. Future research should involve the use of validated instruments to assess the effects of the methodology.

Moreover, the development of a more sophisticated digital platform specifically designed for educational gamification is essential. The current reliance on manual tracking of student progress and the limitations of using a third-party platform highlight the need for a proprietary system. Such a platform could incorporate real-time performance monitoring, automate the leaderboard, and provide interactive activities directly linked to course content, ultimately enhancing both the gamified experience and educational outcomes. Additionally, testing the gamified approach and platform with different instructors and larger cohorts could offer valuable insights into its adaptability across diverse teaching styles and contexts.

By addressing the identified limitations and expanding the scope of future research, this study presents a gamified approach for further exploration and improvement in game-based learning and gamification. This study seeks to encourage academics and researchers to design and develop engaging and effective learning environments.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

FC: Conceptualization, Data curation, Resources, Software, Writing - original draft, Writing - review & editing. AB-A: Data curation, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. DaiE-C: Investigation, Project administration, Visualization, Writing - review & editing. JN: Investigation, Methodology, Project administration, Validation, Writing - review & editing. DavE-C: Conceptualization, Methodology, Supervision, Visualization, Writing - original draft, Writing - review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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