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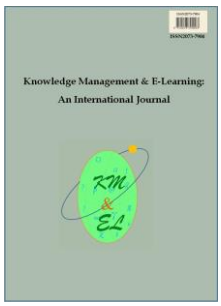

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Digital game-based learning: Does it improve university students' learning in an online context?

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Abstract: The use of digital game-based resources constitutes an alternative educational practice to improve the teaching-learning process in the context of higher education. This research aims to examine students' learning when employing serious games (Socrative and Cerebriti) and educational videos based on the video game *Assassin's Creed Odyssey* to improve and reinforce their learning. The work was carried out during a semester with university students (N = 171) in an e-learning context. A pre- and post ad hoc learning questionnaire was applied. The results show a positive impact on learning after the didactic experience. Consequently, this work contributes to the scientific community by offering a practical proposal. Utilizing serious games and educational videos within a digital game-based learning framework significantly improves students' learning in terms of their active, experiential, participatory, autonomous, and meaningful learning, as well as their knowledge and interest in learning key competencies of the 21st century.

Keywords: E-Learning; Serious games; Educational videos; Game-based learning; Active learning methodologies

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1. Introduction

Technology is in a constant state of evolution, and Information and Communication Technologies (ICT) have become an integral part of everyday life. Rapid advances and innovations have significantly transformed how we live, learn, communicate, work, and conduct research (Van Laar et al., 2020). In light of these changes, it is imperative to rethink university-level education and adopt methodologies that enable future educators to respond to these new demands from a critical and reflective perspective (Opre et al., 2022; Timotheou et al., 2023). Teachers need to acquire the necessary knowledge and skills to integrate appropriate and effective ICT tools into their daily teaching practices to enhance the teaching and learning process (Ishak et al., 2023). Consequently, university training that explicitly addresses digital competence is essential (Heine et al., 2023; Yurinova et al., 2022).

In this context, Štemberger and Konrad (2021) along with Nikou and Aavakare (2021), emphasize that the integration of ICT in education has fostered new forms of interaction between students and teachers. These interactions facilitate a multidimensional approach to content and support the development of students' multiple intelligences within enriched and flexible learning environments (Ricardo-Barreto, 2020; Ruíz-Cabezas et al., 2020). Therefore, the educational context must incorporate these advancements to ensure updated teaching practices and to prepare students for the creative, critical, and safe use of digital technologies.

Building on these perspectives, the present study supports the implementation of Game-Based Learning (GBL) through the use of serious games and educational videos as tools to support knowledge acquisition, assimilation, and assessment in an online university setting (Pineda-Martínez et al., 2023; Rodríguez-Ferrer et al., 2023). GBL in digital environments represents a promising pedagogical approach in higher education. This innovative experience responds to the current instructional needs of university education. Accordingly, and with a focus on the potential impact of this methodology on students' learning, the following research question arises: Following the implementation of a digital GBL-based instructional design, were there observable differences in undergraduate students' learning outcomes? The findings aim to offer educational insights that address the challenges of the e-learning teaching and learning process.

2. Literature review

2.1. Game-based learning methodology and its educational relevance

Games are a powerful tool for holistic human development, as they engage multiple dimensions of the individual – psychomotor, neurological, social-ethical, cognitive, affective-emotional, and educational (Larson, 2020; Wadley & Stagnitti, 2020). Through play, individuals explore their environment, solve problems, test ideas, and develop interpersonal and intrapersonal understanding. As Hutt et al. (1989) affirm, play is a universal language for learning. Games foster motivation by allowing failure without penalty, encouraging learners to learn from mistakes and try again. Given their broad educational benefits, excluding games from university-level instruction would be a missed opportunity, as their pedagogical potential is both significant and transformative (Chang et al., 2020; Troussas et al., 2020).

A growing body of research supports the use of games as tools for pedagogical innovation in higher education (Chen, 2023; Rodríguez-Ferrer et al., 2023). Studies by Dahalan et al. (2023) and Liu et al. (2020) demonstrate that games enhance attention, motivation, and learning efficiency, among other outcomes. Accordingly, this study supports the use of GBL as a methodology for achieving 21st-century skills (Bakhsh et al., 2022), by creating rich learning environments where students engage in projects and activities that promote knowledge discovery, application, and development.

In this context, GBL is widely recognized as an effective active methodology that places students at the center of the learning process, promoting meaningful and competency-based learning (Fernandez-Raga et al., 2023; Pineda-Martinez et al., 2023). GBL is defined as a learning environment in which game content and playfulness enhance the acquisition of knowledge and skills. It involves problem-solving, decision-making, and challenges that provide learners with a sense of accomplishment (Wardoyo et al., 2021). Through experimentation, students work toward goals, make choices, and experience the consequences of their actions in a safe and engaging environment. The learning pace is adapted to individual needs, and the knowledge gained can be transferred to real-world contexts (Arzfi et al., 2025). Drawing on Gentile et al. (2014), the GBL model is structured around three core elements: challenge, response, and feedback, forming a dynamic loop that fosters continuous learning.

2.2. Serious games as resources to enhance learning in educational contexts

Given the popularity of digital games among young people and adults, researchers and educators have increasingly explored the use of serious games to promote autonomous, networked learning, motivating new generations in their learning process (Shohel et al., 2022; Udeozor et al., 2022). Within the GBL framework, serious games have proven effective in fostering active and responsible student participation. Their interactive nature offers a level of engagement and motivation that traditional teaching materials often lack (Chen & Tang, 2023; Hayak & Avidov-Ungar, 2023). Moreover, serious games are recognized as innovative tools in higher education (Chen & Tu, 2021; Ishak et al., 2022). Empirical research has demonstrated the benefits of serious games across various educational stages and modalities (face-to-face, b-learning, and e-learning). These benefits include improved academic performance (Ortiz-Martínez et al., 2022), increased motivation and interest (Chang & Yeh, 2021), enhanced experiential learning through real-

world simulations (Zhao et al., 2022), and more participatory and collaborative classroom dynamics (Li et al., 2023). Additionally, serious games have shown particular value in inclusive education, supporting students with functional diversity (Chaidi & Drigas, 2022), and promoting meaningful learning across disciplines (Jarrah et al., 2022).

Aligned with the present study, other research has focused on the optimization of learning outcomes through self-perception assessments in higher education (Nguyen et al., 2021; Stepić, 2022). For instance, Stepić (2022) found that pre-service teachers trained in the use of serious games felt more professionally prepared and competent to integrate digital games into their future classrooms. Similarly, Nguyen et al. (2021) reported that students felt significant improvements in vocabulary acquisition through the use of serious games.

2.3. Educational videos as a resource to strengthen digital learning

The employment of educational videos has expanded across all educational levels, particularly in higher education, where they are recognized as effective tools for promoting meaningful learning (Noetel et al., 2021; Vaganova et al., 2019). As a result, many university institutions are now producing their own educational videos, not only for the classroom but also to enrich the digital resources available for various subjects. These videos are often created using tools such as OBS Studio, Loopster, Shotclip, Magisto, Ezpuzzle, TikTok, or WeVideo, and are integrated into the planning and delivery of instructional activities (Castro-Valdivia & Vázquez-Fariñas, 2023; Escamilla-Fajardo et al., 2021).

In this context, educational videos serve multiple didactic functions. They present content in a structured and visually engaging manner, while also activating communicative competencies through their expressive and narrative dimensions. Moreover, they can stimulate students' effective and creative responses through the use of imagery and sound (Morales Sales, 2021). As Gedera and Zalipour (2021) argue, videos have become essential educational resources that should be included in the daily practice of educational centers and serve as tools for reflection and critical analysis.

In this study, educational videos were elaborated using content from the video game *Assassin's Creed Odyssey* to enhance dynamism and maintain pedagogical continuity (Yildirim, 2018). These videos were designed to support teaching and learning processes that encourage reasoning, questioning, interpretation, classification, synthesis, evaluation of different perspectives, decision-making, and problem-solving (Janaki & Surendran, 2022).

3. Method

3.1. Objectives

The primary objective of this study is to examine whether the use of educational videos and serious games, implemented under the umbrella of GBL, improves undergraduate students' learning in an online environment. Recent research (Li et al., 2023) has demonstrated improvements in meaningful and autonomous learning among students who engaged with GBL in face-to-face settings. Building on this evidence, the present study

explores its effectiveness in a fully online environment. Accordingly, the following hypotheses are proposed:

H1: The employment of digital GBL does not improve students' learning in an online context

H2: The employment of digital GBL improves students' learning in an online context.

3.2. Research design

This study adopts a quantitative, positivist research paradigm (Maciejewski, 2018), aiming to explain the potential improvement in undergraduate students' learning outcomes resulting from the implementation of digital GBL in an online educational setting.

A pre-experimental design with pre-test and post-test measurements was employed (Maciejewski, 2018). This design was selected due to the presence of a single experimental group (comprising online university students) who received this instructional intervention and were assessed before and after its implementation. In September 2022, prior to the intervention, a pre-test questionnaire was administered. The instructional unit was delivered over a six-month period (from September 2022 to February 2023), after which the same questionnaire was administered again to evaluate potential learning gains.

3.3. Participants

Participants were selected through non-probabilistic convenience sampling. The initial sample consisted of 176 undergraduate students enrolled in the Faculty of Education at a private university during the 2022-2023 academic year. However, five students did not complete all sessions, resulting in a final sample of 171 university students (45 males, 126 females). The age distribution was as follows: 68 students aged 20-30, 72 aged 30-40, 30 aged 40-50, and 1 aged 50-60. All the students attended online classes and had no prior experience with digital GBL.

Inclusion criteria required students to: (1) attend the pre-test session; (2) participate in all GBL-based classes; (3) complete the post-test session; and (4) provide informed consent. The research adhered to the ethical principles outlined in the Declaration of Helsinki.

3.4. Implementation of the lesson plan

The instructional design centered on the *Discovery Tour* mode of the video game *Assassin's Creed Odyssey,* selected for its alignment with the learning objectives related to the historical and artistic knowledge of Ancient Greece, as outlined in the Primary Education degree program. This educational mode-free from fictional or combat elements- offers interactive tours of heritage sites such as the Parthenon and the Acropolis of Athens, enabling a rigorous exploration of architectural styles, symbolic functions of monuments, and cultural-religious practices of the era.

The didactic sequence was structured into three online workshops, combining educational videos (created using *Discovery Tour* imagery and narrated by the instructor) with gamified activities on platforms such as Socrative and Cerebriti. These activities were directly linked to the course content and targeted learning objectives such as identifying and contextualizing Classical Greek monuments, critically analyzing their historical value,

and enhancing visual interpretation through digital media. This approach positioned the *Discovery Tour* not as a supplementary tool, but as the central axis of the instructional design, supporting immersive, student-centered learning. Prior research (Arbuckle, 2021) reinforces the pedagogical value of video games in higher education, validating their use within the GBL framework.

3.4.1. Workshop 1: Educational video-based learning

In the first session, students viewed two educational videos created from the video game *Assassin's Creed Origins Odyssey* using the *Discovery Tour* mode (Ubisoft. 2021). These videos *Meet the Parthenon* and *Important Aspects about the Goddess Athena* were produced using OBS Studio and included teacher narration. The videos were made available on the instructor's YouTube channel for asynchronous access: https://youtu.be/U1VSMSsnDf8 and https://youtu.be/BcQcQX3YJQY. Fig. 1 is a screenshot from the educational video *Meet the Parthenon*. From a didactic and pedagogical standpoint, the video was designed to support teaching-learning processes, as the use of this specific game mode – free of fictional or combat elements – allows for a rigorous exploration of heritage sites, facilitating an immersive, student-centered experience. During the session, students took notes while watching the videos. Afterward, they answered a series of questions related to the content, with the teacher providing guidance and clarification. The session concluded with a review and discussion of the correct answers.

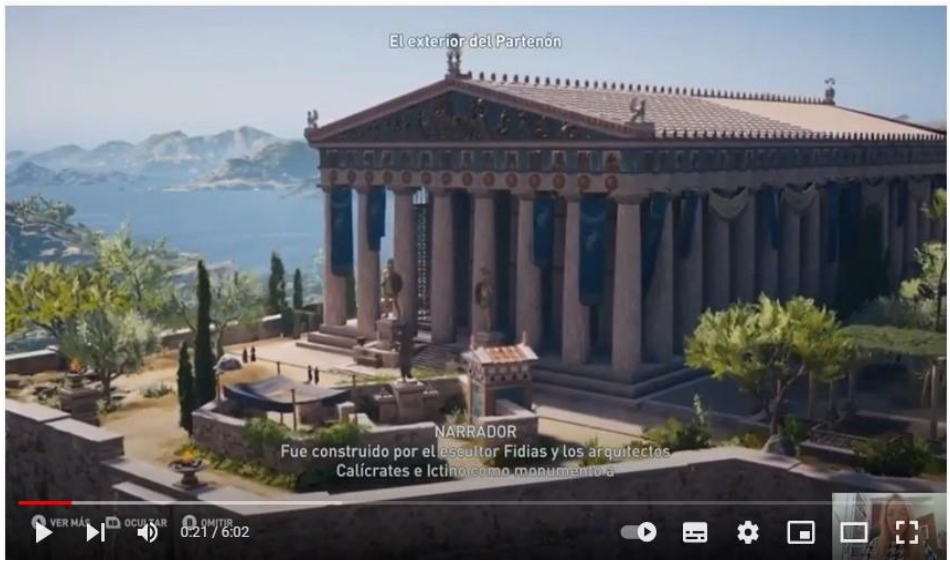

Fig. 1. Screenshot of an educational video *Meet the Parthenon*, using *Discovery Tour* mode in *Assassin's Creed Origins Odyssey*

3.4.2. Workshop 2: Gamified learning with socrative

In the second session, students participated in three Socrative games, each consisting of ten questions derived from the *Discovery Tour* content. The questions included multiple-choice, true/false, and open-ended formats, focusing on the cultural and artistic heritage of

Ancient Greece. Each correct answer was worth one point, with a maximum score of ten. Students accessed the game synchronously using a code provided by the instructor and completed them individually on their mobile devices. Upon completion, they received immediate feedback and a detailed performance report. The teacher then reviewed the correct answers and facilitated a group discussion, encouraging students to share their reflections and engage in collaborative analysis.

Fig. 2 provides an example of Question 7 from the Socrative game *Discover the Main Monuments of Ancient Greece*. With this Figure, we can see precisely what is being asked of students, how immediate feedback is facilitated, and how error review and subsequent teacher-guided discussion are promoted.

Fig. 2. Question 7 of a Socrative game *Discover the main monuments of Ancient Greece* (retrieved from https://b.socrative.com/teacher/#edit-quiz/67611834)

3.4.3. Workshop 3: Gamified learning with Cerebriti

In the third workshop, students completed three interactive games on the Cerebriti platform. Each game consisted of ten matching questions in which students needed to identify and name different monuments from Ancient Greece. Each correct answer was worth one point, with a maximum score of ten. Similar to the Socrative activities, these games served as an optimal, engaging, and visually dynamic tool for reviewing or reinforcing content that students had not yet fully mastered. Their playful and accessible format contributed to a relaxed learning environment that supported content retention. An example of one of the three Cerebriti games used in this third workshop is presented below (see Fig. 3), where we can see the type of interaction students engage in (identifying and naming monuments) and can understand the pedagogical value of this resource as a final review activity.

Fig. 3. Screenshot of a Cerebriti game *Discover the monuments of Ancient Greece (II)* (retrieved from https://www.cerebriti.com/juegos-de-tecnologia/descubre-los-monumentos-de-la-grecia-antigua-ii)

3.4.4. Conclusions and evaluation of the workshops

At the end of the workshops, the professor invited students to reflect on the experience by responding to an open-ended question in the class chat. This approach allowed all responses to be shared in real time, fostering collective reflection and discussion. Additionally, the professor summarized student participation and administered the post-test questionnaire before the end of the final session. The results of this process demonstrated the effectiveness of the workshops. The integration of flipped classroom (FC) strategies through game-based videos and gamified resources proved to be a valuable complement to the teaching of historical content (Ancient Egypt and Classical Greece) as outlined in the course curriculum. These resources also contributed to increased student motivation and engagement, as evidenced by more frequent and in-depth questions during class, critical discussions in the chat, and a notable increase in views on the instructor's YouTube channel, where the educational videos were hosted. Students completed tasks independently and proactively, without the need for reminders.

3.5. Instruments

To assess the impact of the instructional design, the researchers developed an online questionnaire tailored to the students' learning experience with digital GBL methodology in an online higher education context. The questionnaire was designed prior to the intervention and aimed to evaluate students' perceptions of their learning outcomes.

The instrument was based on a previously validated questionnaire (Carrión Candel & Colmenero, 2022), which analyzed undergraduate students' experiences with active methodologies intended to optimize learning. While the original instrument contained a broader set of items, this study focused on five of them. Following a comprehensive review of the relevant scientific literature on the topic, five additional items were developed to specifically address learning-related dimensions, resulting in a ten-item questionnaire (see Table 1). To validate the instrument, an Exploratory Factor Analysis (EFA) was then conducted to verify whether the ten items collectively measured the construct of learning. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy yielded a value of 0.925, and Bartlett's test of sphericity was statistically significant ($p < .0001$), both indicating the suitability of the data for exploratory factor analysis. Using principal axis factoring and Varimax rotation, the analysis revealed a single underlying factor structure that accounted for 74% of the total variance. All ten items loaded onto this factor, with factor loadings equal to or greater than .66, indicating that the instrument reliably measured the construct of learning. Responses were collected using a five-point Likert scale, with options ranging from 1 (strongly disagree) to 5 (strongly agree).

The overall reliability of this questionnaire in this sample was high, with $\Omega = .92$, $\alpha = .91$ in the pre-test and $\Omega = .82$, $\alpha = .81$ in the post-test.

3.6. Procedure

At the beginning of the academic term in September, during the first online session, undergraduate students provided informed consent to participate in the research by responding to a consent item included in a Google Forms questionnaire shared via the class chat. In the same session, a second Google Forms form was also distributed to administer the pre-test questionnaire, which included sociodemographic questions (gender and age) and the ten learning-related items. At the end of the instructional period, during the final

session in February, the post-test questionnaire was administered using the same format. A total of 171 students completed both the pre-test and post-test questionnaires, resulting in a 100% response rate.

3.7. Data analysis

Given the ordinal nature of the Likert scale data, reliability analyses were conducted using both Cronbach's Alpha and McDonald's Omega coefficients. To assess the distribution of the data, the Kolmogorov-Smirnov test was applied to assess the normality of the ten questionnaire items. With a significance threshold of $p < .05$, all the variables yielded $p < .01$, indicating non-normal distribution. Secondly, to evaluate differences in students' learning before and after the intervention, the Wilcoxon signed rank test (W) was used, with significance set at $p < .05$. Thirdly, the effect size was also calculated using biserial rank correlation at 95%, interpreted according to Coolican (2009). To control for potential confounding variables, age and gender were analyzed using non-parametric tests. The Mann-Whitney U test was applied to assess gender differences, and the Kruskal-Wallis H test was used for age group comparisons, both with a significance level of $p < .05$. All statistical analyses were performed using R (version 4.3.0) and SPSS.

Table 1
Questionnaire items and definitions (Carrión et al., 2024)

Questionnaire	Questions	Definition
Achievement of goals	Need to learn knowledge in digital resources and active learning methodologies	This dimension assesses the extent to which students consider the development of digital skills and familiarity with active teaching methodologies essential for enhancing their learning processes.
	Active learning with objectives that are not achievable with passive learning	It measures whether students acknowledge that the use of active learning strategies such as digital games or interactive videos enables them to achieve educational goals that might not be attainable through traditional methods.
	Improved interest in learning	This indicator captures whether the didactic experience increased students' enthusiasm, curiosity, or motivation toward the course content.
	Experiential learning in real situations	It evaluates whether students felt that the resources used provided a learning experience that closely resembled real-world or practical contexts, thereby facilitating the connection between theoretical knowledge and practical application.
	Improved knowledge	This dimension refers to students' perception of the extent to which the experience contributed to the acquisition or reinforcement of specific content knowledge.
Classroom participation	Participative learning	It assesses whether students felt actively engaged in the sessions by sharing ideas, asking questions, and collaborating with peers.
	Collaborative learning	This indicator measures students' perception of their involvement in cooperative activities and the exchange of ideas with classmates.
Autonomous work tools	Autonomous learning	It determines the degree to which students were able to manage their own learning, including time management, resource access, and task completion without constant supervision.
The most positive and meaningful classroom work	Promotion of more meaningful learning	This dimension evaluates whether the didactic proposal enabled students to connect new knowledge with prior learning, thereby enhancing the coherence and relevance of the content.
Recommended approaches for other subjects	Improvement of the learning of the subject contents	It assesses whether students perceived an improvement in their comprehension and mastery of the topics addressed throughout the course.

4. Results

The results are presented in two parts: (1) analysis of intervening variables and (2) comparative analysis of pre-test and post-test scores.

4.1. Analysis of intervening variables

Given the non-randomized nature of the pre-experimental design (N = 171), it was necessary to control for potential intervening variables such as age and gender. The non-parametric Kruskal-Wallis H test, applied before the learning intervention (H = 3.085, p = .37), indicated no differences among the four age groups with similar results and a non-significant value ($p < .05$). We administered the same test after the didactic experimentation (H = 1.073, p = .78), which indicated no differences among the four age groups, with similar results, showing a non-significant value ($p < .05$). Besides, to test gender, the non-parametric Mann-Whitney U test was applied before the pedagogical implementation (U = 2.767, p = .92), which indicated no significant differences ($p < .05$), which reflected no differences between males and females. After the didactic proposal, the same test was employed (U = 2.547, p = .38) with a significance $p < .05$, and there was no difference between males and females. These findings suggest that neither age nor gender significantly influenced the learning outcomes, thereby supporting the internal validity of the results.

4.2. Comparative results

The primary objective of this research was to determine whether the use of digital GBL improves undergraduate students' learning in an online context. To this end, pre-test and post-test scores were compared using the Wilcoxon signed-rank test. Table 2 presents the findings for the whole sample (N = 171), and in general, the total scores from the learning questionnaire showed a statistically significant improvement following the intervention (Wilcoxon negative rank sum = 4705.00; positive rank sum = 7385.00), indicating that students perceived enhanced learning outcomes.

In the first question about the necessity of learning knowledge using ICT and active learning methodologies, responses remained stable (Wilcoxon negative rank sum = 649.00; Wilcoxon positive rank sum = 626.00), possibly reflecting the pre-existing awareness of the importance of digital competence in post-pandemic education.

In all the remaining questions of the questionnaire, the undergraduates reported improvements in their learning after the educational intervention, in active learning, significant improvement was observed (Wilcoxon negative rank sum = 2182.00; Wilcoxon positive rank sum = 3813.00), students reported increased motivation regarding interest in learning (Wilcoxon negative rank sum = 1589.50; Wilcoxon positive rank sum = 2505.50), experiential learning and perceptions of real-world relevance improved (Wilcoxon negative rank sum = 2252.50; Wilcoxon positive rank sum = 3525.50), improvement of learned knowledge (Wilcoxon negative rank sum = 1742.00; Wilcoxon positive rank sum = 2818.00), more participatory learning (Wilcoxon negative rank sum = 1362.50; Wilcoxon positive rank sum = 2292.50), more collaborative learning (Wilcoxon negative rank sum = 2290.00; Wilcoxon positive rank sum = 3066.00), more autonomous learning (Wilcoxon negative rank sum = 2495.00; Wilcoxon positive rank sum = 3833.00), more meaningful learning, enhancing the integration of new and prior knowledge (Wilcoxon negative rank sum = 2551.50; Wilcoxon positive rank sum = 3889.50), and improved

understanding of content knowledge (Wilcoxon negative rank sum = 1702.00; Wilcoxon positive rank sum = 2858.00).

Table 2
Results of the effects of digital GBL

Items		Average rank	Rank sum	*W*	*p*	Effect size
Need to learn knowledge in digital resources and active learning methodologies	Negative ranks	25.96	649.00	.11	.9	.01
	Positive ranks	25.04	626.00			
Active learning	Negative ranks	51.95	2182.00	2544	.01*	-.27
	Positive ranks	56.91	3813.00			
Interest in learning	Negative ranks	38.77	1589.50	1984	.04*	-.22
	Positive ranks	51.13	2505.50			
Experiential learning	Negative ranks	53.63	2252.50	2120	.03*	-.22
	Positive ranks	54.24	3525.50			
Improved knowledge	Negative ranks	43.55	1742.00	2105	.03*	-.23
	Positive ranks	51.24	2818.00			
More participative learning	Negative ranks	38.93	1362.50	2162	.03*	-.25
	Positive ranks	45.85	2292.50			
Collaborative learning	Negative ranks	50.89	2290.00	1347	.17	-.14
	Positive ranks	52.86	3066.00			
Autonomous learning	Negative ranks	53.09	2495.00	2046	.04*	-.21
	Positive ranks	58.97	3833.00			
More meaningful learning	Negative ranks	56.70	2551.50	2032	.04*	-.20
	Positive ranks	57.20	3889.50			
Learning of the subject contents	Negative ranks	48.63	1702.00	2291	.02*	-.25
	Positive ranks	47.63	2858.00			
Total learning	Negative ranks	74.68	4705.00	2396	.01*	-.27
	Positive ranks	80.27	7385.00			

Note. * $p < .05$

Table 2 shows that, in general, the instructional intervention significantly improved students' learning ($W = 2396$, $p = .01$, effect size = - .27), specifically in active learning ($W = 2554$, $p = .011$, effect size = - .27), interest in learning ($W = 1984$, $p = .04$, effect size = -.22), experiential learning ($W = 2120$, $p = .03$, effect size = - .22), improvement of learned knowledge ($W = 2105$, $p = .03$, effect size = - .23), more participatory learning ($W = 2162$, $p = .03$, effect size = - .25), more autonomous learning ($W = 2046$, $p = .04$, effect size = - .21), more meaningful learning ($W = 2032$, $p = .04$, effect size = - .20), and learning subject knowledge ($W = 2291$, $p = .02$, effect size = - .25). Question 10 on more collaborative learning improved but not significantly ($W = 1347$, $p = .17$, effect size = - .14). All effect sizes were small, according to Coolican (2009). Therefore, the intervention demonstrates a limited yet positive impact on educational practice. Nonetheless, although the effect size is small, the observed positive trend suggests the potential for further refinement of the strategy. Any improvement in students' perception of learning, however modest, may contribute to long-term educational enhancement. These results reject the null hypothesis (H0) and support the alternative hypothesis (H1), namely that the employment of game-based learning using serious games and educational videos improves students' learning in an online context.

In the specific case of question 1, on the need of teachers to learn ICT and active learning methodologies knowledge ($W = 0.119$, $p = .90$, effect size = .01), the differences were not significant between before and after the learning intervention, and the values were similar. This question indicates that using digital game-based learning did not improve the students' need for ICT and active methodologies knowledge in an online context.

5. Discussion

This study examined the impact of a digital GBL intervention featuring serious games and educational videos on undergraduate students' learning in an online university context. The findings of this study indicate a generally positive effect, as evidenced by the Wilcoxon test results and effect sizes presented in Table 2.

With the exception of one item, the null hypothesis (H0) was rejected in favor of the alternative hypothesis (H1): the use of digital GBL significantly improves students' learning in an online environment. The results show improvement after the learning intervention with statistically significant differences in active learning, interest in learning, experiential learning, improvement of learned knowledge, participatory learning, autonomous learning, meaningful learning, and subject knowledge. These results align with previous studies (Nguyen et al., 2021; Zhao et al., 2022; Jarrah et al., 2022; Li et al., 2023), which also reported enhanced learning outcomes following the implementation of digital GBL strategies.

Students reported increased engagement with the subject matter, deeper understanding of content, and greater alignment between learning and professional practice. They also demonstrated more active participation, collaboration, and autonomy—key indicators of twenty-first-century learning. These findings are consistent with Stepić (2022), who observed similar improvements in students' perceptions of learning in face-to-face university settings. Although the effect sizes were small across all items of the questionnaire, the statistical significance of the results supports the validity of the intervention, despite small sizes. The modest magnitude of the effect of the didactic implementation suggests that while the intervention was beneficial, further refinement could enhance its impact. Future research should explore potential mediating variables that may amplify these outcomes, such as instructional design, feedback mechanisms, or learner characteristics.

Nevertheless, digital GBL has certain drawbacks. Greipl et al.'s (2020) study argues that games cannot replace but complement traditional educational approaches. Bakhsh et al. (2022) stated that, despite the multiple advantages of this approach, it may involve a high-cost learning process, requirements for an up-to-date curriculum and difficulties integrating this approach into the curriculum. However, with thoughtful planning, diverse game formats, and validated instructional models, these challenges can be addressed.

Regarding the first questionnaire item -about the need for future teachers to learn ICT and active learning methodologies knowledge-, the result obtained was similar before and after the didactic experience. This finding may be due to students' pre-existing awareness of the importance of digital tools in post-pandemic education (Alenezi et al., 2023). Certainly, the formulation of the question may also have lacked the specificity needed to capture nuanced shifts in awareness. Moreover, as digital natives (Prensky, 2010),

they naturally assumed the presence of digital tools in all contexts, including education, and did not consider that education without screens can also be possible.

Despite these limitations, the study demonstrates that digital GBL can create meaningful learning environments in online higher education. Students recognized the value of the approach, suggesting its potential for broader application across university courses. Research in recent years (Mohamed & Lamia, 2020) indicated the relevance of changing traditional classrooms to develop active learning methodologies and active learning among students in online environments. Currently, classrooms must be characterized by dynamism and interactivity (Chang & Yeh, 2021; Chen & Tang, 2023), with the student being the center of learning (Strelan et al., 2020). Namely, the use of digital GBL enhances students' learning by optimising knowledge acquisition, as indicated in recent meta-analyses (Ren et al., 2024; Wang et al., 2022; Zhou & Bakhir, 2023) and in empirical classroom-based research (Zeng et al., 2020).

Learning through digital games offers an enriched educational experience that fosters meaningful learning and pedagogical innovation (Fernández-Raga et al., 2023). El Mawas et al. (2022) found that GBL was more efficient than standard traditional approaches in a secondary education setting, particularly when combined with gamification and learner autonomy. Similarly, Bakan et al. (2022) highlighted the flexibility and accessibility of GBL across time and space. However, the successful implementation of GBL requires adequate training, time, and resources, especially on the part of the teacher (Zawilinski et al., 2020). It is paramount to include immediate feedback since it helps students to reflect on their learning process. Immediate critical feedback prompts students to reflect on mistakes, confirmatory feedback reinforces positive behavior, and explanatory feedback clarifies assessment criteria (Su & Zou, 2024). Yet, creating personalized feedback can be extremely time-consuming, especially when it is tailored to students' learning proficiency levels (Song & Sparks, 2019).

This research provides clear empirical evidence of the benefits of digital GBL (using serious games and educational videos) for enhancing student learning in online higher education. Although the impact was modest, the positive trend in students' perceptions of learning suggests a promising direction for future instructional design. These results motivate us to continue working in this line in higher education for formal and informal courses and MOOC courses offered to students by universities. In this work, we used open resources so that the educational intervention could be replicated in other formal, informal, or MOOC-based university or non-university courses.

Although the use of digital games and educational videos has been progressively incorporated into higher education, the originality of this study lies in the structured and sequential integration of digital resources within a fully online, empirically evaluated instructional design. Rather than employing games or videos as supplementary materials, this research designs a coherent and methodologically grounded educational experience. It combines educational videos created with digital tools such as OBS Studio and gamified digital activities using platforms like Socrative and Cerebriti, all contextualized within the historical universe of *Assassin's Creed Odyssey* (Ubisoft, 2021) and guided by the pedagogical principles of Game-Based Learning.

Unlike previous studies, this approach does not treat videos and games as isolated elements but as interconnected digital resources embedded in a series of pedagogical workshops that promote reflection, critical thinking, and meaningful learning. In doing so, it contributes to the development of essential 21st-century competencies such as autonomy,

active participation, decision-making, and digital literacy (Van Laar et al., 2020; Bakhsh et al., 2022).

Moreover, the study highlights the use of a high-quality commercial video game with rich graphic and narrative features as a didactic resource. Importantly, the game was not used in its conventional entertainment format, but rather through its *Discovery Tour* mode, which serves as an educational tool. This represents a relatively uncommon yet pedagogically enriching use, as it enables an immersive experience free from ludic distractions that might hinder learning (Arbuckle, 2021; Ubisoft, 2021). Such use promotes exploration, historical contextualization, and experiential learning (Zhao et al., 2022). Furthermore, the proposed didactic approach contributes to educational innovation in virtual teaching contexts, addressing the challenges posed by accelerated digital transformation in post-pandemic higher education. As Shohel et al. (2022) point out, the effective implementation of active methodologies based on digital games requires not only appropriate tools but also a structured and evaluated methodological design (precisely the kind of framework presented in this study).

6. Limitations and prospective

While the findings of this study are promising, several limitations must be acknowledged, as they may influence the interpretation and generalizability of the results. First, the study employed a pre-experimental design without a control group, which limits the ability to establish causal relationships. This choice was made to ensure that all university students had the same teacher and the sessions of the didactic experience (the sample comprised only one group), that is, consistency in instruction. The second limitation is related to the random selection of the sample for convenience. To mitigate this, previous analyses were conducted to control, at least, gender and age both before and after the didactic experience, confirming no significant differences between groups before and after intervention. Thirdly, this study relied on self-reported perceptions of learning rather than objective measures such as academic performance or standardized assessments. While self-perception is a valuable indicator of engagement and satisfaction, future research should incorporate both objective and subjective data to provide a more comprehensive evaluation of learning outcomes. Based on this research, proposals can be made to improve these results, including expanding the sample size to include university students from other academic disciplines and educational and cultural contexts, as well as face-to-face, blended learning (b-learning), and online environments. Employing experimental or quasi-experimental designs with control groups would strengthen the validity of the results. Additionally, mixed-methods approaches combining qualitative and quantitative techniques could be used to test, for example, the academic performance of students taught with serious games in GBL compared with traditional lecture-based instruction. Future studies could also include longitudinal tracking to evaluate whether the learning is retained over time, and whether they influence students' academic and/or professional performance. In addition, the link between academic performance and self-perceived learning could be tested. Finally, the impact of the different types of feedback (e.g. immediate, explanatory, adaptive) on the learning outcomes could be analyzed as well as the cost-benefit ratio and scalability of implementing GBL in higher education, including teacher training and fidelity of implementation.

This study lays the groundwork for several future lines of research that may strengthen the evidence base regarding the use of GBL in online higher education contexts.

Firstly, it is recommended to conduct longitudinal studies that assess learning retention over the medium and long term. Such studies would help determine whether knowledge acquired through GBL remains stable over time and can be transferred to other academic or professional contexts. In this regard, El Mawas et al. (2022) conclude that GBL may be more effective than traditional approaches, particularly when the learning environment supports student autonomy, underscoring the need for continued investigation into its long-term impact. Secondly, it would be pertinent to develop comparative studies between GBL and traditional methodologies, employing experimental or quasi-experimental designs with control groups. This approach would allow for a more objective assessment of differences in academic performance, motivation, and competency development, and help identify the conditions under which each methodology proves most effective (Hafeez, 2021; Yasir et al., 2021). Finally, other relevant research avenues include the analysis of feedback types integrated into GBL environments – such as immediate, explanatory, or adaptive feedback – and their impact on self-regulation and learning comprehension (Fernández-Raga et al., 2023). Further exploration of individual learner factors, such as self-efficacy, learning style, or digital competence, is also warranted, as these may influence the effectiveness of GBL. Advancing this knowledge would support the development of more personalized and effective interventions tailored to the diversity of university learners.

7. Conclusion

This research aimed to shed light on undergraduates' learning after using educational videos and serious games with GBL methodology in an online higher education context. The research focused on the implementation of a structured didactic experience during the 2022–2023 academic year, designed to innovate pedagogical practice and enhance student learning outcomes. A pre- and post-intervention questionnaire was used to assess students' perceptions of their learning.

The current educational environment, characterized by active learning methodologies and digital resources, constitutes the context of this online research. Specifically, learning based on digital games is an effective pedagogical alternative in Higher Education to promote active, participatory, and playful learning (Arbuckle, 2021; Ishak et al., 2023). This approach is consistent with the didactic experience carried out to improve student learning. The results of the study point to positive but limited learning effectiveness after the use of meaningful digital games. This type of methodology involves university students in their learning, motivating them and fostering autonomous learning (Shohel et al., 2022; Udeozor et al., 2022), and it has also been shown to encourage sustained attention to instructional content (Zou et al., 2021).

The study offers several pedagogical implications that verify an improvement in the quality of the teaching-learning process in an online training context. First, it demonstrates that the integration of serious games and educational videos can enhance the quality of the teaching-learning process in online environments. The proposed instructional model is transferable to other virtual courses and disciplines. Second, these digital resources were shown to promote interaction, motivation, engagement, and participation. Educational videos, in particular, supported the development of cognitive skills and the construction of knowledge. Overall, the findings confirm the effectiveness of digital GBL in innovating teaching methods and enriching higher education practices. Finally, the theoretical underpinnings of this study are grounded in the principles of Gee (2003), who argues that well-designed video games create authentic learning environments where

students solve problems, receive immediate feedback, and apply knowledge in meaningful contexts. These principles are fully aligned with the pedagogical foundations of our proposal, which emphasizes active, participatory, and autonomous learning through the use of the *Discovery Tour* mode in *Assassin's Creed Odyssey* and gamified platforms such as Socrative and Cerebriti.

In the same vein, we highlight the contributions of Gentile et al. (2014), who developed the *General Learning Model*, an approach that conceptualizes learning as a dynamic sequence of challenge, response, and feedback. This model facilitates active cognitive immersion on the part of the learner and is directly reflected in the structure of our proposal, in which students engage in gamified activities that involve decision-making, trial and error, and critical reflection. Similarly, Wardoyo et al. (2021) emphasize that GBL fosters autonomous, adaptable, and meaningful learning by placing students at the center of the process and enabling them to learn through action in safe and motivating environments. These principles are embodied in the use of the *Discovery Tour* mode of *Assassin's Creed Odyssey*, which offers immersive experiences free from unnecessary distractions or competition, allowing for the exploration of historical curricular content through an experiential lens.

Author Statement

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