

EDUCATIONAL TECHNOLOGIES IN NURSING: GAMIFIED LEARNING FOR DRUG PREPARATION AND ADMINISTRATION

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ABSTRACT

The use of gamification as a pedagogical strategy in nursing education has shown potential to optimize the teaching-learning process, highlighting the need for evaluating structured proposals that support its systematic implementation. This study aimed to develop and implement a hybrid course, offered both in-person and online, on drug preparation and administration, incorporating gamification elements as an evaluative tool to analyze the effectiveness of active methodologies among undergraduate nursing students. This is a technological, cross-sectional study with a quantitative approach, conducted between 2020 and 2023, involving 80 students from the 2nd and 3rd years of the Nursing program at the Federal University of São Paulo. The first phase included the development of theoretical content and the creation of the online course, along with the design of a game-based assessment activity. In the second phase, the course was initially delivered in person and, one month later, offered online with the gamified activity. Student performance was assessed using a structured questionnaire via Google Forms®. Results showed an average score of 55.58% in the in-person course and 80% in the online gamified version. Performance across different levels of question complexity was also higher in the online format. It is concluded that the integration of interactive games into the nursing curriculum significantly enhances learning by promoting greater student engagement, understanding, and academic performance.

Keywords: Educational Assessment; Distance Education; Nursing Students

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TECNOLOGIAS EDUCACIONAIS APLICADAS AO ENSINO DE ENFERMAGEM: GAMIFICAÇÃO NO PREPARO E ADMINISTRAÇÃO DE FÁRMACOS

RESUMO

A utilização da gamificação como estratégia pedagógica na educação em enfermagem tem demonstrado potencial para otimizar o processo de ensino-aprendizagem, sendo necessária a avaliação de propostas que sustentem sua aplicação de forma sistematizada. O presente estudo teve como objetivo desenvolver e implementar um curso híbrido nas modalidades presencial e à distância sobre o preparo e administração de medicamentos, incorporando recursos de gamificação como instrumento avaliativo, para analisar a efetividade de metodologias ativas dos discentes da graduação em enfermagem. Trata-se de um estudo tecnológico, de abordagem quantitativa e delineamento transversal, conduzido entre os anos de 2020 e 2023, com a participação de 80 estudantes do 2º e 3º anos do curso de Enfermagem da Universidade Federal de São Paulo. A primeira etapa contemplou a elaboração do conteúdo teórico e do curso online, bem como o desenvolvimento de uma atividade avaliativa em formato de jogo educativo. Na segunda etapa, o curso foi inicialmente ofertado de forma presencial e, após um mês, disponibilizado em formato online com a atividade gamificada. A avaliação do desempenho foi realizada por meio de questionário estruturado no Google Forms®. Os resultados indicaram média de acertos de 55,58% no curso presencial e 80% no curso online com gamificação. O desempenho por nível de complexidade das questões também foi superior na modalidade online. Conclui-se que a inserção de jogos interativos no

O contexto da formação em enfermagem favorece significativamente a aprendizagem, promovendo maior engajamento, compreensão e desempenho acadêmico dos estudantes.

Palavras-chave: Avaliação Educacional; Educação a Distância; Discentes de Enfermagem;

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RESUMEN

El uso de la gamificación como estrategia pedagógica en la educación en enfermería ha demostrado potencial para optimizar el proceso de enseñanza-aprendizaje, lo que pone de relieve la necesidad de evaluar propuestas estructuradas que sustenten su implementación sistemática. Este estudio tuvo como objetivo desarrollar e implementar un curso híbrido, ofrecido tanto de forma presencial como en línea, sobre la preparación y administración de medicamentos, incorporando elementos de gamificación como herramienta de evaluación para analizar la eficacia de las metodologías activas entre estudiantes de grado en enfermería. Se trata de un estudio tecnológico, transversal y de enfoque cuantitativo, realizado entre 2020 y 2023, con la participación de 80 estudiantes de 2.º y 3.º año del programa de Enfermería de la Universidad Federal de São Paulo. La primera etapa incluyó el desarrollo del contenido teórico y la creación del curso en línea, así como el diseño de una actividad de evaluación basada en un juego educativo. En la segunda etapa, el curso se impartió inicialmente de forma presencial y, un mes después, se ofreció en línea con la actividad gamificada. El desempeño de los estudiantes se evaluó mediante un cuestionario estructurado en Google Forms®. Los resultados mostraron un promedio de aciertos del 55,58 % en el curso presencial y del 80 % en la versión en línea gamificada. El desempeño en los distintos niveles de complejidad de las preguntas también fue superior en el formato en línea. Se concluye que la inclusión de juegos interactivos en el contexto de la formación en enfermería favorece significativamente el aprendizaje, promoviendo un mayor compromiso, comprensión y desempeño académico de los estudiantes.

Palabras clave: Evaluación Educativa; Educación a Distancia; Estudiantes de Enfermería

INTRODUCTION

Information Technologies (IT) have driven significant advances in twenty-first-century education, especially by expanding access to knowledge and accommodating different learning styles (Druce & Howden, 2017). In this context, Distance Education (DE) has stood out for meeting students' needs and offering opportunities for personal and professional development in different educational settings (Lochner et al., 2016; Druce & Howden, 2017; Burgess et al., 2017).

DE was designed to align with students' profiles, providing progressive learning experiences supported by innovations in pedagogy, instructional design, mobile technologies, and digital educational resources (Cohen et al., 2018; Stamps & Opton, 2019). Current reflections indicate that educational technologies should not be optional, but an essential part of education, and point out that DE can achieve levels of excellence comparable to in-person education because of the variety of interactions with content (Wozniak, Ellaway & De Jong, 2018; Casida & Vandermolen, 2018; Pennington et al., 2018; Tobase et al., 2018).

These technologies promote interactive strategies that stimulate reasoning and motivate students, fostering important cognitive and behavioral changes in the university context (Drummond et al., 2017; Cook et al., 2018; Stamps & Opton, 2019). In this setting, gamification has become established as a promising pedagogical resource. Based on playful dynamics, educational games enrich learning, particularly in health care, which requires critical decision-making skills (Johnson et al., 2016; Sardi et al., 2017; Kelders et al., 2018). Digital games enable safe simulations without risks to patients and have been adopted as effective training strategies, especially in preventing failures related to medication administration—one of the leading causes of adverse events in care (Johnson, Guirguis & Grace, 2015; Lumsden et al., 2016; Da Silva & Krishnamurthy, 2016; Kelders et al., 2018; Rodrigues et al., 2019).

Since 2010, the São Paulo Regional Nursing Council (COREN-SP) has mobilized professionals to promote patient safety, encouraging a critical stance toward identifying failures. In 2017, COREN-SP released "Safe medication use: Guide for Preparation, Administration, and Monitoring" (COREN-SP, 2017). Although educational campaigns are relevant, practical and continuous training initiatives represent significant progress in the pursuit of better care practices. Thus, encouraging and strengthening Continuing Education sectors is essential for improving professionals' technical and scientific competencies.

In addition, CNE/CES Resolution No. 3/2001 and the National Curriculum Guidelines (DCN) establish that nurses must receive critical, reflective, and generalist training, be able to learn continuously, and act in accordance with the principles of the Unified Health System (SUS), guided by universality, comprehensiveness, and equity (MEC, 2001).

Against this background, this article aimed to develop and implement a hybrid course, in in-person and online formats, on medication preparation and administration, incorporating gamification as an assessment resource to analyze the effectiveness of active methodologies in the teaching-learning process of undergraduate nursing students.

METHODOLOGY/MATERIALS AND METHODS

Design

This study was characterized as technological, exploratory, cross-sectional research with a quantitative approach. The development of the online course and educational games through technological studies encompassed several phases involving investigations and assessments related to the target audience and content. It also included stages such as storyboard creation, prototyping, visual identity development, design and layout arrangement, as well as formulation of the methodological and pedagogical navigation design and definition of actions, outcomes, and scoring systems, varying according to the complexity and technological elements involved in the interaction. These studies underwent validations based on benchmarking and were also subjected to user performance and satisfaction analysis.

The development of the course and the game was grounded in active teaching methodologies, which place students at the center of their own learning. According to Bacich, Tanzi, and Trevisani (2015), active methodologies promote students' active participation in constructing knowledge through strategies such as problem-based learning, projects, games, and the use of digital technologies. Moran (2015) reinforces that, with the pedagogical use of technology, it is possible to create interactive and meaningful experiences that enhance students' engagement, autonomy, and critical reflection. In this context, the use of educational games presents itself as an effective tool by stimulating problem-solving, decision-making, and clinical reasoning, central elements in the meaningful learning process.

Still from this perspective, Bordenave and Pereira (2011) emphasize that genuine learning occurs when students are encouraged to act, think, and create, becoming active subjects in the educational process. Demo (2011) complements this view by pointing out that teaching is much more than transferring knowledge; it is prompting students to construct meaning.

From reality and investigation. These ideas converge with Freire's (1996) critical pedagogy, according to which dialogue and problematization are essential to the construction of knowledge, promoting a liberating, ethical, and contextualized education. By applying these approaches to the design of an interactive game for teaching safe medication administration practices, this study sought to align technical content with innovative and effective pedagogical practices.

Course and Game Production

The process of creating and implementing the lesson "Basic Concepts of Medication Preparation and Administration" and the activity with games followed the stages below, in accordance with the study's specific objectives: Stage 1 - Analysis and preparation of the lesson content: Application of the online knowledge test via Moodle. "Patient Safety: medication preparation and administration."

The target audience consisted of students enrolled in the second or third year of nursing, and the content was therefore aligned with the institution's curriculum. In addition, a literature review was conducted by searching the Medline bibliographic database for literature from the previous five years, using the following Health Descriptors: Medication Error; Patient Safety; Professional Training; University Education; Educational Technologies. This review aimed to study and select the most recent protocols on the research topic, as well as the best evidence-based nursing practices.

Stage 2 - Assessment and selection of the virtual platform: the virtual platform was analyzed and selected according to the specific features of the content to be applied, taking into account the target audience, educational objectives, pedagogical strategies, type of monitoring (tutored or self-instructional), and duration, set at 30 minutes to integrate the students' complementary activities. In this selection process, cost was not considered, because there are public-domain and open-source platforms that do not require user licenses. These platforms can be programmed and individually adapted to meet specific needs. In addition, ease of use for both developers and students was an aspect of great importance. Platform usability, avoiding

unintuitive and difficult-to-navigate interfaces, was considered in order to prevent problems. It was also necessary to assess the use of specific technological resources, since their implementation requires programmable adaptations to meet the learning objectives. In view of these considerations, Moodle was chosen, a public-domain option that met the study's needs.

Stage 3 - the topics addressed in the lesson/research were developed from the selection of content approved by the author, based on the institution's syllabus. The creation of the game, in turn, followed crucial stages established by the scientific community. These stages seek to prepare, contextualize, and guide the process of creating and developing the activity in question (Figure 1).

Figure 1. Model for constructing educational *games*. Source: Teixeira DG. 2017.



1. Ideia: Pedagogical content, narrative, and gameplay

3. Objectives: Experiences of freedom in learning, creativity, and gameplay

5. Embedded Narrative Structure: Adopt a narrative structure and follow a dramatic arc

7. Dialogues: Instructional texts and character dialogues

2. Story: Plot, events, and conflicts

4. Characters: Develop the dimensions of playable and non-playable characters

6. Scene Outline: Organize scenes with narrative space, characters, objectives, game mechanics, etc.

8. Visual Representation: Storyboard creation

From these initial stages, the methodological and technical representation was obtained as a basis for constructing the game, resulting in the creation of prototypes, storyboards, layouts (menus), and visual identity (Figures 2 to 4).

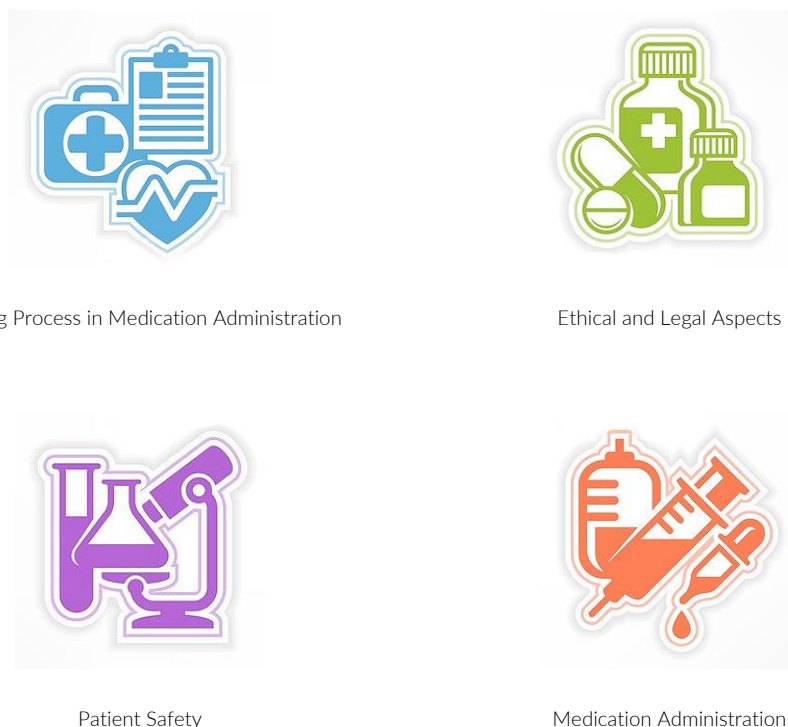
Figure 2. Prototyping and storyboard. Source: Author's own work. São Paulo-SP. 2020.



Figure 3. Visual identity. Source: Author's own work. São Paulo-SP. 2020.



Figure 4. Layout and navigation menus. Source: Author's own work. São Paulo-SP. Source: 2020.



Thus, the decision was made to develop the game through a reasoning and decision-making exercise that included corresponding outcomes. Students had the opportunity to participate in the game once for subsequent performance analysis. The activity was programmed using the H5P content collaboration framework, a free and open-source platform based on JavaScript. This platform is integrated into Moodle to simplify the creation, sharing, and reuse of interactive content. It is also accessible on mobile devices and supports the iOS® and Android® operating systems. As mentioned previously, the virtual platform chosen for the lesson and the game was Moodle, on a Unifesp test platform. It was configured with a specific layout for online activities, including main and secondary menus as well as study sessions for required readings and reflective activities, such as the game. The visual identity was customized with icons for moving forward and backward, among other navigability features. The design process..

Instructional design focused particularly on creating inviting experiences that resulted in meaningful learning.

Stage 4 - The pilot testing of the lesson and game with students did not consume in-person class hours because students were able to complete the activities outside regular class time, using the workload of the curriculum unit related to the topic. The date for the test or game was chosen to coincide with the period when the patient safety topic was being studied, in order to ensure continuity of the subject and complement the teaching plan. For this purpose, the author obtained authorization from the institution's Nursing Program Coordination. Subsequently, students received prior guidance, accessed the environment, and began the study, including navigating the content and completing the game. The activity was conducted individually, and at the end students were instructed to complete a form containing feedback questions about the online lesson. The test had a maximum duration of 30 minutes.

Population and Sample

The population consisted of 80 students of both sexes, with a mean age of 19 and 21 years, from the Nursing Program of the Paulista School of Nursing at the Federal University of São Paulo, São Paulo-SP. The sample was selected from students in the second and third years of this program. To be included in the study, students had to be enrolled and active and agree to participate in the educational activities after signing the Informed Consent Form (ICF). As an exclusion criterion, students could not be engaged in professional nursing activities in health services, whether as volunteers, nursing assistants, or nursing technicians. These measures were intended to ensure and preserve the students' genuine performance through their participation in the educational activities proposed in the study.

Analysis of Results and Statistics

Data on students' performance in the Game were collected by extracting information from Moodle databases. This collection occurred virtually because the activity was carried out by students on the teaching platform itself. The student satisfaction survey was conducted individually, immediately after the activities were completed. The questionnaire consisted of closed-ended questions addressing several aspects, such as ease of access, intuitive navigation, interface quality, the Game's technological performance, learning effectiveness, satisfaction level, capacity for immersion and concentration, and reflection on the content, among other relevant pedagogical aspects. These questions were prepared and made available through the online Google Form® tool, with responses based on a Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). After the response collection period, the data obtained were described through tables and explanatory texts.

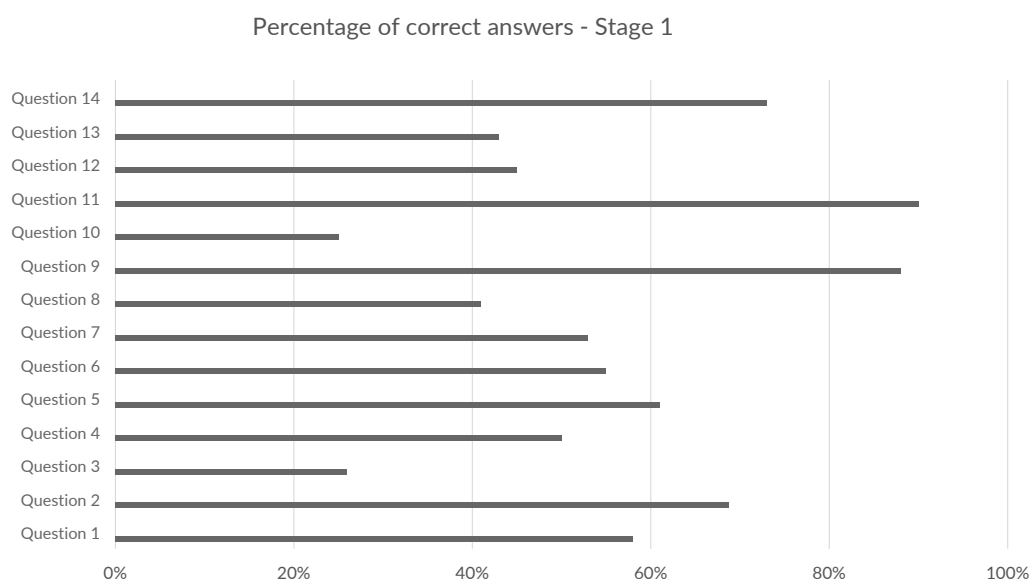
RESULTS/DISCUSSION

Data analysis revealed a high level of engagement and active participation by students in the educational game, with most completing all proposed stages. Records extracted from the Moodle platform showed easy navigation, a user-friendly interface, and an intuitive user experience, favoring participant immersion. The high activity completion rate suggests effective application of the content addressed.

Data from the first stage of the educational game's application in 2022 indicated a solid understanding of the content addressed, especially in safe prescribing (68.75% correct), enteral administration (87.5%), and intramuscular administration (90%). Topics such as handwashing (74.68%) also achieved good accuracy rates. On the other hand,

Contents considered more complex, such as sublingual administration (26.25%) and parenteral administration and absorption (25%), showed lower performance, indicating the need for pedagogical reinforcement on these points (Figure 5).

Figure 5. Number of correct answers - Stage 1 of the Game application. Source: Author's own work. São Paulo-SP. 2023.



In the second stage of the game, conducted in 2023, the questions were organized into levels of complexity (low, medium, and high), allowing for a more structured assessment of participants' competencies (Table 1). The results revealed significant differences between tests administered in person and online.

Table 1. Performance Comparison: Tests Administered In Person vs. Online by Complexity Level. Source: Author's own work. São Paulo-SP. 2023.

LOW COMPLEXITY		
STATEMENT	IN-PERSON TEST	ONLINE TEST
Q7. The intradermal route is indicated for hypersensitivity tests and consists of introducing medication directly into the dermis by puncture. The ideal body areas are those without hair and with little pigmentation. The main sites are the inner forearm and the upper back; the formation of a wheal at the injection site indicates that the technique is correct. Administration is not recommended if the patient's skin is moist, and the site should not be massaged. According to the guidance above, select the incorrect alternative.	42 (53%)	70 (88%)
Q9. The subcutaneous route is indicated mainly for slowly absorbed medications; the best known include heparin, insulin, and vaccines. The sites indicated for this technique are the posterolateral surfaces of the arms, the abdomen, the anterior thigh, the scapular area, and the upper ventral and dorsal gluteal areas. Regarding medication administration, it is correct to state:	70 (88%)	75 (94%)
Q11. For intramuscular medication administration, the following must be considered when choosing the site: muscle mass large enough to absorb the medication, adipose tissue thickness, the patient's age, the drug's irritability, and distance from important vessels and nerves. Select the correct option.	72 (90%)	49 (61%)
Q12. Regarding injection sites, four muscles may be used: 1 - Ventrogluteal-involves the gluteus medius muscles. 2 - Vastus lateralis-the muscle is located on the anterolateral surface of the thigh. 3 - Dorsogluteal-the gluteus maximus muscle is the traditional injection site, but because there is a risk of reaching the sciatic nerve, it is not recommended in some. 4 - Deltoid-the muscle is not well developed and is used for administering small volumes. Indicate the medication administration route suitable for moderate volumes, oily vehicles, and some irritant substances. Select the correct alternative:	36 (45%)	77 (96%)
Q15. Handwashing represents an important form of prophylaxis against hospital infections and, together with other strategies, is essential for infection control in the hospital environment. Handwashing should occur from personal hygiene moments to necessary moments such as entering the unit to provide noninvasive and invasive patient care. The handwashing technique is most often inadequate because some steps in the process are forgotten and because of workload, with concern for quantity rather than quality. Based on the alternative above, select the correct alternative.	64 (84%)	77 (96%)

MEDIUM COMPLEXITY		
STATEMENT	IN-PERSON TEST	ONLINE TEST
Q1. The main rules governing prescription are Federal Laws 5,991/73 and 9,787/99, as well as Resolution 357/2001 of the Federal Council of Pharmacy and Resolutions 1,552 (of 20/08/99), 1,477 (of 11/7/97), and 1,885 (of 23/10/08) of the Federal Council of Medicine. In the State of São Paulo, CREMESP Resolution No. 278/2015, which regulates medical prescription of medications, is in force. Medical prescription of medications must comply with minimum criteria. In this case, analyze the alternatives below and select the incorrect alternative regarding what the CREMESP Resolution establishes.	46 (58%)	76 (95%)
Q2. The National Patient Safety Program (PNSP), established by the Ministry of Health through Ordinance MS/GM No. 529 of April 1, 2013, includes the protocol "Safety in the prescription, use, and administration of medications." According to this protocol, the most common errors occur during prescribing and administration. For safe medication prescribing in the hospital unit, the following must be considered: select the correct alternative.	55 (68,7%)	65 (81%)
Q4. Compared with the oral route, the sublingual route allows a drug to enter the body more quickly. Some observations must be made regarding this sublingual route of medication administration. Select the alternative that does not correspond to the concepts of sublingual administration:	40 (50%)	67 (84%)
Q5. Oral medications refer to the administration of drugs that are swallowed and absorbed mainly through the gastrointestinal tract. The oral route is the most common and most frequently used for medication administration because it is safer, more economical, and more comfortable than other routes. Select the correct alternative. The administration route that DOES NOT avoid hepatic first-pass metabolism is the following route:	49 (61%)	71 (89%)
Q14. Intravenous medication administration consists of introducing medication and/or solutions directly into a vein (bloodstream) through venipuncture for rapid absorption of the substance in use, whether hypertonic, isotonic, or hypotonic solutions, organic salts, electrolytes, or medications that must be soluble in blood and free of crystals or any other visible suspended particles. COFEN Virtual Library-2020. Medication administration is one of the activities performed very frequently by nursing technicians and requires close attention and solid technical-scientific grounding. Analyze the items below:	59 (73%)	49 (61%)

HIGH COMPLEXITY		
STATEMENT	IN-PERSON TEST	ONLINE TEST
Q3. The sublingual route is used especially for nitroglycerin medication in angina situations because of its rapid absorption, as the medication is absorbed and enters the bloodstream immediately without first passing through the intestinal wall and liver. Regarding medication administration routes, select the incorrect alternative:	21 (26%)	39 (49%)
Q6. The oral route is comfortable and the most widely used and known, painless and safe for administering medications. It is self-administered and absorbed through the intestinal mucosa, the medium through which it reaches the bloodstream. Liquid drugs are absorbed more easily than tablets or capsules when handled orally because they do not need to be broken down by the body beforehand. According to the statement above, select the correct alternative:	44 (55%)	43 (54%)
Q8. The intradermal route is also indicated for administering vaccines and as an aid in diagnostic and sensitivity tests. Regarding administration routes, analyze the incorrect alternative:	33 (41%)	68 (85%)
Q10. In order to avoid errors during medication administration and provide greater medication absorption, the use of vasoconstrictors or warming the site is highly recommended for this enteral route, in which drugs are administered: Select the correct alternative.	20 (25%)	76 (94%)
Q13. Choosing the intravenous route provides a rapid response to the medication's action in the body. The intravenous route is medication administration that occurs directly in the bloodstream, promoting rapid absorption. It can be performed at several peripheral or central access sites. Fill in the blanks according to the alternatives below: The main parenteral administration routes are _____, _____, and intramuscular. By the _____ route, drugs in solution are absorbed rapidly depending on the blood-flow rate at the administration site. Select the alternative containing the expressions that correctly complete the blanks in the text above.	35 (43%)	70 (88%)

For low-complexity questions (items 7, 9, 11, 12, 15), students achieved a higher number of correct answers in the online tests, possibly because of their familiarity with the virtual environment. The same pattern was observed in medium-complexity questions (items 1, 2, 4, 5, 14), related to oral, sublingual, and intravenous administration and to reading prescriptions, where performance was also higher in the online format.

For high-complexity questions (items 3, 6, 8, 10, 13), performance was again better online, suggesting that the virtual environment provides a context more conducive to understanding more elaborate content-perhaps because it reduces stressors typical of in-person assessments and offers students autonomy in conducting the activity. These findings reinforce the importance of reassessing the teaching and assessment methods used in the in-person format, indicating the potential of educational technologies and interactive methodologies to support learning, especially for content requiring greater clinical reasoning and critical interpretation.

CONCLUSION

The results of this study show that the use of educational games represents an effective strategy for teaching medication preparation and administration to nursing students. Gamification demonstrated potential to facilitate understanding of theoretical content, promote greater knowledge retention, stimulate student engagement, and develop practical skills in a safe and interactive environment. By transforming learning into a dynamic experience, games contribute to training professionals who are better prepared, critical, and aware of the importance of safety in medication administration. Thus, integrating educational games into the nursing curriculum constitutes a promising approach aligned with the contemporary needs of health education.

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