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Pediatric Prev-Sepsis Digital Educational Game

Jogo Educativo Digital Prev-Sepse Pediátrica

Juego Educativo Digital Prev-Sepse Pediátrica

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ABSTRACT

Introduction: Serious games are a new teaching and learning strategy in the fields of education and health; however, few are available for healthcare professionals on pediatric sepsis.Objective: To describe the development of a prototype of an educational and digital game on pediatric sepsis. Method: This is a methodological study for the creation of an educational and digital game, based on the design thinking methodology. The content was extracted from nationally and internationally published scientific evidence. The screens were developed according to serious game design requirements and created using the Canva online platform. Results: The game screens for *Prev-Sepse Pediátrica* were developed with gamification elements that facilitate learning about: the concept, identification, initial treatment, and prevention of sepsis; as well as the concept and prevention of healthcare-associated infections. Conclusion: The prototype provides a preview of the game's content, as well as the visual format and screen dynamics of the executable version.

DESCRIPTORS:

Games; Software; Sepsis; Pediatrics; Distance Education; Educational Technology.

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INTRODUCTION

Gamification is characterized by the use of game elements in contexts beyond mere entertainment, aiming to maintain the player's interest and motivation while delivering educational content, without necessarily involving a complete game.[1]

In today's society, gamification is present as a new teaching methodology across various levels of education, including elementary, secondary, and higher education. Given the trends and advantages identified in this type of teaching and learning strategy, games,especially digital ones,are also beneficial for professionals, including those working in healthcare.[2-3]

When games have objectives beyond entertainment, they are referred to as serious games, as they are internationally known. In healthcare, serious games can be used to educate the general population, students, and professionals across various specialties.[4]

Serious games can be designed for health promotion and disease prevention for individuals of varying age groups, such as games developed to teach children about oral hygiene or to prevent childhood obesity. There are also educational games aimed at students on how to carry out the nursing care process or teach basic life support.[5-8]

Although the literature features several serious games focused on health, there is a predominance of studies targeting the general population or students, with few aimed at active professionals in healthcare services. Only a minority of games are developed for both academic and professional training on sepsis—especially pediatric sepsis.[4,9-10]

Digital games keep individuals more actively engaged in the learning process, while also maintaining their interest and motivation for longer periods due to their dynamic and interactive nature. This innovative teaching methodology aims to keep pace with societal development and has the added advantage of being accessible anytime and anywhere through widespread use of mobile devices.[11-13]

Therefore, this study aims to describe the development of an educational digital game on pediatric sepsis.

METHODS

This is a methodological study aimed at developing an educational digital point-and-click game (an interaction method that involves using a mouse or touchpad to point, click, and perform desired actions), based on the design thinking methodology for problem-solving and project creation. Design thinking involves the stages of inspiration, ideation, and implementation.[14-15]

In the inspiration stage, the needs of individuals are understood, and the problems are defined. In this study, challenges in training healthcare professionals and students on pediatric sepsis were identified, considering the work dynamics and time constraints for educational activities.[14-15]

All content deemed essential regarding Healthcare-Associated Infections (HAIs) and pediatric sepsis—specifically definitions, causes, prevention, and treatment—was collected based on references published up to the game's development. These references were found in the following documents: Diagnostic Criteria for Healthcare-Associated Infections; Measures for the Prevention of Healthcare-Associated Infections; Pediatric Clinical Protocol from the Latin American Sepsis Institute; International Guidelines for the Management of Septic Shock and Organ Dysfunction in Children; and the International Consensus on Pediatric Sepsis and Septic Shock Criteria.[16-20]

A scoping review was conducted on educational technologies related to sepsis using the following databases: PubMed, LILACS, Cochrane, Web of Science, Scopus, and Embase. A total of 1,138 studies were initially retrieved. After screening and eligibility assessment, only 9 articles were included, revealing a low number of games, apps, or other educational technologies addressing the topic—particularly in pediatrics and targeting professional education.

A quick search was also performed on mobile app download platforms to identify games or apps about sepsis. Similarly, only a small number of software options were found, and few were focused on professional education.

During the ideation stage, ideas were generated to solve the problem and develop the product. It was considered necessary to provide concise yet sufficient content on pediatric sepsis for the learning of healthcare professionals and students—accessible according to the individual's availability. This led to the

creation of a medium- to high-fidelity prototype of the educational digital game on pediatric sepsis.[14-15]

Also in the ideation phase, a mind map was created on HAIs and pediatric sepsis content to be included in the prototype, using the Canva platform.

As a learning game, the prototype was designed to deliver content on HAIs and pediatric sepsis while incorporating gaming and gamification elements, as proposed by Kapp and Boller (2018), outlined in Table 1.[1]

Table 1. Characteristics of the "Prev-Sepsis Pediatric" game according to items proposed by Kapp and Boller (2018). Londrina, Paraná, Brazil, 2024.

Item	Prev-Sepsis Pediatric
Game Goal What must be done to win the game	Treat and prevent sepsis
Instructional Objective What should be learned from the game	Learn the definitions of HAIs* and sepsis, how to identify a potential case of HAI* and sepsis, the initial steps to take in response to a sepsis scenario, and how to prevent HAIs* and sepsis.
Core Dynamics What must be done to achieve the game's goal	Solution: solving questions about HAI* and sepsis and making decisions according to the proposed problem and situation.
Game Mechanics Set of rules to reach the final goal	There are five stages. In each stage, the player must correctly choose the response or action according to each question. If the answer is correct, the player proceeds to the next stage; otherwise, they have the opportunity to try again. When answered correctly, the response is shown again to reinforce the content. In the case of an error, the correct answer is displayed, and only after that can the player attempt again, reinforcing the content once more.
Game Elements Components that enhance the game experience (gamification strategies)	Theme: pediatric sepsis. Aesthetics: the game setting is a hospital; the images reflect a hospital environment, and the characters are also based on this context (patient and healthcare professional). Storyline: the game involves a child showing signs and symptoms of sepsis originating from an HAI*. Timing: in stage 4, where actions must be taken in response to a sepsis case simulating real life, the player must make quick decisions. Levels: each stage of the game presents a higher level of difficulty than the previous one.

***HAI:** Healthcare- Associated Infection.
Source: Adapted from Kapp and Boller (2018).[1] **Content:** Brazil (2017a); Brazil (2017b); ILAS (2019); Schlapbach et al. (2024); Weiss et al. (2020).[16-20]

The prototype was intentionally developed for use on computers or mobile devices. It was created using the online Canva platform, and the images were sourced from Canva, Freepik, and iStock, following subscription-based licensing.

Finally, in the implementation phase, the prototype was made available to professionals in the field for content evaluation and validation. After the assessment, feedback was provided regarding the elements they agreed with and those that required improvement.

Given that this is a learning game designed to educate both healthcare professionals and students, it was decided in this phase to deliver the material to pediatric specialists and request an evaluation and feedback on the content. Interface and usability will be validated separately by technology experts using a different validation form and scale, only after the completion of the content validation.

The evaluation was carried out in two rounds using a Google Forms questionnaire. The judges were intentionally selected through a non-probabilistic approach, based on the following criteria: holding a degree in Nursing or Medicine, possessing at least a postgraduate degree in Pediatrics, and working in secondary or tertiary healthcare services in the municipality of Londrina, Paraná. The form consisted of 50 questions covering all prototype screens, with five-point Likert scale responses: 5 – strongly agree; 4 – agree somewhat; 3 – neither agree nor disagree; 2 – disagree somewhat; 1 – strongly disagree. An open-ended question was also provided for evaluators to offer suggestions or comments on each screen.

After the first round, the judges were invited to participate in a second round and completed a questionnaire aimed at content validation, with multiple-choice questions based on a previously validated Educational Content Validation Instrument in Health. Following the feedback from professionals, the material was revised in accordance with the specialists' suggestions, and the game was finalized.

This study is a part of the project *Evaluation of Healthcare-Associated Infections in Children and Adolescents*, approved by the Research Ethics Committee of the State University of Londrina, under CAAE number: 28068119600005231.

The prototype and the name of the digital educational game Pediatric Prev-Sepsis have a trademark registration request filed with the Brazilian National Institute of Industrial Property (INPI) under the number: 934465100.

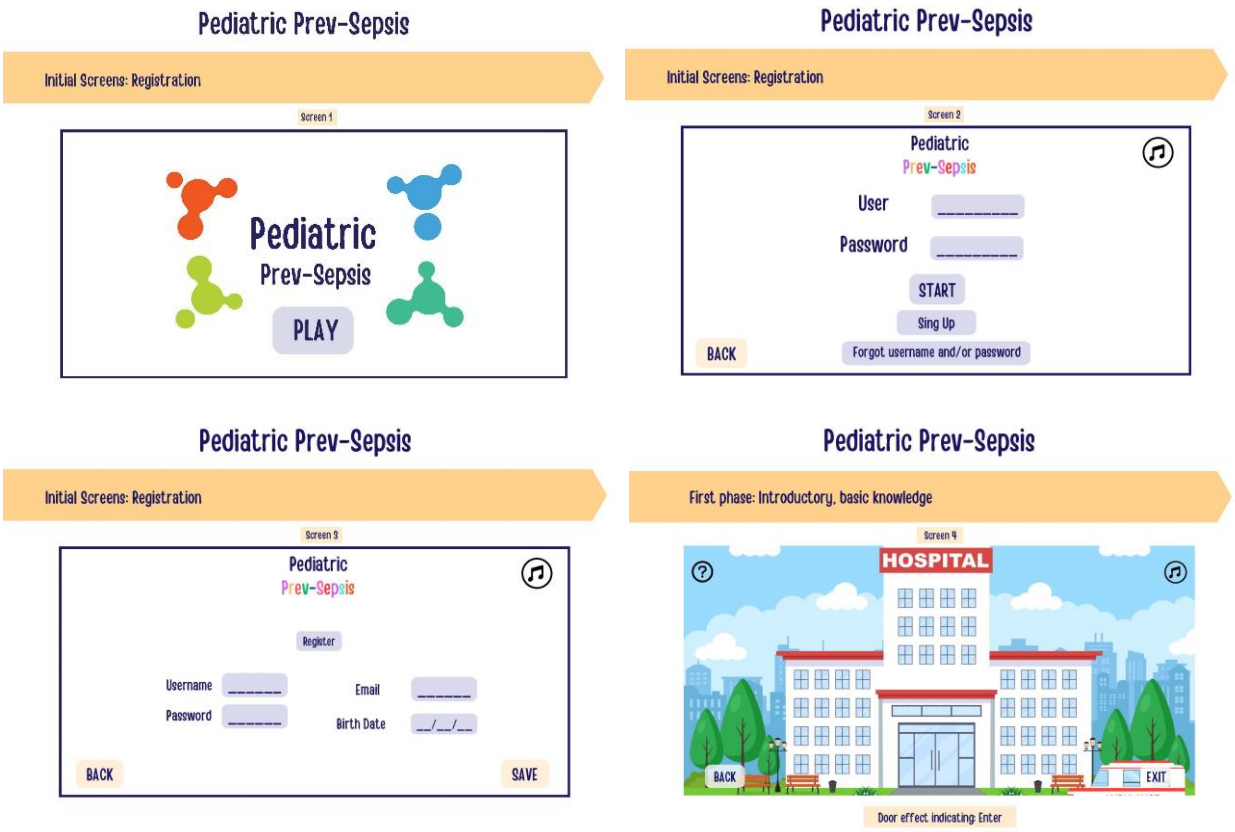
RESULTS

A total of 184 prototype screens were developed and distributed as follows: a) Initial screen: 4 screens; b) Game stages: 1) 23 screens; 2) 13 screens; 3) 17 screens; 4) 14 screens; 5) 91 screens; Help Center: 21 screens. The final screen consisted of 1 screen. The estimated maximum time to complete the game is 20 minutes, depending on each player's prior knowledge and skill level. The formatting and intended game mechanics for each stage are described below.

Initial Screen

The first four screens present elements for player registration, where the user can either register or enter their username and password if already registered. It also includes an option for password recovery. On the actual registration screen, the user must enter a chosen username, password, email address, and date of birth. The fourth screen informs the player that the game is about to begin, indicating that the setting and storyline will take place within a hospital.

Figure 1. Initial prototype screens of the Pediatric Prev-Sepsis game. Londrina, Paraná, Brazil, 2024.



Stage 1

Stage 1 contains 23 screens where the player is introduced to a nurse character who addresses them by the username they previously entered.

The goal in this stage is to unlock doors in order to progress through the game and attend to the child. To achieve this, the player must have basic knowledge about HAIs and sepsis. The game mechanics in this stage are replicated in stages 2 and 3.

On each screen, the player must choose the most appropriate option in response to the character's question. If the player does not know the answer, they are directed to a content screen and then returned to the question screen to respond. If they choose to answer immediately and get it right, they are directed to a screen confirming their response. If the player answers incorrectly, they have the opportunity to try again and select the correct answer on a second attempt.

Figure 2. Sample screens from Stage 1 of the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.

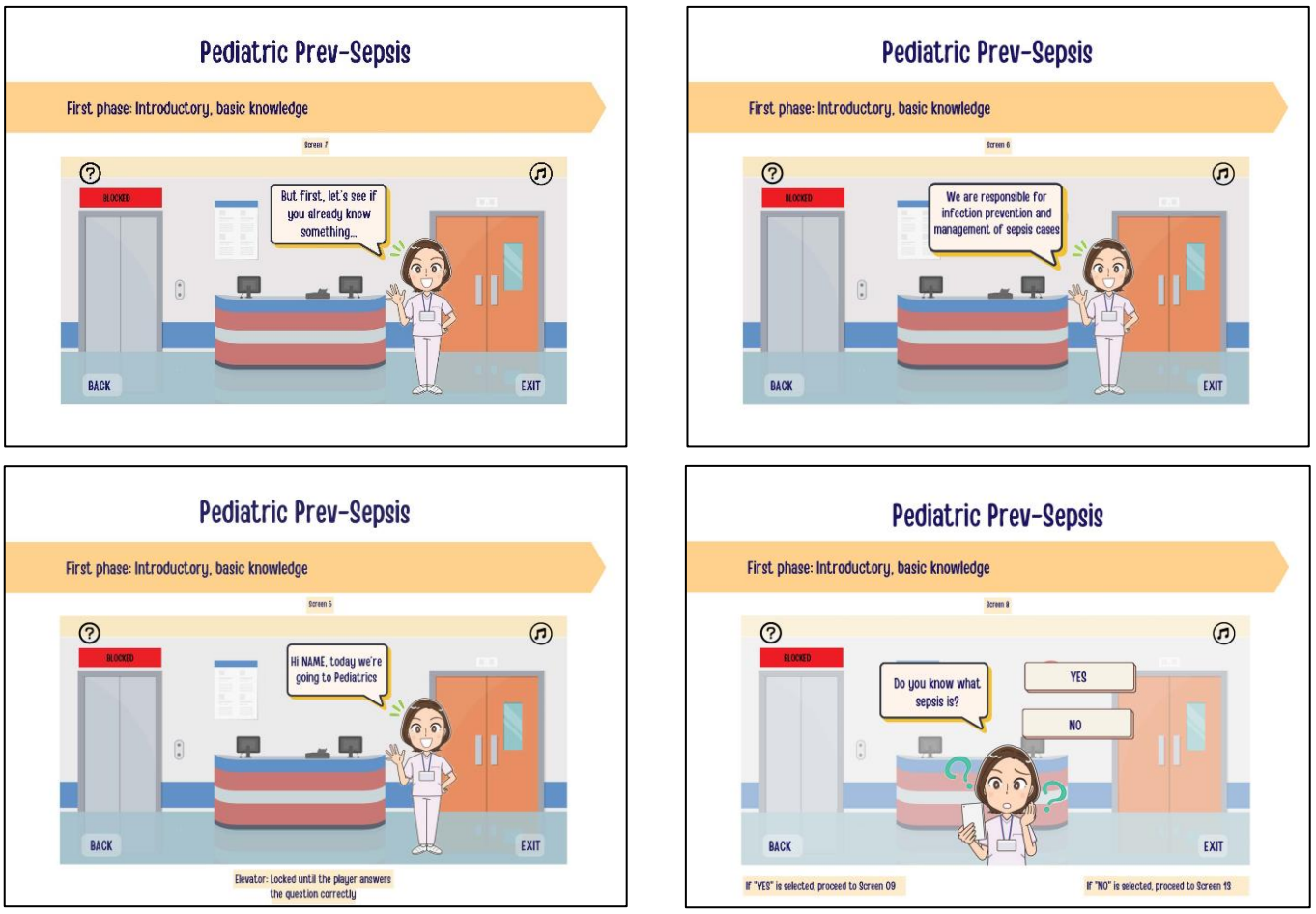
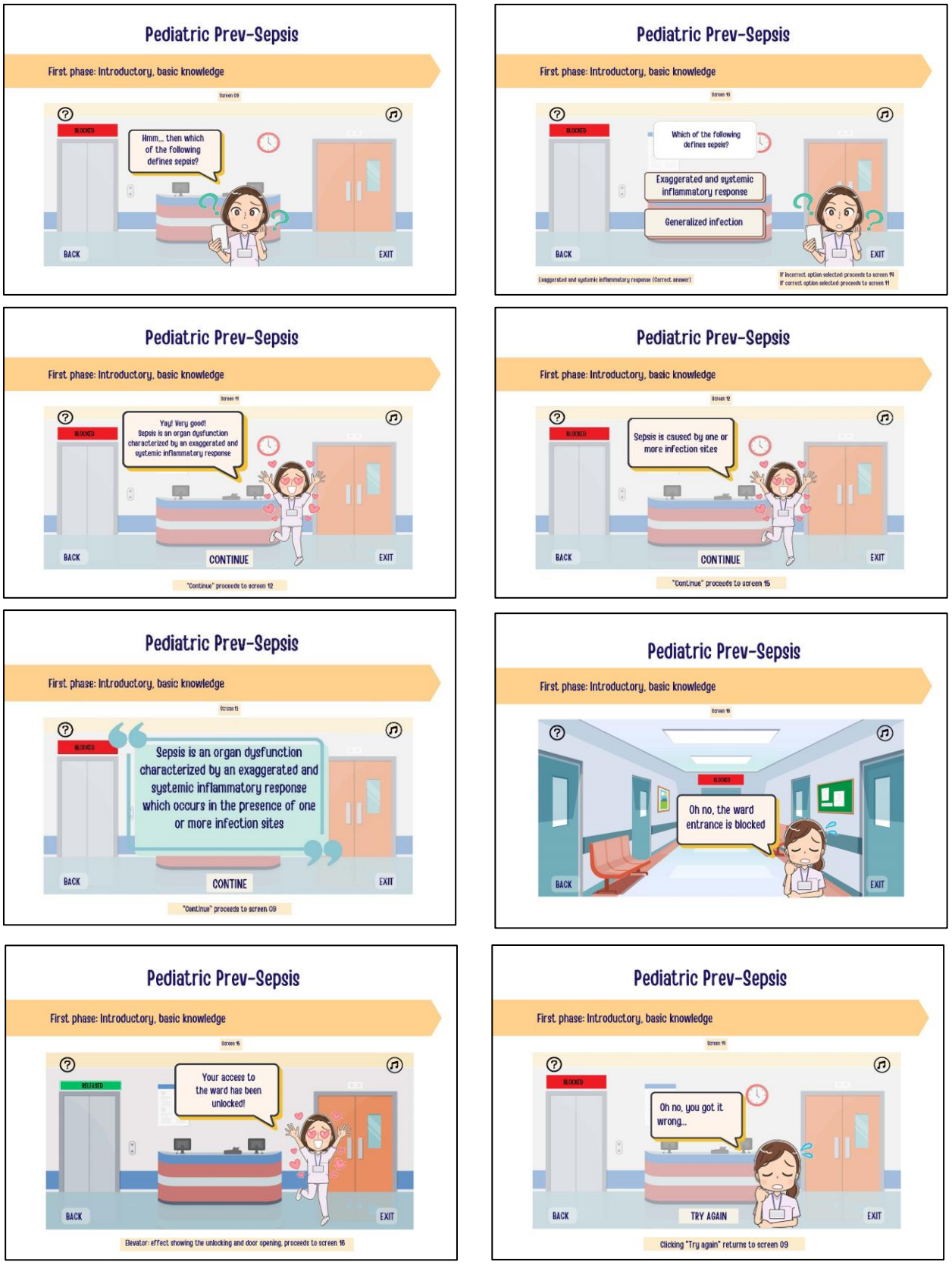


Figure 2, continued. Sample screens from Stage 1 of the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.

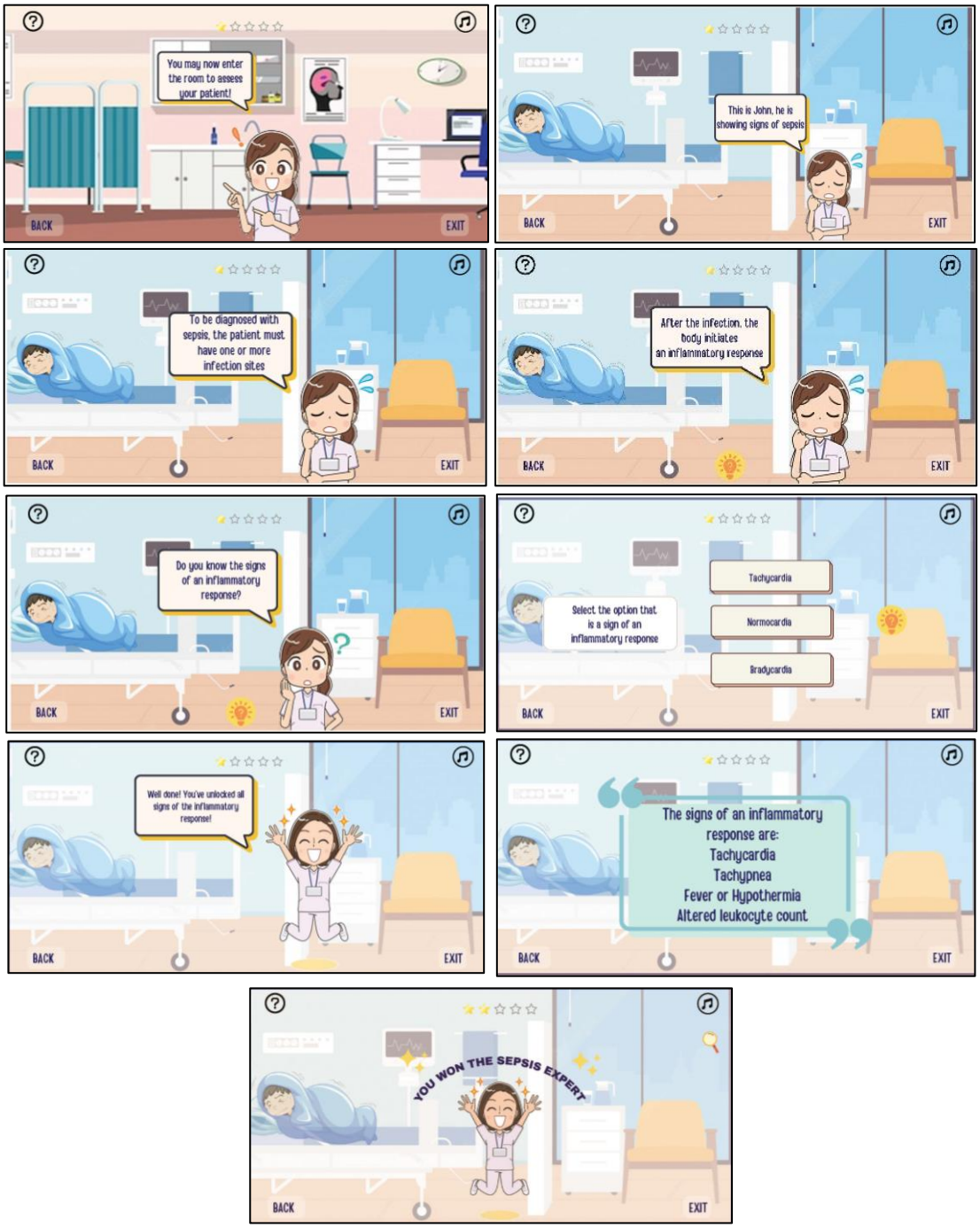


Stage 2

This stage includes 13 screens and follows the same game mechanics as Stage 1 but focuses on content related to systemic inflammatory response. From this stage forward, the player can select an icon that leads to Help Center screens on the topic.

As shown in the images, the player can see which stage they are in, receiving a star in the star panel representing completed stages. Upon finishing this knowledge stage on inflammatory response, the player earns the bonus “Sepsis Expert,” symbolized by a magnifying glass.

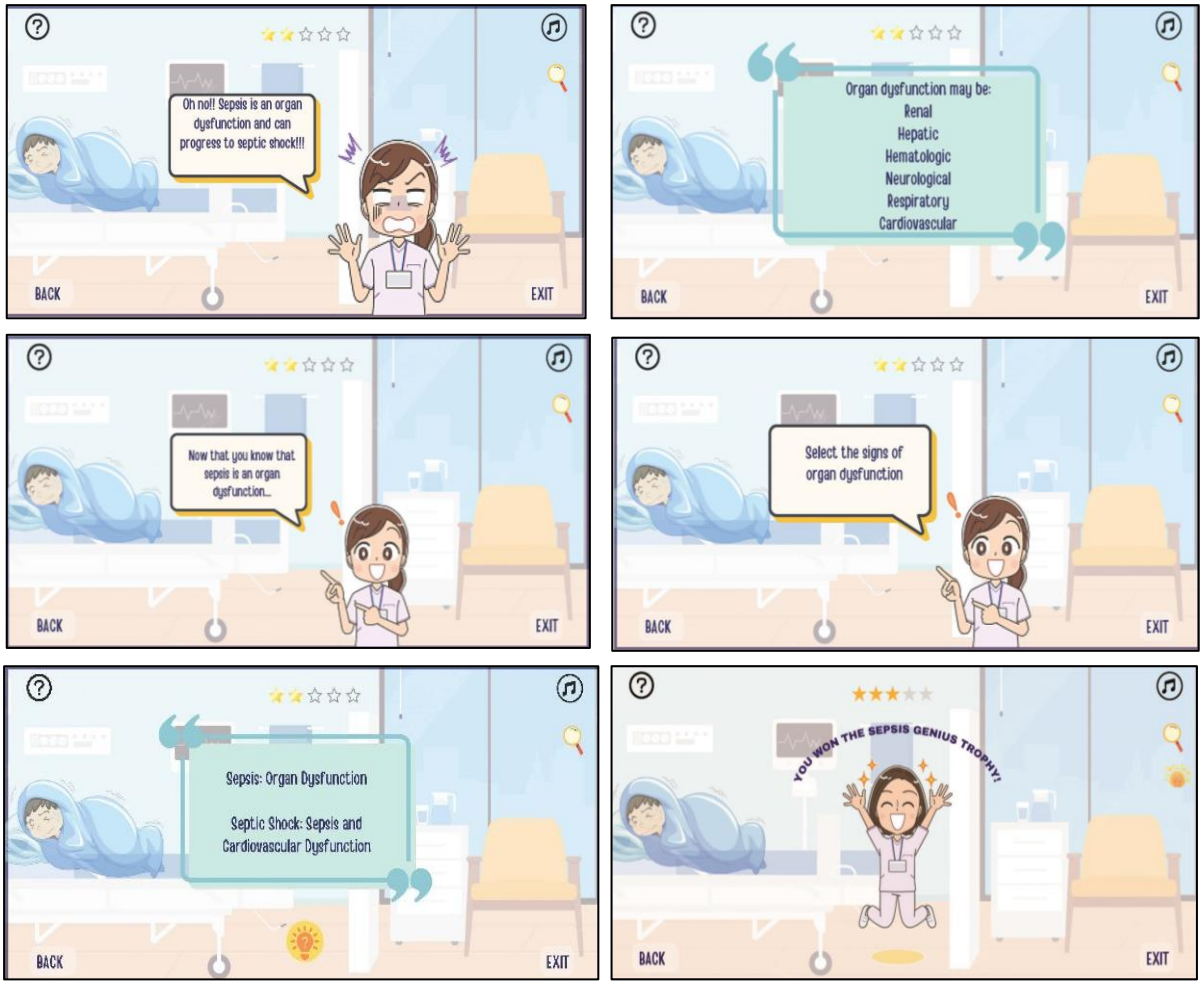
Figure 3. Sample screens from Stage 2 of the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.



Stage 3

Stage 3 consists of 17 screens. Like the previous stages, the player must select the correct option from the alternatives. This stage focuses on signs of organ dysfunction and also offers access to Help Center screens. When the stage begins, the second star is filled in, indicating two completed stages. Upon finishing Stage 3, the player earns the "Sepsis Genius" bonus, represented by a brain, for mastering the signs of organ dysfunction.

Figure 4. Sample screens from Stage 3 of the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.



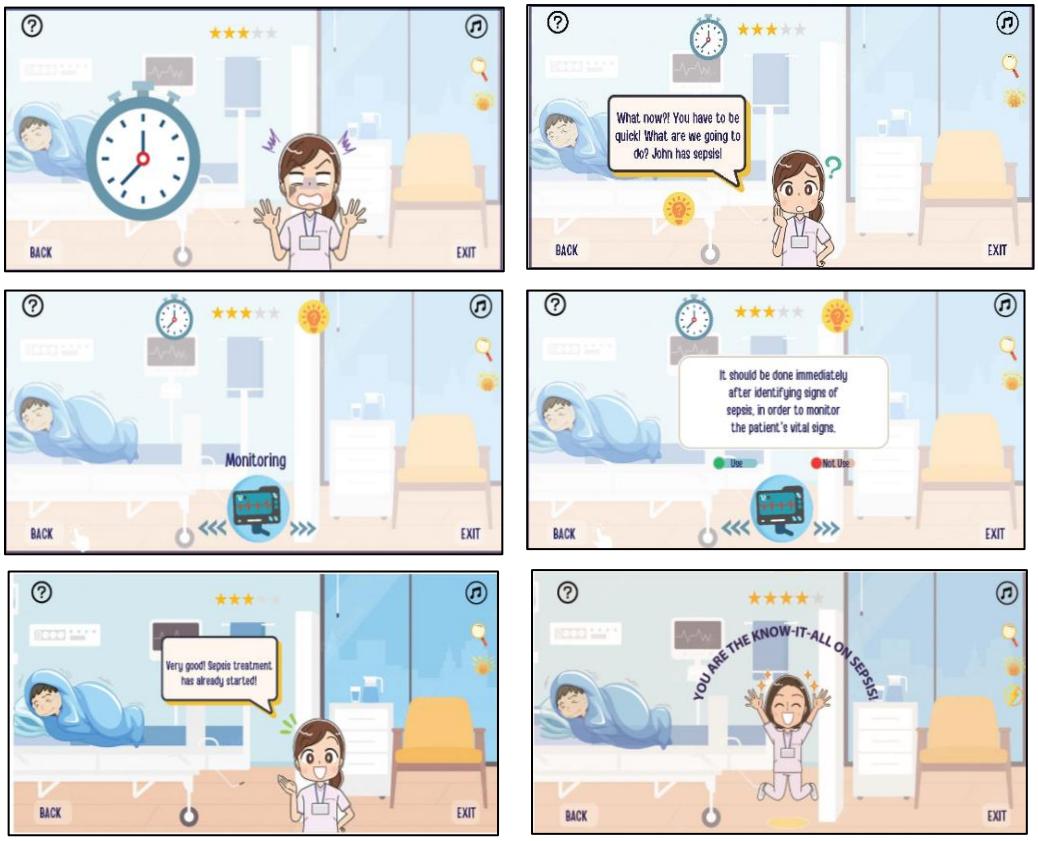
Stage 4

This stage introduces a time-based element and contains 14 screens. A clock icon is prominently displayed, and the player must act within the given time limit, simulating real-life scenarios where professionals must respond within one hour in suspected sepsis with organ dysfunction and within three hours in cases of systemic inflammatory response without organ dysfunction.

To manage these suspected sepsis cases, the player must choose responses based on priority. For each selection, the game provides an explanation of what the action is and what it is for. If the player makes a wrong choice, the available time decreases. If the player fails to complete all required actions in the designated time, they are given another opportunity. Otherwise, the game is not completed.

At this point, three stars are filled in, indicating completion of the previous three stages. At the end of this stage, the player receives the bonus "Sepsis Master," represented by a lightning bolt.

Figure 5. Sample screens from Stage 4 of the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.



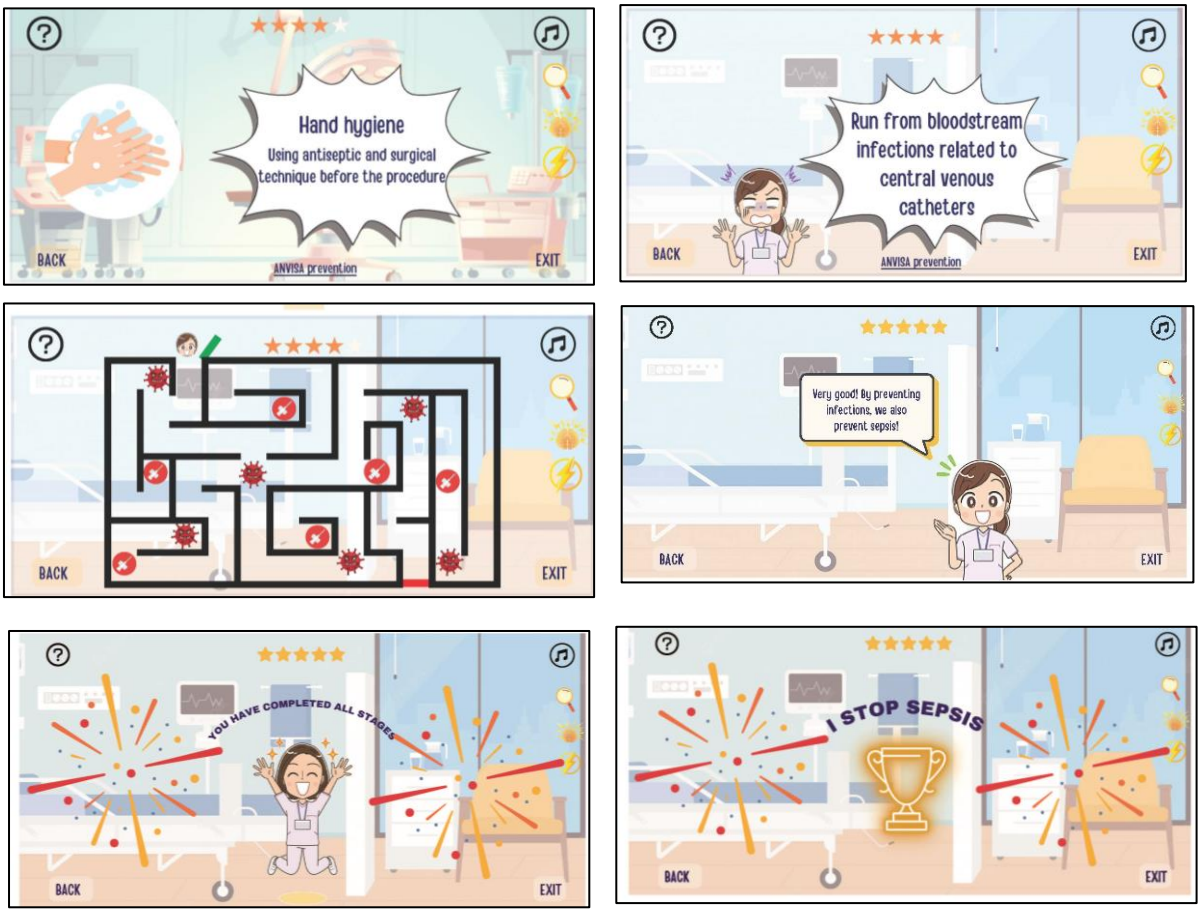
Stage 5

This stage employs a “maze and collection” dynamic and includes 91 screens. It presents prevention strategies for HAIs. The player must guide the character through a maze specific to a type of HAI. Within the maze, there are images simulating microorganisms. If the character is hit, the player loses a life and must restart the maze.

Prevention icons are scattered throughout the maze. When the player reaches an icon, a corresponding HAI prevention strategy is displayed. Each completed maze leads to another with increased difficulty in terms of size and the number of attacking microorganisms.

The action screen in this stage shows four filled stars, indicating four stages have been completed and the player is now on the fifth and final stage. Upon completing this stage, the player finishes the game and receives the highest bonus: “I Stop Sepsis,” represented by a trophy and fireworks—signaling victory and fulfillment of the game’s learning objective.

Figure 6. Sample screens from Stage 5 of the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.

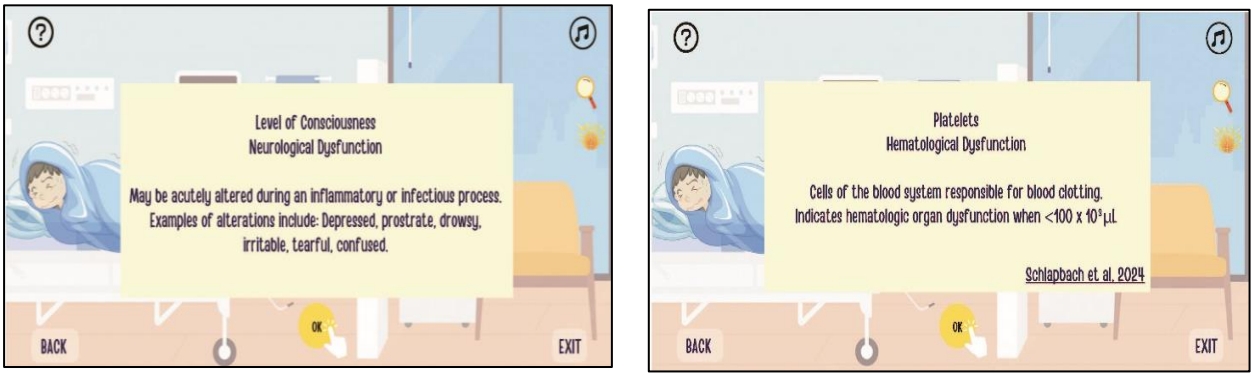


Help Center Screens

The Help Center screens provide additional content in case the player has questions about the material presented in the main gameplay screens. These assist the player in selecting the correct answers during stages two, three, and four.

On certain screens, citations for the referenced content will be available. These can be accessed by clicking the underlined citation, which is formatted as a hyperlink.

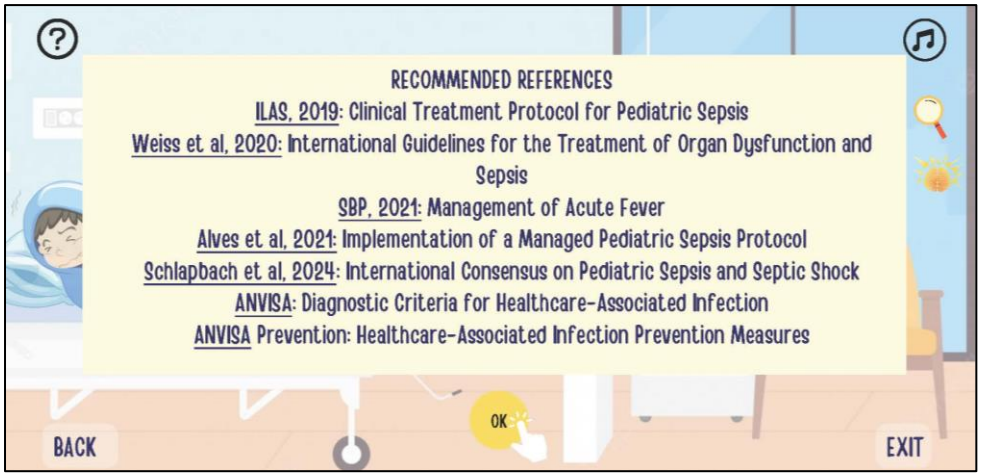
Figure 7. Sample Help Center screens from the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.



Final Screen

At the end of the game, a single screen is displayed offering references related to the topic. When clicked, these links direct the player to the respective material access pages.

Figure 8. Final screen of the Pediatric Prev-Sepsis game prototype. Londrina, Paraná, Brazil, 2024.



DISCUSSION

Aspects of Serious Games and Gamification

The aim was to develop a medium-to-high fidelity prototype based on guidelines and criteria established in the literature for designing serious games, such as: integrating game objectives with learning goals within a contextual framework; using visual and verbal language with topic-relevant images and explanatory text boxes; and promoting easy comprehension of the storyline, setting, and chosen characters.[1,21–22]

The game also includes levels ranging from simple to complex, with questions and answers tailored to the specific knowledge area. Additionally, it provides messages explaining errors and how to correct them, thus avoiding penalization.[1,21–22]

There was an intentional effort to clearly present the rules and objectives and to provide feedback to the player. The game also features stages with varying forms of interaction and rewards—such as stars and trophies—for each completed task. Moreover, the initial screens are simple and designed to yield quick, positive results.[1,21–22]

The prototype was designed to be easily accessible via smartphone or tablet and features in-game tools that allow users to track their progress, pause or return to previous screens at any time, and toggle audio settings.[1,21–22]

The screens display visual consistency in terms of color, font, and imagery. They clearly show what the player has learned at each stage, and there is a dedicated area providing instructions on how to play.[1,21–22]

Certain layout characteristics of the prototype—such as icons, setting, characters, sound, and colors—are also observed in other educational prototypes developed in the fields of health and education.[23–25]

Narrative and Storyline

The prototype features an embedded game narrative, meaning it tells a story that unfolds as the stages progress and the player performs. However, the sequence and events are fixed and predesigned by the author. Having a narrative provides the player with a meaningful learning context, reinforcing the importance of both playing and learning about the topic.[26–28] The narrative in electronic games is considered a new way of storytelling through the player's active immersion.[29,30]

To qualify as a narrative, a game must include a storyline, time, space, characters, and a narrator—which may be a character within the game.[27] In Pediatric Prev-Sepsis, the plot begins with the player being questioned and guided by the “nurse” (character and narrator) about their knowledge of sepsis and HAIs. As

the story progresses, the plot unfolds around the patient "João" (a character) who begins to show signs and symptoms of sepsis, and throughout the game, the condition worsens due to signs of organ dysfunction.

From that point forward, the player must treat the illness. After treatment, "João" improves, and the player is challenged to identify the etiological factors of sepsis and implement prevention strategies, thereby consolidating the knowledge acquired. By completing the game, the player successfully treats the sepsis and wins the game (conclusion).

Time is represented by the game's internal timeline from diagnosis to recovery, and space is characterized by the hospital setting.

As with this prototype, the game "*Septris*" by Evans et al. (2015)[31] includes an embedded narrative, simulating patients with names, ages, and signs and symptoms of sepsis who must be identified and treated promptly—otherwise, the patient dies in the game.

In a serious game developed to educate professionals about vaccination, Silva (2020)[32] also used this type of narrative, where the game sequence depends on the player's choices, following national manuals and guidelines.

Usability

The "Pediatric Prev-Sepsis" game enables players to learn through error. Making mistakes and being given the opportunity to try again encourages the selection of alternative or correct actions and thus promotes reflection.[26,33] Adhikari et al. (2021)[34], when evaluating an immersive virtual reality simulation game, concluded that learning was enhanced through error, since within the simulated environment, players had independence and felt secure in their decision-making without putting real patients at risk.

Silva (2020)[32] also included the reason behind errors in her prototype by displaying information in the form of a note in a text box on the screen. However, there was no reaffirmation of the player's action—only a nonverbal positive response from the characters within the game.

The use of rewards is considered a form of rapid feedback that motivates players to continue pursuing the game's objective.[26] Although this prototype does not use a points system, it does employ trophies awarded at each new stage, which can be equated to the point systems described by Lopes (2020).[34] These systems foster a sense of responsibility and achievement within the game, aligning with one of the criteria for making a game attractive to users, as presented by Studart (2022)[35] when discussing gamification with instructional design.

In a serious game developed for the prevention of surgical site infection, players earned a point for each correct answer, and no points for incorrect answers, although immediate feedback was provided explaining the error.[24] Stabile et al. (2024)[23], in a game prototype for students with cerebral palsy, also implemented a points system, where points were gained for correct answers and deducted for incorrect ones.

The Pediatric Prev-Sepsis prototype demonstrates that it is a digital educational game with relatively low difficulty. However, as players progress through the stages, the complexity gradually increases and demands more knowledge from the player. This progression fosters a sense of growth and personal achievement within the game.[26]

This feature of low initial difficulty followed by increasing levels of complexity is also observed in other serious games designed for elementary and high school students or for educating the general population or individuals with specific comorbidities.[36–38]

Creation

This study employed the Design Thinking methodology. Other studies have used different resources and strategies for game development, such as: Castrillon (2020)[6], who created a serious game for learning kinematic physics using the *Unreal Engine 4* software; Agati and Housen (2018)[38], who applied the MOLDE strategy (*Measure-Oriented Level Design*) for designing a game aimed at promoting healthy living and preventing childhood obesity; and Souza, Oliveira, and Borges (2023)[39], who used the EDA model (*Dynamic Artifact Experience Structure*) and the UCD (*User-Centered Design*) methodology to develop a serious game prototype for children with Attention Deficit Hyperactivity Disorder (ADHD).

It is worth noting that most studies providing detailed descriptions of prototype or game development are authored by professionals in the field of technology. When developed by professionals from health or education fields, the focus is often on validating the content or usability, rather than on describing the development process itself. In this prototype, the participation of a technology professional will occur during

the final version development, while the initial prototype was built by the author.

For screen creation, an online platform widely known and relatively easy to use was chosen. While it can be accessed for free, a subscription was purchased to unlock advanced features. Similarly, in a study by Moraes and Ferraz (2021)[33], an easy-to-use application was employed for screen design; however, a computing professional was required to create the prototype, utilizing more robust tools.

It is important to emphasize the value of empowering education and health professionals to create prototypes—even with limited design skills—through accessible and moderately complex platforms. This autonomy encourages the dissemination of new ideas and educational tools.

As in other studies, the content selected for this prototype was based on published references from national and international institutions, aiming to provide coherent and updated information on the subject.[32] Some studies opt to develop a script, also referred to as a *game design document*, to outline the narrative, artistic concept, and gameplay—either instead of producing the screens themselves or to serve as a framework for building the prototype or final design, once handed over to the computing and software design team.[24,32]

Unlike the authors above, the script in this study was used in a simplified and personal manner by the author to create the prototype screens. These screens were then submitted for content validation and made available to the computing team for the development of the executable version intended for the target audience.

CONCLUSION

The prototype of the educational digital game Pediatric Prev-Sepsis was developed across 184 screens containing content related to pediatric sepsis, based on national and international literature. It enables the representation of how the final version will be applied.

The screens are organized in a simple and self-explanatory manner, facilitating easy understanding of both theoretical concepts and gameplay aspects. This aligns with recommendations from the literature on educational game design, which may positively influence players' learning and content retention.

As a game that meets the criteria of serious games, it has the potential to be considered an innovative tool in higher education and health professional training, given the scarcity of published studies on digital games for pediatric sepsis education.

This study serves as a guide for developing educational games in the health field by researchers who may not have formal training or specific skills in software design but are interested in creating and disseminating educational apps, games, websites, and other technologies focused on specific content.

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AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST

The authors declare no conflict of interest.