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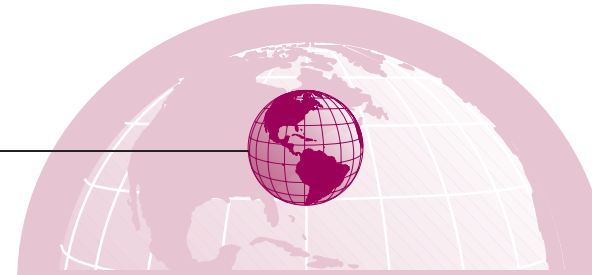
FEATURE ARTICLE



Development of the e-Baby Serious Game With Regard to the Evaluation of Oxygenation in Preterm Babies

Contributions of the Emotional Design

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The present study aimed to describe the development process of a serious game that enables users to evaluate the respiratory process in a preterm infant based on an emotional design model. The e-Baby serious game was built to feature the simulated environment of an incubator, in which the user performs a clinical evaluation of the respiratory process in a virtual preterm infant. The user learns about the preterm baby's history, chooses the tools for the clinical evaluation, evaluates the baby, and determines whether his/her evaluation is appropriate. The e-Baby game presents phases that contain respiratory process impairments of higher or lower complexity in the virtual preterm baby. Included links give the user the option of recording the entire evaluation procedure and sharing his/her performance on a social network. e-Baby integrates a Clinical Evaluation of the Preterm Baby course in the Moodle virtual environment. This game, which evaluates the respiratory process in preterm infants, could support a more flexible, attractive, and interactive teaching and learning process that includes simulations with features very similar to neonatal unit realities, thus allowing more appropriate training for clinical oxygenation evaluations in at-risk preterm infants. e-Baby allows advanced user-technology-educational interactions because it requires active participation in the process and is emotionally integrated.

KEY WORDS

Breathing • Education • Educational technology • Infant • Nursing • Premature • Video game

The potential use of interactive digital technologies, especially those supported by the Internet, for training and education is unquestionable. There are several types of applications for informatics resources in health education, and all of these have strengths and weaknesses. This article focuses on the development of a serious game about evaluations and physical examination to determine the need for oxygenation in preterm infants.

Such technologies have been increasingly incorporated into nursing and health education. Learning from a computer can help students construct their own knowledge, transforming and using the machine as a dynamic and inventive feature. The teacher can help students use the computer to receive information and to think about and create new knowledge in nursing.

This study continues previous research in which we developed educational technology related to the clinical

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evaluation of preterm newborns.[1] Although experts considered the technology to be appropriate in terms of content and functionality,[2] at that time, we did not focus on questions of emotional analysis in human-machine interactions.

When developing educational technologies for human-machine interactions, it is important to contemplate three basic characteristics: technical quality, ergonomic quality, and esthetic quality. The International Council of Societies of Industrial Design[3] provides the following definition: "Design is a creative activity whose aim is to establish the multifaceted qualities of objects, processes, services and their systems. Therefore, it is the central factor in humanization and technology innovation."

The primary objective of emotional design is to optimize the relationship between the user and the product. Emotional design intends to associate esthetics with functionality and thus design a product that appeals to the user's subjective emotions about an action. The design can stimulate the brain on three different levels, which has resulted in the division of emotional design into three areas: visceral, behavioral and reflective design. Visceral design is based on the appearance of an object (esthetics); therefore, it intends to cause an emotional and instinctive response in the user to trigger a corresponding action. Behavioral design focuses on the user's experience with the product and on the usability and performance the product offers; it is focused on the user's needs. Reflective design is related to the product's meaning and use.[4]

In the evolution of games, there has been a large investment in making games more realistic through improved graphics. In recent years, however, the developers of the best games have realized that they need to do more than increase the games' realism. To create something new, they have included emotional aspects. Emotion is one of the most powerful elements of an experience; therefore, we use emotional design to inspire intense emotions, which increases players' desire to experience what the game offers and makes these experiences enjoyable and memorable. Through emotional design, we provide stimulating, immersive, and empowering experiences.

Experiences from other areas, such as engineering, have long been incorporated into emotional design to build products and to adapt existing ones. Many companies' marketing methods take advantage of the possibility of identifying the user with the product by projecting aspirations and emotions; the companies produce advertisements or stories that create strong emotional relationships. Many times, we do not think about our relationships with the various products in our daily lives, but all of these objects have a considerable influence on our affective experience with them and consequently on our use of the product.

The World Health Organization (WHO), using concepts based on design and emotion, performed a worldwide repercussion campaign that shows images of the effects of smoking on cigarette packages. The emotional impact of the warning images, which were indicative of life-threatening consequences and/or body injuries, increased responses linked to detachment and repulsion.[5]

Regarding health, this new emotional design approach has not been recognized, and the virtual use of this knowledge has not occurred.

Serious games are based primarily on emotional responses. This characteristic has been specifically highlighted[6] by allowing the user to feel emotionally integrated by the ludic nature of the play action.[7]

Serious games can facilitate the building of knowledge and support in neonatal nursing education about clinical evaluations of oxygenation, an essential subject for nurse trainees in a critical care field. However, no studies in the literature have provided strong evidence supporting the efficacy of such games compared with traditional classroom training; instead, there are only student statements that technology-based learning is more interesting than traditional classroom learning. Serious game technology helps students learn about preterm infants because the game presents a child with clinical instability and provides many details that address students' questions. This level of information can help students minimize insecurity, anxiety, and fear when they encounter a real baby during practical activities in the neonatal unit, thus facilitating meaningful learning.

In this study, we used the theory of meaningful learning: for a student to learn, he/she must be willing to encounter new information, and the content to be learned must be potentially significant in terms of its logical and psychological meaning. The logical meaning depends on the content, and the psychological significance depends on the individual student's experience.[8] Thus, we believe that nursing education, when aided by the learning environment, can take advantage of pedagogical practices in which the student is the subject of active learning that can be significant and cooperative and can facilitate mutual coexistence.[8]

The theoretical and practical teaching of evaluating a patient's oxygenation needs, as well as students' mastery of this procedure, results in the excessive manipulation of and additional stresses to the premature infant. Therefore, we consider it essential for both the student and the professional to have clinical evaluation training experiences before they perform evaluations directly on infants. During a learning process that alternates between real and virtual infants, students can practice with the most realistic and population-representative simulations possible. In this way, the students can interact appropriately while perceiving themselves as part of the evaluation process and being emotionally integrated with the virtual preterm baby.

As mentioned in a report by the WHO, prematurity is the second major cause of death among children younger than 5 years worldwide (after pneumonia). The present study

promotes the implementation of measures to optimize the training of health professionals to promote preterm infant survival, among other issues.[9]

In prematurity, interventions can address a considerable number of the risk factors associated with neonatal death, such as early identification and improved oxygenation, for which quality neonatal care is required.[10]

The current study describes the development process of a serious game that enables users to evaluate the respiratory process in a preterm infant based on an emotional design model. The study acknowledges advances in informatics and user satisfaction and the need to train nurses to properly identify respiratory conditions in preterm infants for early and effective intervention.

The Serious Game

Serious games can be defined as interactive digital technologies for training and education that include games and simulations that explore interpersonal development, diplomacy, organization, health, education, management, and leadership. The aim of a serious game is to create communication opportunities in which the players learn about their strengths and weaknesses, receive real-time feedback on their game performances, and share different solutions and strategies before, during, and after the game. In serious games, simulations enhance the human-machine interaction.[11]

We believe that the user's affective experiences when interacting with the game are important; rather than focusing only on aspects of quality and usability, emotions integrate thinking, learning, curiosity, creativity, and decision making.[5] Thus, we are currently interested in emotional design, which, via both engineering and design initiatives, has become a new and promising but little-explored area.[12]

This new approach could potentially improve the educational technologies developed by different fields to support the teaching-learning process.

People do not use interactive software as a mere tool; instead, they demonstrate interactions that integrate a wide range of social rules and learned behaviors. The interfaces induce various emotions in the users, who, in turn, attribute these emotions to the interfaces.[13]

Positive emotions are important to learning, curiosity, and positive thinking. Happiness broadens the thinking processes and facilitates creative thinking. Happy people more efficiently find alternative solutions and, as a result, are more tolerant of minor difficulties.[4]

This emerging interest in user-centered design has stimulated a shift in focus from behavior and cognition to the user's affective experiences during human-product interactions.[12,13] This computational technology development model attempts to ensure the creative potential. The template includes the following stages of development: the selection of the project's theme and motivational factors, the analysis of end-users' needs, the identification of solutions, prototyping, and the final evaluation with users. The user-centered design helps to promote the user's affective experience because the model stimulates creativity and is visually compelling, feature-rich, and easy to use.[14]

We assumed that educational technologies could potentially contribute to the teaching-learning process, but we do not intend to present such technologies as a response to problems in nursing education. We believe that these technologies can facilitate the teaching of clinical evaluations of at-risk infants within the complex and continuous process of professional nursing training. The contributions of educational objects to the teaching-learning process depend on the educational methods used to develop and apply the objects, along with the introduction of such objects into the institution's political pedagogical projects and the development and validation of quality materials while considering technological, pedagogical, and emotional dimensions. Technology can help with nursing education in a variety of ways. The student or senior nurse can take advantage of general application features available on the Internet (e-mails, lists, forums, chats and homepages). It is possible to develop courses with specific content for distance education and educational technology, but these features can also be added to the daily classroom experience, thus providing another set of learning opportunities. Specifically in nursing, technology can reduce the risks of errors in procedures and decrease students' fear and anxiety, allowing them to comprehend abstract content. Technology can also provide nursing students with a new way to learn, according to the current student profile.

METHODS

This is a methodological study of the construction of a serious game. To develop a serious game for incorporation into the existing educational technology semiotechnique and semiology of preterm newborns (SSPN),[1] we used the user-centered design methodological model,[13] which was formulated in accordance with design focused on user emotion.

The serious game development was based on emotional design and sought to transcend the reductionist idea of a product tool through an approach that was aimed at understanding the emotional significance of the relationship between products and people.[13]

Seven components have been presented as relevant to emotional design-based products[15]: subject consistency (a product's consistency or effectiveness in responding to the user's wants and his/her reasons for using the product), intrinsic pleasure (the extent to which a product provides sensory pleasure), confirmation of expectations (whether the product confirms the user's expectations relative to an infinite list of possibilities, starting with the presence of

unexpected elements in a product), agency (the agent as the cause of something, either positive or negative), standards conformity (the product meets or exceeds standards, compared with its market equivalents), assurance (the extent to which the product inspires confidence, including confidence about its effects in the future), and coping potential (the extent to which the user can address what is real or expected in a given situation and the user's real or perceived problem-solving abilities).

Emotional design requires an understanding of how the product relates to individual interests and a comprehension that emotion itself cannot be manipulated; a design that attempts to address what drives a person to evaluate a product in a certain way and the corresponding emotion it arouses would be a form of "designing for emotions" (as opposed to "designing emotions").[16]

There are seven phases of model development: (1) the subject choice and motivational factors of the project, (2) evaluation and analysis of the user's needs, (3) solution identification, (4) goal articulation, (5) question analysis, (6) development and prototyping, and (7) user evaluation.[17]

In phase 1, the project's subject choice and motivational factors were based on our experiences with teaching preterm care and on a literature search. We feel that subject choice and motivational factors were instigated by the potential of cybernetics and emotional design and the need to incorporate increments into the teaching-learning process of oxygenation evaluation, an important component of morbidity and mortality in preterm infants.

In phases 2 to 6 of the serious game development, the information obtained during the study's construction, including oxygenation evaluation issues raised by the nursing student users based on their needs and oxygenation evaluation content constructed from scientific evidence and validated by experts, was properly prepared and organized.[1]

The oxygenation evaluation topics and content were processed in a movie-like script to create scenarios, characters, and actions. The game was produced with Macromedia Flash 8 (Adobe Systems Inc, San Jose, CA), Adobe Dreamweaver CS3, and WampServer (open source; available from http://www.wampserver.com/en/) and incorporated into educational technology.

A course was created in the Modular Object Oriented Dynamic Learning Environment (Moodle) virtual learning environment (VLE) (Moodle, Perth, Australia) to generate a tool that will be used to complete phase 7, user evaluation of the serious game. This phase will be the subject of a future study using evaluation tools that address technological, educational, and emotional areas.

RESULTS

The existing educational technology was incrementalized in a serious game called e-Baby that features a simulated incubator environment in which the user performs a clinical oxygenation evaluation of a virtual preterm infant (Figure 1). e-Baby was registered with the Portuguese ISBN 978-989-97031-2 and the Brazilian ISBN 978-85-86862-58-8.

To present e-Baby, we organized phases of the methodological model and correlated them as follows: phases 1 to 5 with the script of the game and phase 6 with the artistic conceptualization (game design), gameplay, and interface[6] settings, which were based on emotional design components.[15]

For the seventh and final stage, we are developing a study that evaluates the students' emotions when using the game, the cognitive impact on the students, ergonomic aspects and the interface of e-Baby with students as well as students' opinion about the game.

Script of the e-Baby Serious Game

The script addresses subject consistency and the emotional design component that responds to the user's wants and his/her motivations for using the serious game.

In phases 1 and 2, the user can perform the following 10 parameters: determine the respiratory rate, observe respiratory features, perform pulmonary auscultation, verify the respiratory tract permeability, verify O_2 saturation, evaluate retraction and its characteristics, evaluate skin color, evaluate apnea episodes, and verify nasal flaring and expiratory groaning. After a few hours, the passage of which is simulated by a clock with rapidly advancing

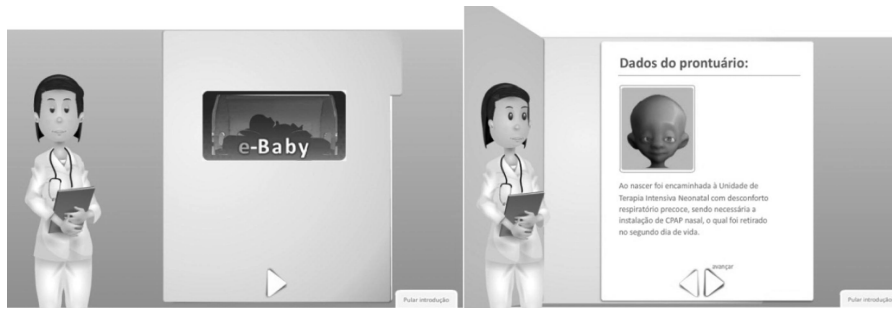

FIGURE 1. Left, an initial screen from the e-Baby serious game. Right, an animated presentation of data from the medical records of the virtual baby in the e-Baby game.

hands, the virtual preterm infant appears to have a more compromised respiratory function, and the evaluator's attention is attracted by a pulse oximeter alarm, which prompts the evaluator to reevaluate all items in response to the baby's worsening condition. During phase 3, the baby presents severe shortness of breath, giving the user a chance to evaluate the following parameters: skin color, respiratory tract permeability, oxygenation, and O_2 saturation.

Neonatal nursing and medical-surgical nursing experts on the game development team chose the infant case addressed in the game from among seven real and validated cases of preterm infants in a neonatal unit.[18] The chosen case involved classic and moderate prematurity that presented problems with oxygenation.

The opening screen of the game features a virtual nurse that presents the baby and her/his case to simulate a shift situation in which the information can be read and heard by the user. In this shift situation, the current history of the preterm baby and the clinical and social data are presented (Figure 1).

Based on the case chosen for the game, a script was produced that included 10 evaluation actions to perform. In phase 1, the virtual preterm infant presents with less affected oxygenation; in the next 10 actions of phase 2, the infant presents with a worsening respiratory condition, and in the last phase, the virtual infant presents with critically affected oxygenation.

Potential coping, an important emotional design component pertaining to the user's abilities to solve real problems, is addressed in the serious game by the increasing severity of the baby's condition. Thus, the user first practices his/her skills with a baby that requires less assistance because the baby does not present problems with oxygenation; later, the user skill requirements increase as the game progresses and the baby's respiratory status worsens.

The script was designed to allow the user to experience a sequence of events. First, the virtual preterm infant, connected to equipment, appears in a dynamic image inside the incubator, while the material needed for the evaluation is chosen from a bar located at the bottom left of the screen. The choice of material is determined by a question regarding the evaluation action to be taken. After choosing the material, the user can see and choose possible answers. The user progresses in the game only if he/she does not need materials for the evaluation, which are available in another bar at the bottom right of the screen.

Artistic Conceptualization (Game Design) of e-Baby

The emotional design component responsible for intrinsic pleasure, which involved the serious game's sensors, was determined during the artistic conceptualization.

We made several drafts of the virtual infant based on photographs and videos available from the researchers and infant care experts. The infant features needed to be as close to those of a real premature infant as possible; specifically, the infant needed to appear emaciated and have a larger head than a full-term infant. There were many back-and-forth tests between the development team and researchers to approve the final virtual preterm infant, including approval of typical sounds and movements for the gestational age and the conditions presented. At each stage of the game, the baby's respiratory impairment changes, and this led to the creation of several versions of babies, sounds, and movements prior to the final approval. There is also a virtual nurse, represented by a young woman dressed in white and wearing an identification badge; despite the fact that the neck placement of the stethoscope does not represent the best way to carry it because the stethoscope could fall off and cause injury to the baby, we decided that this professional was changing shifts with the user and not directly caring for the baby.

The constructed scenario was an incubator with the equipment and materials needed. On the right are buttons for the clinical oxygenation evaluation (pulse oximeter, clock, stethoscope, eye, ear). The left buttons are a pulse oximeter sensor and oxygen therapy masks used to care for the baby; these were designed by the development team according to photographs and videos provided by the researchers (Figure 2).

There is a bar on the bottom left of the screen with the necessary tools for the clinical evaluation. On the right, the bottom bar displays materials for preterm infant care. Despite the fact that interventions are not the object of the game, we believe that, in this teaching moment, it is

FIGURE 2. Left, the scenario, virtual character, and buttons in the e-Baby serious game. Right, instructions for how to play the e-Baby serious game.

necessary to remember that actions are always concurrent and linked; each item to be evaluated in the baby can promote an intervention that is often immediate and early.

All evaluation buttons, designed on the basis of real materials, the scenario, and the characters, were created in three-dimensional models. The definitions of their colors and textures, the sounds and movements to be produced in response to the player's action, and the location scenarios of the baby were designed according to the proper literature and the researchers' approval.

Gameplay of the e-Baby Serious Game

To confirm expectations, which is a required component of the emotional design, the presence of unexpected elements in the serious game was determined at the time of gameplay.

We defined the rules of the game and the difficulty levels to be provided. Such rules were specified by the development team to explore strategies and techniques. These rules are translated to the users via an icon that they can access early in navigation (Figure 2); this icon is represented by an "i" (instructions) in the upper right corner of the screen and is visible throughout the game.

The virtual preterm infant is in an incubator and is evaluated by the game user. The user's knowledge is tested via a question presented on the right side of the screen for each evaluation action. The alternative answers can be chosen only after a challenge is overcome; for each evaluation action, there is a challenge, such as the choice of the correct materials and verification in the care bar of what is needed to continue the game. For each correct answer, the user gains points, which are shown in a blue sidebar on the left side of the screen. The bar moves up or down according to the user's choice and corresponds to the sounds produced by the baby, which can be either laughing or crying; specifically, if the answer is adequate, the baby laughs, and if the answer is inadequate, the baby cries (Figure 3).

The e-Baby game comprises phases, each of which presents a different respiratory condition of the virtual preterm infant as well as changing movements and sounds. The first phase presents fewer complications with regard to the oxygenation evaluation; in the second phase, the baby worsens until the last screen, where the virtual infant presents severe oxygenation impairment (Figure 4).

Another study that is a continuation of this one aims to verify the impact of the use of the e-Baby serious game on the emotions of Brazilian and Portuguese nursing students. The initial data have shown more than 80 positive emotions that can be related to the characteristics and techniques used in e-Baby (ie, the realism of the game) and the knowledge that students develop from the use of the game.

At the end of the game, the user is redirected to the feedback screen to receive the game score, which is presented as a percentage, followed by a word or sentence. For example, 100%, excellent; 75%, good; up to 50%, you can improve; and up to 25%, you need to study more.

The game is presented in Moodle as part of a course that includes classroom and online activities. After using the game, the students are debriefed individually via e-mail and chat. The student presents his/her questions and considerations, and the instructor provides the debriefing. The evaluation of the e-Baby and the student (cognitive and emotional) is provided in the Moodle virtual environment.

The opportunity to publish game results on Facebook allows students to share their activities with their colleagues. The use of this social network is very common among generation Y in Brazil for collaboration in learning and other purposes.

Interface of the e-Baby Serious Game

The agent component of the emotional design, specifically the product, user, or situation that causes either a positive or a negative emotional reaction, was determined during the interface by each component's ability to communicate with the user.

To ensure that the interface permits proper communication between the game and the player while motivating and emotionally integrating the user, all screens in the e-Baby

FIGURE 3. Left, the challenge demonstrated by selecting the eye and the stethoscope. Right, the user challenge in the e-Baby serious game includes obtaining the stethoscope, auscultating all lung extensions, and choosing the correct alternative.

FIGURE 4. Left, a second-phase action in the e-Baby serious game. Right, the final stage of the e-Baby serious game, in which the virtual baby has progressively worsened.

game have the same layout: The baby appears in the center left, the question triggering the action appears in the center right, and the instructions button and the "x" to exit appear at the top right. At the left of the screen, the user follows his/her score on a blue bar that rises or falls depending on the player's performance. A bar at the bottom left of the screen contains the tools necessary for the clinical evaluation. At the bottom right, a bar shows the materials for preterm care.

We included a recording camera that is integrated with the user's machine webcam through a click button that records all clinical evaluations conducted on the virtual preterm infant, thus allowing the user to watch the evaluations later and learn from his/her performance.

If desired, the user can use a link on this screen to send his/her results regarding the virtual preterm baby to the Facebook social network (Figure 5).

The e-Baby educational technology element is integrated into the Clinical Evaluation of the Preterm Baby course, which is available on the Moodle VLE as part of the offered content, allowing students to perform activities that provide automatic feedback for self-evaluation along with other interactive activities, chats, and forums.

DISCUSSION

We constructed the e-Baby serious game as an opportunity to incrementalize the developed SSRNPT educational technology by incorporating a serious game that would facilitate clinical oxygenation evaluations in preterm infants during nursing training. We believed that facilitating the learning process through informatics technology would contribute to improved nurse training.

As recommended, a serious game enables user interference during story development. This game incorporates the user's choices to modify future phases or challenges, thus increasing the level of difficulty and repeating the content at a higher level of difficulty. Additionally, because it is a game, the ludic aspect is included. Thus, the contents and strategies explored in the game are described in detail in the script to emphasize the need for the continued participation of healthcare professionals, who suggested, amended, and approved the methods used to approach the content.[6]

The clinical situation presented in the e-Baby game was based on a real case and real situations experienced by a premature baby who was admitted to the neonatal intermediate care unit of a Brazilian university hospital and her/his family. This case is part of a series of seven cases collected by two researchers to ensure the reliability of the study. Established nursing diagnoses were validated by a group of six nurses according to the scientific recommendations of the field.[16] Thus, the case used for the e-Baby presents the actions of a clinical oxygenation evaluation, as recommended by the SSRNPT educational technology[1] and other authors.[19]

The simulation of cognitive function and motivation and the opportunity to construct new knowledge are key elements of a serious game. Because this is an application with a specific purpose, its planning required the involvement of healthcare professionals. Thus, neonatal and medical-surgical nursing experts' participation on the development

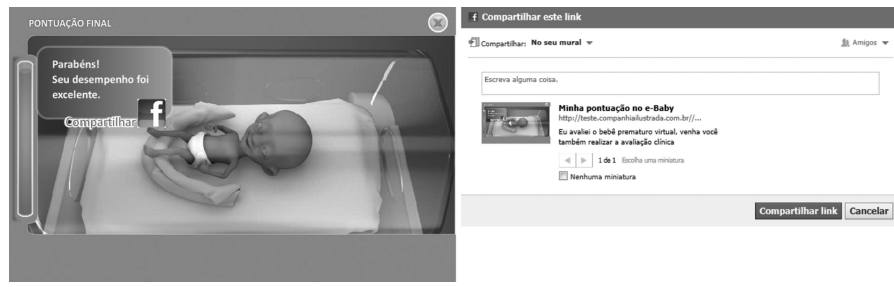

FIGURE 5. Left, a screen showing the user's score for the e-Baby serious game, with a link for the user to share his/her score on Facebook, if desired. Right, Facebook sharing of an e-Baby serious game performance.

team was essential for outlining the scope of the game and for determining the most appropriate ways to address oxygenation in preterm infants. Serious games are applied to simulate critical situations that involve risk, decision making, and the development of specific skills.[6]

The interface provided during the game is responsible for sending data from the player to the application and vice versa and is characterized by the presentation of the game, with an introduction, instructions, and configuration. The best interface will be completely unnoticed by the player, allowing him/her to concentrate during the development of the story and his/her actions and reactions. Very elaborate interfaces can confuse the player or draw more attention to the interface than to the main focus of the game, which should be the user's interaction with the story. Thus, a complex interface could discourage the player and cause him/her to lose interest in the game.[6] In e-Baby, the interface is simple and clear; the element names are highlighted when the mouse is moved, and the buttons and appropriate, standardized tools in all screens are intended not to confuse the user. Four positive emotions (happiness, desire, fascination, and satisfaction) and four negative emotions (sadness, boredom, annoyance, and dissatisfaction) are presented in the e-Baby game by Layered Emotion Measurements tool (LEMtool) instruments (SusaGroup, Enschede, The Netherlands); the game includes dynamic facial expression animation and corporal and vocal components.

The user can move forward and backward in e-Baby as many times as necessary until he/she learns what is required during practice with a real baby without excessive manipulation. The e-Baby presents a simulation that is as realistic as possible for this population group, and thus, the student can interact in the most appropriate way by perceiving himself/herself as an emotionally integrated part of the process.

Regarding emotion and technology, users do not respond to interactive software as a mere tool; instead, they demonstrate an interaction that contemplates a wide range of social rules and learned behaviors. The interfaces induce various emotions in the users who, in turn, attribute them to the interfaces.[13]

Positive emotions are important to the learning process and to curiosity and positive thinking. Happiness broadens the reasoning processes and facilitates creative thinking. Happy users more efficiently find alternative solutions and, as a result, are tolerant of minor difficulties.[4] When e-Baby is used, the user's happiness can be observed by his/her achievement of goals and needs and the pleasantness and safety of navigation, and self-esteem will be positively influenced.

We believe that educational technology can assist with teaching preterm infant care within the complex and continuous process of professional nurse training when it is potentially significant and has a logical meaning to the student.[8] The contributions of educational technologies to the teaching-learning process depend on the teaching methods used to develop and apply the technologies,[20] on the incorporation of technology into the political pedagogical projects of the institution, and on the quality of developed and validated materials, while considering technological, educational, and emotional dimensions.

The technology was available as part of a Moodle course on clinical evaluations of preterm infants, increments of face-to-face encounters in the Simulation Center and the neonatal units, and the study of distance moments using the navigation in the technology itself as well as chats and forums on the subject.

The course on the clinical evaluation of preterm infants is offered to students in the last semester of the nursing degree course. In addition to being available in the Moodle course, the e-Baby game can be accessed every day free of charge n the Web site of the Research Group in Nursing Care for Children and Adolescents at the University of São Paulo at Ribeirão Preto College of Nursing, http://www2.eerp.usp.br/site/grupos/gpecca/objetos/ebaby/.

In higher education, the availability of technology in courses in the Moodle virtual learning environment is more efficient than in courses for which the course materials are available on the Web site because of the set of activities in which the students participate during the learning process.[21] In the literature, in a comparison of Moodle courses and courses with materials available on the Web site, the students showed greater satisfaction and learning motivation in Moodle courses and greater interpersonal contact (learning from each other). The professor reported improved online contact with students and monitoring of their activities. Technology-inclusive courses that use a combination of online and face-to-face experiences will be predominant in the future.[22]

CONTRIBUTIONS AND LIMITATIONS

The implementation of a serious game about oxygenation provides educational technology with great potential to support a more flexible, attractive, and interactive teaching-learning process with simulations that allow maximum approximation of reality.

We believe that technology facilitates more useful training for clinical oxygenation evaluations of an at-risk population group, specifically preterm infants, because the user can interact more appropriately with the educational technology and perceive himself/herself as an emotionally integrated part of the process.

The limitations of the serious game include the fact that the user needs access to a computer or tablet with a good Internet connection. Moreover, the effective learning mediated by a serious game can occur only during a pedagogical nursing education that ensures student autonomy and participation and provides debriefing moments with the user after navigation.

CONCLUSIONS

Serious game development enabled the production of an educational technology tool for nurse training that considered pedagogical and psychological aspects related to the learning process in accordance with the current scenario of intense informatization.

With this study, we hope to contribute to research on the development and use of emotional design-focused educational technologies and to thus assist the teaching-learning process while envisioning a new technological and educational context that includes electronic and mobile learning.

According to the 2012 WHO document, prematurity is the second most common cause of infant mortality among children younger than 5 years worldwide. The report recommends adequate and permanent training of the health team that works with premature infants.

This study may strengthen the training of nursing professionals who work with premature newborns, a vulnerable population. The game can be a feature of training via free access on the Internet, and it can be used in professional training courses offered by educational or health institutions.

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