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Immersive learning laboratory in health and nursing: learning biosafety in a virtual world

Laboratório imersivo de aprendizagem em saúde e enfermagem: aprendendo biossegurança em mundo virtual

Laboratorio de sumersión de aprendizaje en salud y enfermería: aprendiendo bioseguridad en mundo virtual

Karen Cardoso[I]
ORCID: 0000-0002-6263-037X

Milton Antônio Zaro[I]
ORCID: 0000-0002-0459-8981

Ana Maria Muller de Magalhães[I]
ORCID: 0000-0003-0691-7306

Liane Margarida Rockenbach Tarouco[I]
ORCID: 0000-0002-5669-588X

[I]*Universidade Federal do Rio Grande do Sul. Porto Alegre, Rio Grande do Sul, Brazil.*

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Corresponding author:
Karen Cardoso
E-mail: karen.caetano@gmail.com

EDITOR IN CHIEF: Dulce Barbosa
ASSOCIATE EDITOR: Maria Elisabete Salvador

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ABSTRACT

Objectives: to develop a virtual simulation and learning laboratory in an immersive virtual world that enables students, nursing professionals as well as health professionals to experiment, reflect and contextualize biosafety actions, infection protection concepts and universal precautions. **Methods:** description of the development of the Immersive Learning Laboratory in Health and Nursing (LIASE) with a focus on biosafety, having as theoretical basis Kolb's experimental learning cycle and the OpenSimulator platform. **Results:** development of the Immersive Learning Laboratory in Health and Nursing: Health Biosafety Module — contains five learning stations. **Final Considerations:** the development of LIASE indicates the possibility of supporting face-to-face learning in a practical laboratory and continuing the study and implementation with the target audience.

Descriptors: Containment of Biohazards; Nursing Education; Virtual Reality; Simulation Training; Computer Simulation.

RESUMO

Objetivos: desenvolver um laboratório virtual de simulação e aprendizagem em um mundo virtual imersivo que possibilite aos alunos, profissionais de enfermagem bem como profissionais de saúde a experimentação, reflexão e contextualização das ações de biossegurança, conceitos de proteção de infecção e precauções universais. **Métodos:** descrição do desenvolvimento do Laboratório Imersivo de Aprendizagem em Saúde e Enfermagem (LIASE) com foco na biossegurança, tendo como base teórica o ciclo de aprendizagem experimental de Kolb e a plataforma *OpenSimulator*. **Resultados:** desenvolvimento do Laboratório Imersivo de Aprendizagem em Saúde e Enfermagem: Módulo de Biossegurança em Saúde — contém cinco estações de aprendizado. **Considerações Finais:** o desenvolvimento do LIASE indica a possibilidade de suporte ao aprendizado presencial em laboratório de práticas e da continuidade do estudo e implementação com o público-alvo.

Descritores: Contenção de Riscos Biológicos; Educação em Enfermagem; Realidade Virtual; Treinamento por Simulação; Simulação por Computador.

RESUMEN

Objetivos: desarrollar un laboratorio virtual de simulación y aprendizaje en un mundo virtual de sumersión que posibilite a los alumnos, profesionales de enfermería así como profesionales de salud la experimentación, reflexión y contextualización de las acciones de bioseguridad, conceptos de protección de infección y precauciones universales. **Métodos:** descripción del desarrollo del Laboratorio de Sumersión de Aprendizaje en Salud y Enfermería (LIASE) con enfoque en la bioseguridad, teniendo como base teórica el ciclo de aprendizaje experimental de Kolb y la plataforma *OpenSimulator*. **Resultados:** desarrollo del Laboratorio de Sumersión de Aprendizaje en Salud y Enfermería: Módulo de Bioseguridad en Salud — contiene cinco estaciones de aprendizaje. **Consideraciones Finales:** el desarrollo del LIASE indica la posibilidad de suporte al aprendizaje presencial en laboratorio de prácticas y de la continuidad del estudio e implementación con el público objeto.

Descriptores: Contención de Riesgos Biológicos; Educación en Enfermería**;** Realidad Virtual**;** Entrenamiento Simulado; Simulación por Computador.

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INTRODUCTION

Health biosafety actions directly impact the safety of patients and the environment that surrounds them; therefore, they are essential learning for all students and health professionals. Although it has a broad concept, biosafety represents a set of actions that aim to prevent, reduce or eliminate risks related to activities that may cause some type of compromise to human and animal health, quality of life and the environment[1].

In the context of biosafety in health, there are two focuses: research and activities with DNA and stem cells; and actions for the prevention and control of risks caused by chemical, physical, biological, ergonomic and psychosocial agents that exist in health institutions and that can affect users and health professionals in the exercise of their daily activities[2].

Practices known as standard or universal precautions were advocated and established by the Centers for Disease Control and Prevention with the objective of reducing the risk of infection and exposure to occupational risks inherent to health care activities. Precautions are based on the principle that bodily fluids (with the exception of sweat) are responsible for transmitting diseases, being a vehicle for pathogenic microorganisms. In this sense, hand hygiene, the use of personal protective equipment (PPE) and collective, the isolation of people with contagious diseases, the care of contaminated waste, especially sharp materials, are some of the actions indicated, being adopted worldwide and regulated by health surveillance agencies in each country[3].

For students of Nursing and other areas of health who provide care directly to patients, it is essential to know the correct hand hygiene and its frequency, as well as the scientific concepts that support such practice. In addition to correct technique, habit must also be created. At the same time, different strategies should be used to teach hand hygiene and biosafety techniques, and it is necessary to include them in the different moments of student learning[4-5].

In this context, space is opened for the development of a support tool for individualized learning, such as a Virtual Laboratory, aiming to provide contact with the technique and theoretical basis, enabling redoing, reviewing, making mistakes, elaborating, and mobilizing the brain for the learning.

It is considered that this proposal is in line with the need to rethink the process of learning and teaching, with a view to making the construction of teaching-learning more interactive for the student, promoting autonomy and respecting each person's time in the consolidation and acquisition of skills for work practice[6-7].

There are different definitions to describe Immersive Virtual Worlds, however Virtual World (VW) is considered a space in which there are people represented by virtual characters (avatars), who share a persistent network (that is, which continues to exist even after the user leaving it) and synchronous to people; they access and populate the VW and have the connection facilitated by networked computers[8].

The avatar is the digital representation of users who access these three-dimensional spaces, having form, movement, and capacity for full interaction with VW and other users. It is the means by which the individual "exists" in the virtual space and is present in it, interacting, developing various actions controlled by this user who created it[8].

VW is characterized as a three-dimensional space, a graphic environment, which represents a physical space, with simulation of gravity, time, seasons and even its own economy, allowing the user to modify this world. VWs can be considered immersive, interactive, and three-dimensional; they are not games, but they can include them. The VW can represent a physical location that already exists, it can create an imaginary location, spaces and situations that can virtually be experienced by the avatar safely and repeating situations and experiences endlessly[8].

In this sense, VWs can help with experiential learning, engagement, contextual learning, and collaborative learning, serving as a tool that allows for repetition and error. In them, experimentation is welcome as part of the learning process, without putting any human being at risk and meeting the growing ethical issues in the field of health education[9].

There are many possibilities for the development and use of VWs: socialization and interaction between people of different origins and cultures, games, browsing through diverse multimedia resources and repositories such as digital libraries, commercialization of goods and services, digital tourism, cultural and educational activities. The OpenSim and Second Life virtual platforms are examples of the diversity and potential of VWs, including the areas of health education, focus of this study[10].

Developing activities with an educational purpose in a VW opens up an infinite range of possibilities, which will depend on the specific focus that educators will give to the chosen areas and themes. In the health area, it is possible to develop learning routes that involve greater or lesser interaction with the environment, the teacher and other users, ambient experimentation and problematization, educational games, lectures, and events. Learning itineraries are guidelines intentionally elaborated by the teacher in order to assist the student in the learning process; they specify what actions are necessary for learning and the expected results when accessing content, media and activities, encouraging the development of autonomy in the learning process[11].

Considering the need for a theoretical framework for the development of learning laboratories in immersive virtual worlds, it is worth highlighting the importance of the experimentation process and contextualization of the contents and concepts presented, which can support meaningful learning.

Thus, we base ourselves on the experiential learning theory, elaborated by Kolb, according to which learning, and development can occur through experimentation, resulting in a meaningful and personalized learning. Kolb's experiential learning cycle approach is adequate for the development of virtual laboratories, as it involves concrete experience and its conceptual aspects, observation and reflection on experience, perception and understanding of the processes and results involved in experimentation, resignification and contextualization in other scenarios[9].

Thus, the present study was developed using digital didactic resources, on the OpenSim platform as Virtual World; and anchored in Kolb's theory of experiential learning, which is based on an integrative holistic perspective and is reflected through experience, concept, reflection, and action.

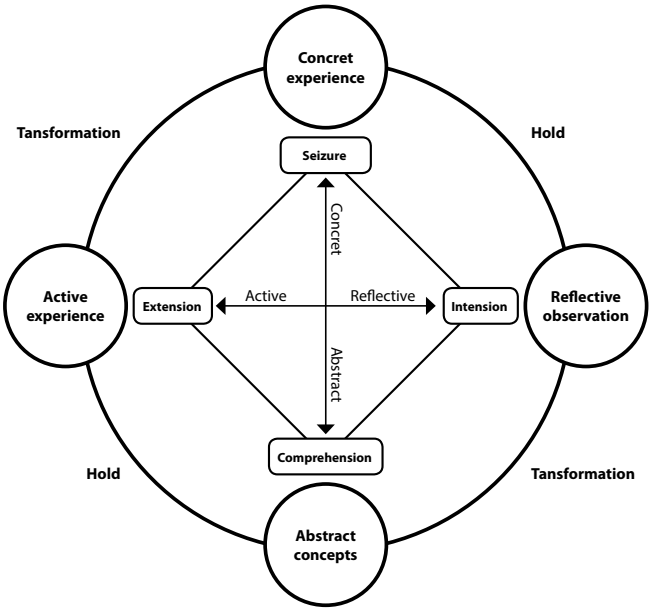
OBJECTIVES

To develop a virtual simulation and learning laboratory in an immersive virtual world that enables students, nursing professionals as well as health professionals to experiment, reflect and contextualize biosafety actions, infection protection concepts and universal precautions.

METHODS

The present study is a methodological research that aims to describe a method for the development of a VWI on the subject of biosafety, for its use in teaching.

Kolb's theory of experiential learning supports the need to perceive knowledge as a process, built and transformed through experimentation and interaction with different contexts. This process takes place in a spiral and cyclic movement. The four types of learning are represented in Figure 1: Concrete Experience (CE); Reflective Observation (RO); Abstract Conceptualization (AC); Active Experimentation (AE). At each advance in the cycle, it is necessary to interact and combine the four dimensions of development, represented by the rectangles within the cycle: Apprehension – Occurs intuitively after concrete experimentation; Intent – It happens intentionally aiming to transform learning; Comprehension – It takes place when the individual understands theories, concepts, symbols; Extension - It happens when the individual is able to apply the knowledge acquired and transformed internally in other contexts and situations[12].



Source: Adapted from Kolb (2014).
Figure 1 – Kolb's experiential learning cycle

In this study, the Immersive Laboratory for Learning in Health and Nursing (LIASE) was developed using the VW Open Simulator (OpenSim) to create the entire learning space, having Kolb's experiential learning as a theoretical basis. The objective was to enable the learning of biosafety themes through exposure to the necessary concepts and actions (e.g., hand hygiene, the use of safety equipment and the handling of hospital waste), in addition to contextualizing standardization and biosafety actions in the context of patient care in different situations. It should be noted that LIASE is not a game, but a learning space in VW.

Methodological steps

The development of the Immersive Virtual World (VWI) LIASE took place at a Federal University of Rio Grande do Sul, from June to December 2019. The planning began with the definition of the theme of biosafety (one of the author's areas of teaching activity) and continued with the development of educational objectives and idealization of the learning script (path to be followed by the avatar) specific for the virtual laboratory.

The script is directed to the main biosafety actions and behaviors that students and nursing and health professionals should develop when coming into contact with the hospital and patient environment, with a focus on safety and reducing the risk of infection.

The development of the learning script involved the selection of content, videos compiled from the internet with public access and applications to interact in the virtual world based on biosafety standards that involve universal precautions and are the basis for safe care and reduced risk of infections[1-5]. Then, the creation phase of the "stations" began, which are the specific places where certain learning events occur during the learning itinerary. The development of the learning stations included the creation of objects, scripts, and the use of specific software for each moment. The target audience are undergraduate Nursing students, nurses and health professionals, possible users of the developed virtual laboratory.

RESULTS

The Immersive Learning Laboratory in Health and Nursing (LIASE)

As a result of this study, the LIASE - Immersive Learning Laboratory in Health and Nursing: Health Biosafety Module was developed, which contains five learning stations.

Station 1 - Hand hygiene

In Station 1, the avatar has contact with the most fundamental and basic aspect of biosafety in health, which is correct hand hygiene.

1. Concrete Experience – The experience of hand hygiene through a video with step-by-step correct movements.
2. Reflective Observation and Conceptualization – Experience reflection occurs when the user has access to another video that questions what happens when people don't wash their hands or do it properly. From this moment of the learning "walk", the avatar starts the process of concepts and actions necessary for asepsis, hygiene, cleaning, acquisition of information about the main microorganisms that inhabit the hands and their risk to the hospital environment.

3. Experimentation and Contextualization – The interaction with the motivational avatar takes place, which invites the user to go to the set of "automatic" washbasins, with a script that perceives the avatar's presence and simulates the flow of water. After simulating lavatory hygiene, the user will contextualize the experience by checking all the situations necessary for hand hygiene. This contextualization takes place in contact with the patient visualized in an interactive figure on VW.

Station 1 and all its components can be seen in Figure 2.

Figure 2 – Virtual Lab Station 1 overview

Station 2 - The use of personal protective equipment

At Station 2, the user has contact with a video that shows what personal protective equipment is and in which situations it should be used, as well as the types of isolation that patients and professionals should observe and take into account.

Season 3 – Wear the personal protective equipment

In Station 3, the user is invited to wear one of the PPEs: the lab coat. Once you accept to attach the object, the avatar is wearing the lab coat. After placement, the user accesses a picture representing the patient in the hospital bed and possible situations at different levels of risk of contamination, in which the PPE must be used through tags with which the user can interact when clicking. Thus, the Kolb cycle involving the actions that took place in Stations 2 and 3 is configured as follows:

1. Concrete Experience – Occurs when the user has contact with the PPE usage video, learns how to use them, and wears one of the PPEs.
2. Reflective Observation and Conceptualization - The user reflects on the use of PPE, types of isolation and concepts necessary to understand the correct use of PPE in the hospital context.
3. Experimentation and Contextualization – In the experimentation process in a context of applicability, the user goes to the photo with the inserted tags (specific tags) that signal the contexts of the use of PPE.

Stations 2 and 3 with the learning objects can be seen in Figure 3.

Figure 3 – Station 3 with the personal protective equipment and part of Station 2

Station 4 - Interaction with the classification of hospital waste

1. Concrete Experience - It is performed when the user has contact with the representation of hospital waste in VW by clicking on the trash cans.
2. Reflective Observation and Conceptualization - The user reflects on the concepts that involve the theme of waste classification and the risks of contamination.
3. Experimentation and Contextualization - Occur when the user associates the different types of hospital waste with the current classification and regulation, as well as with the correct disposal location.

Station 4 with the classification of medical waste can be seen in Figure 4:

Figure 4 – Station 4 and classification of medical waste

Station 5 - Self-Assessment

1. Concrete Experience - It happens when the user has had contact with all the proposed activities.
2. Reflective Observation and Conceptualization - The user reflects on the concepts that involve the themes of biosafety included in the VW.
3. Experimentation and contextualization – These occur when the user answers the self-assessment instrument with objective questions developed in the Hot Potatoes

program, contextualizing the activities developed and understanding the concepts.

DISCUSSION

The limiting aspects and necessary care for the development of educational activities in VWs in health and nursing are demonstrated in a systematic review conducted by Liaw[9]. Among the aspects found are the absence of a defined theoretical framework, the type of specific activities not connected to educational objectives and the evaluation of the educational VW based on the student's positive or negative opinion. Another limiting aspect mentioned is the need for funding for the implementation and maintenance of VWs[9].

Study limitation

One of the limitations to the use of VWs in education is funding for their development, research, and maintenance. Therefore, there is a need for institutional support and a perception of its multidisciplinary educational potential.

Contributions to the Area

The conception, development and implementation of the Immersive Laboratory for Learning in Health and Nursing (LIASE), with a focus on learning biosafety in health, has as an educational proposal the possibility of offering support to face-to-face activities that take place in a laboratory with traditional practices. The student is able to appropriate aspects of the content and some aspects of experimentation in practice, before entering the traditional laboratory. It also allows accessing the laboratory in VW and repeating the available actions and experiments, learning from the error, without the real risk, evaluating the results and applying the concepts understood in scenarios that simulate real contact with the patient. The use of LIASE in continuing education in health services is also a possibility to be implemented.

It stands out as a contribution to nursing education the possibility of personalization of teaching, in which the teacher can be present synchronously with the whole class in the VW; or, asynchronously, monitor and adapt the learning of each student, checking interactions between students and between students and objects. A virtual laboratory like LIASE can be part of teaching strategies based on active methodologies.

The potential of VWs such as LIASE in Nursing education has expanded with the change in scenario caused by the COVID-19 pandemic involving restrictions on practical face-to-face activities. One of the most striking aspects evidenced by the onset of the pandemic was to expose issues related to the training of health professionals (and especially nursing) about the importance of the correct use of PPE, adherence to precautionary measures and hand hygiene, in addition to the adoption of safe behaviors by professionals. These measures are the only ones that can reduce the risk for you, your own family, patients, and the population. Evidence of the failure in the training and continuing education of professionals is demonstrated in several studies carried out before the serious context in which we live today.

FINAL CONSIDERATIONS

The practice of nursing care requires a series of skills that need to be developed during the training process for nursing and health professionals in general. Knowledge of biosafety actions is essential throughout training, to change behavior, as well as throughout professional life. Based on acquired, experienced, and contextualized knowledge, nurses are constantly articulating the work process, whether with their team - in relation to which they exercise leadership and supervision of care - or with patients who need the recreation and transformation of acquired knowledge through lived experiences, recognizing and adapting it to the different dimensions of organizational culture and the sociocultural context of individuals and groups under its responsibility.

The design and development of LIASE fills a gap in knowledge of biosafety practices. In the current context, in which all biosafety and patient safety practices are being put to the test, it is up to the implementation and continuation of LIASE research.

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