FDLA Journal

Volume 7 *Spring 2023*

Article 6

April 2023

Using Specially Designed Software to Create a Simulation Space Design Assignment

Desiree A. Díaz
University of Central Florida, desiree.diaz@ucf.edu

Mindi Anderson
University of Central Florida, mindi.anderson@ucf.edu

Kathleen Bastedo
University of Central Florida, kathleen.bastedo@ucf.edu

Corey Peterson
University of Central Florida, corey.peterson@ucf.edu

Recommended Citation

Díaz, Desiree A.; Anderson, Mindi; Bastedo, Kathleen; and Peterson, Corey (2023) "Using Specially Designed Software to Create a Simulation Space Design Assignment," *FDLA Journal*: Vol. 7, Article 6.
Available at: https://nsuworks.nova.edu/fdla-journal/vol7/iss1/6

Using Specially Designed Software to Create a Simulation Space Design Assignment

Cover Page Footnote

The authors with to thank Corey Peterson, Kylee Woodland, Sam Belcastro, Daniel Brinkman, Nathan Dabu, Ryan Eppers, and Bill Funk who worked on various pieces of the widget.

Using Specially Designed Software to Create a Simulation Space Design Assignment

Introduction

The art of teaching online can create an impetus for training faculty in university settings. Completing a specific hybrid professional development course is a requirement to teach in the online or blended format at a large southern university. The course content is a blend of interactive teaching strategies as well as best practices in online teaching. Once faculty have successfully completed this professional development course, they are credentialed to teach online at which time they will have access to resources and services introduced during the training. Services introduced during the course include an assigned instructional designer, a video team, a graphics team, and software programmers from the Learning Systems & Technology (LS&T) team. LS&T creates educational web applications and a variety of learning widgets for these credentialed faculty. Faculty throughout the university are encouraged to make the most of these services during and post professional development to continually enhance course content.

Partnerships across the college campus can provide unique opportunities to augment curricula. One such partnership is with the College of Nursing (CON). The CON designed and launched an online master's degree (i.e., Master of Science in Nursing [MSN]) and a graduate certificate in healthcare simulation). Additional types of students can take the associated courses including those in Nurse Educator MSN, Doctor of Nursing Practice (DNP), Doctor of Philosophy (Ph.D.), and other tracks both inside and outside the nursing discipline; thus, creating interdisciplinary courses. The online program consists of three healthcare simulation-specific courses, one of these being related to organizational operations in simulation. The underlying premise of the course is the management and creation of a standalone simulation center, including cost analysis and budget considerations during remodeling or repurposing space. As part of the organizational operations in the simulation course, exclusively online, one of the requisite components originally required students to design a simulation space as a pen-and-paper activity. During initial implementation, the use of an antiquated form of media for an online course became cumbersome. The lead faculty member of the course creatively designed an innovative computer-based student assignment that required the students to "build" a hospital simulation room in a realistic learning environment. However, the faculty did not have the computer-science expertise to fabricate the innovative assignment in a representative, online, and usable fashion. A collaboration was created with the instructional designer, the software programmers from LS&T, and the faculty.

In this paper, simulation will be discussed and defined for healthcare, including types of simulation, along with the importance of learning simulation room design for those specializing in healthcare simulation. A collaboration to develop a simulation room design interactive activity will be described. A descriptive evaluation study to evaluate the simulation room design activity will then be presented.

Literature Review

Simulation

Simulation definitions have varied, especially in the last decade. Currently, simulation is delivered in a variety of mediums including computer games, manikin, and augmented reality/virtual reality (AR/VR) technologies (Lioce et al.,2020). Multiple disciplines have embraced simulation including healthcare. The Simulation Dictionary by Lioce et al. (2020) defines healthcare simulation (spelled "health care" simulation) as "a technique that creates a situation or environment to allow persons to experience a representation of a real health care event for the purpose of practice, learning, evaluation, testing, or to gain an understanding of systems or human actions (Society for Simulation in Healthcare)" (p. 21).

The use of simulation allows learners to be interactive with content, within the context of what they are learning (Adamson & Rodgers, 2016). Experiential learning creates a deeper understanding of information presented by faculty (Hill, 2017). A learner must apply concepts and recreate the framework which allows for enhanced conceptual understanding of the original concept.

Healthcare Simulation

Healthcare simulation has become a specialized profession with an associated code of ethics (Park et al., 2018). Certification in healthcare simulation education is available, i.e., Certified Healthcare Simulation Educator (CHSE®) (Society for Simulation in Healthcare, 2018). Anecdotally, the current body of literature on healthcare simulation is becoming more rigorous with increased numbers of experimental and qualitative studies.

Nursing education has incorporated manikins for basic applications, e.g., cardiopulmonary resuscitation and injections with static manikins (Sanford, 2010). Utilization has also included high-fidelity patient simulators (HFPS), or manikins, which offer realistic physiologic human-like features, like breathing and blinking. These HFPS have been introduced into realistic patient scenarios for training, creating healthcare simulations. This type of HFPS, as well as high-fidelity simulations in general, has become more common throughout nursing and medical schools (Basak et al., 2016; McGaghie et al., 2010; Sanford, 2010; Motola et al., 2013). Computer-based simulations, i.e., those that often include a keyboard as well as a mouse (Aebersold & Dunbar, 2021), are also being incorporated into nursing curricula. In one study, computer-based simulations were found to be effective for student learning, especially as preparation for lab-based simulation (Donovan et al., 2018).

Augmented, virtual, and mixed reality simulations have been implemented and are increasing in its use (Aebersold & Dunbar, 2021; Plotzky et al., 2021). They have been shown to be effective in educating students in a variety of settings, some of which include or are specifically tailored to nursing students of various levels (Aebersold & Dunbar, 2021; Anderson et al., 2021; Chen et. al, 2020; D'Errico, 2021; McCarthy & Uppot, 2019). In a meta-analysis, Chen et al. (2020) found that virtual reality (VR) was a more effective method to increase knowledge than traditional methods in nursing education. Skill acquisition has been demonstrated in VR (Kavanagh et al., 2017; Smith & Hamilton, 2015). An advantage of VR technology is the flexibility, as well as it has the potential for wide adoptability (Aebersold & Dunbar, 2021).

Regardless of simulation type (i.e., such as manikin or AR/VR), it is important that where the simulation is conducted is considered. This includes the simulation room.

Simulation Room Design

Simulation room design should begin with a designer that has the knowledge needed to appropriately outfit the environment (Palaganas et al., 2020, Chapter 16). CHSEs®, per the Society for Simulation in Healthcare (2018), must be knowledgeable in simulation resources and associated environments. Additionally, CHSEs® must know how to effectively manage budgetary resources (Society for Simulation in Healthcare, 2018), which may include appropriately making provisions for the center's design or redesign. Knowing and understanding fiscal resources is essential in simulation center operations (INACSL Standards Committee et al., 2021).

Unfortunately, there is no standard process to create a full-sized simulation space, however, there are some standards for certain design features (Palaganas et al., 2020, Chapter 16). Best practices are still being developed (Palaganas et al., 2020, Chapter 16). Although, advances have occurred (Kutzin, 2016), simulation center design is a complicated process (Davies & Davies, 2015). It is important that when designing a simulation center, physical space is contemplated. It should be accessible, adaptable, usable, and the associated rooms should serve multiple functions (Davies & Davies, 2015; Kutzin, 2016; Palaganas et al., 2020, Chapter 16). Various types of rooms may be incorporated into a simulation center, such as those specifically used for HFPS, which replicate patient rooms seen in medical settings like hospitals (Palaganas et al., 2020, Chapter 16), as well as pediatrics and labor and delivery (Davies & Davies, 2015; Kutzin, 2016). Other examples of rooms include a control room and space for debriefing; however, these are only a few of the many room types that exist (Davies & Davies, 2015; Kutzin, 2016; Palaganas et al., 2020, Chapter 16).

Specific factors need to be accounted for during the design and planning phase. Healthcare simulation rooms and the overall purpose of the simulation center layout, such as the type of flooring, electrical outlets, audiovisual equipment, medical gasses (e.g., real or simulated oxygen), simulators (e.g., manikins), furniture, egress, flow, and the size of the doorways, are among some considerations (Davies & Davies, 2015; Kutzin, 2016; Palaganas et al., 2020, Chapter 16). Soundproofing of rooms is also important (Davies & Davies, 2015), along with the space requirements needed for the desired number of learners to occupy each area (Kutzin, 2016; Palaganas et al., 2020, Chapter 16) as well as safety egress in accordance with local ordinance. Ultimately, the space should be determined based on the stakeholders' needs and the overall program and educational goals and objectives (Kutzin, 2016; Palaganas et al., 2020, Chapter 16; Seropian & Lavey, 2010), and it must be appropriately managed (INACSL Standards Committee et al., 2021). The location of real safety equipment, restrooms, exits, budget considerations (Henri, 2011; Kutzin, 2016; Seropian & Lavey, 2010), realism (Henri, 2012; Kutzin, 2016), and location of operational guides and policy manuals may be additional factors to ponder.

For those specializing in healthcare simulation, learning about simulation room design is important. However, these individuals may not have the necessary experience or the educational background in these areas. Thus, the need for preparation via an assignment.

Background

Original Assignment

The original pen and paper simulation space activity course assignment was strategically placed within a simulation operation curriculum, specifically designed to initiate creativity, and incorporate critical thinking when designing a multipurpose learning space. Students were required to think about the growth and future development of their simulation program. Incorporating required building elements, such as the Americans with Disabilities Act of 1990 (United States Department of Justice, 2010) building codes for door widths, egress, and height of emergency equipment stretched the concept of creating a fictional space to one that is functional. Another area of conceptual application was attempting to create realistic placement of power outlets for both HFPS, monitors, intravenous pumps, and electronic hospital beds to necessitate the student to imagine the potential space along with long-term usage.

Originally, the assignment was developed as a paper and pen activity with graph paper, like a schematic design used when creating a simulation center space (Palaganas et al., 2020, Chapter 16). This activity had no limitations on what the student could draw, however anecdotally, spaces that were not realistic in size, budget, or to scale. The designs typically lacked budgetary considerations or restrictions, which is an important factor to consider in a build-out. A realistic to scale design computer-based software was desired to create a project which the student could potentially utilize in future endeavors or if the opportunity arose in their place of employment. Computer software would allow the student to create a multi-purpose space for high-fidelity, simulation-based education (SBE), including all the specifics such as interior design. Elements of the interior design features included awareness of the door egress, wall spacing, running water, as well as visualizing spatial factors.

Virtual Simulation and Software

At the time of development, there appeared to be only a few computer programs which allowed individuals to create simulation center designs, such as those for architects (Palaganas et al., 2020, Chapter 16), or other computer-generated software or models for developing simulation center architectural design (Henri, 2011; Henri, 2012). It was difficult to locate software that allowed students specifically to design their own simulation room as described in this article. Therefore, the collaborative team decided to develop such software.

The team explored the use of virtual simulation, paired with browser-based, three-dimensional (3-D) web application software for students to design a healthcare simulation space floor plan. The Nursing Simulation Builder (University of Central Florida [UCF], 2018) widget developed as a joint project between CON and LS&T provides an effective first step towards developing an actual simulation floor plan which is a necessary component in healthcare simulation organization and management. Organizational management includes creating patient spaces that mimic real-life healthcare settings. The student must have the ability to create via simulation a space that can be subdivided into individual rooms and populate it with assets. An asset is an icon within the program that visually represents and looks like necessary items in a location (Laviola et al., 2021) such as a hospital or clinic and includes items such as beds, tools, curtains, furniture, and simulators such as high-fidelity manikins.

Widget

The Nursing Simulation Builder (UCF, 2018), i.e., "widget," for the purpose of this article, refers to the browser-based application designed to operate within the university's educational platform. A widget is a colloquial name for a web-based instructional tool that can be customized by instructors utilizing their content for their courses (Kim et al., 2013).

Purpose

The purpose of this manuscript is to first, describe the assignment and widget development (Phase I) and then, discuss the study to determine the usability and student perception of the widget created to learn simulation room design from both current and past students of the associated course (Phase II).

Method

Phase I: Assignment and Widget Development

An innovative computer-based student assignment was designed and authored using 3D web browser-native technology to offer students a "hands-on" experience of "building" a hospital simulation room. Completion of the assignment was required in the university's online learning system. The assignment was created using the Nursing Simulation Builder (UCF, 2018) widget, an open-source platform built by LS&T. The following three elements were embedded in the assignment:

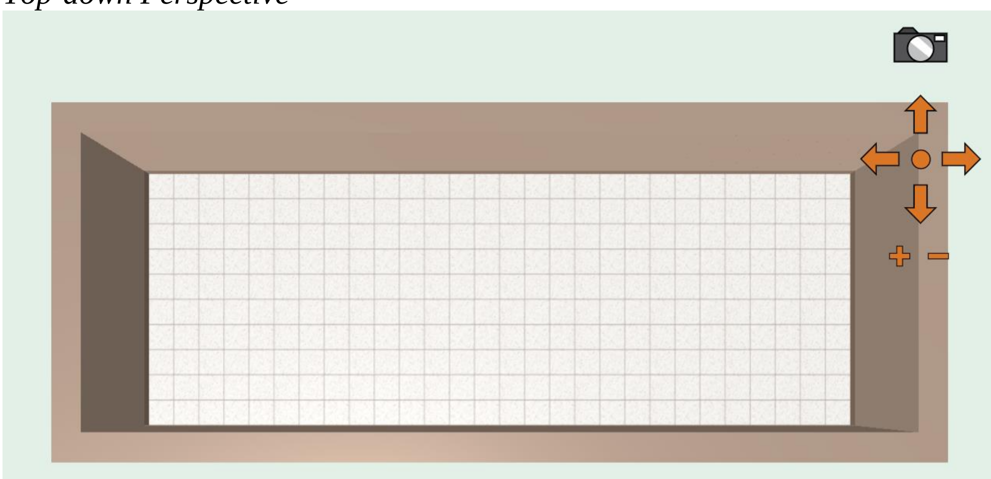
1) A written paper focused on space justification and budget requirements that should be considered when designing an actual simulation space.
2) A requirement to design a simulation space that involved students using the widget.
3) A written critique that required students to incorporate each aspect of the widget including the realism of assets, "how-to directions," and feasibility of the widget.

Creation of a simulation space activity that replicated the development of the space to scale was imperative. The assignment was built to explore the student's thinking and application of knowledge. It also required the placement of specific furniture, devices, and equipment that could be potentially recommended to simulate a floor plan incorporating best practices for patient safety, equipment location, and ease of movement. Students were instructed to create the proposed simulation space using the newly developed widget.

Widget. Within the widget, students could place and arrange 3D assets and other tools that would be included as analogous to a real-world simulation space. Assets in the room incorporated items such as intravenous (IV) poles, tables, furnishings, and equipment. The space originated as an empty rectangular room, and the user is, by default, providing a top-down perspective of a blank floor plan where they can add the assets according to the floor plan they designed (see Figure 1).

Figure 1

Top-down Perspective



The user was also capable of switching to a first-person perspective to explore the space from the viewpoint of someone standing within it (see Figure 2).

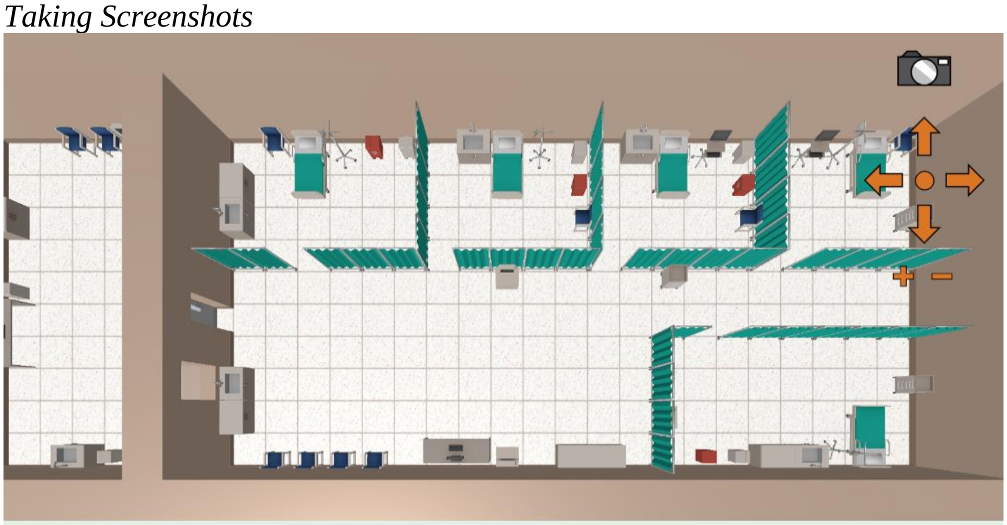
Figure 2

First-person Perspective

Once the floor plan was completed, students were instructed to take a screenshot of the design to submit as part of the assignment. The widget allows for screenshots to be taken by clicking the Camera Icon located on the top right of the interface and then saved by selecting the “Save as” button. Students can then submit the screenshot as part of the assignment (see Figure 3).

Figure 3

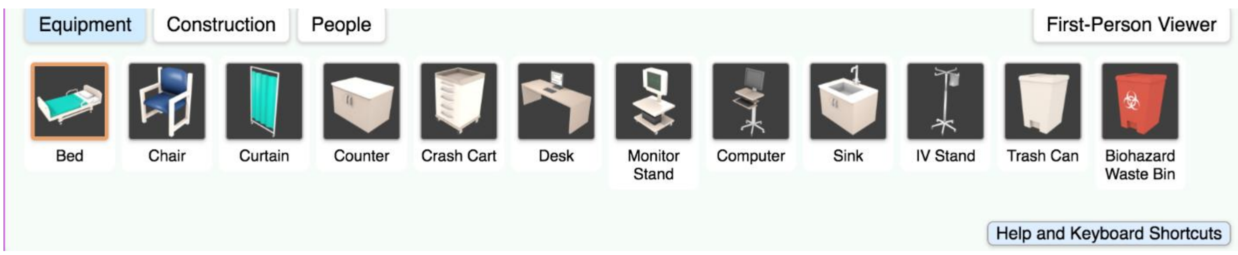
Taking Screenshots



Widget Iterations

Student feedback was needed to evaluate student perceptions of ease-of-use and other aspects related to how the widget worked (Sauro, 2011), as has been done in other simulation studies when implementing new strategies (e.g., Anderson et al., 2021). Prior to the study, the widget was used by students, and many iterations of the assignment were implemented to improve student engagement. While the initial versions of the widget allowed placement of basic clip art type elements, the assets were simple and often lacked color or textures which were added in later updates of the assets (see Figure 4). An enhanced iteration included transforming the paper/pencil process to a 3D format. Students were able to position and place 3D assets such as chairs, tables, and IV poles in direct proportion to the patient bed enhancing realism of the design.

Figure 4
3-Dimensional Assets



The initial software user interface (UI) was extremely rudimentary. Considering anecdotal student feedback, enhancements were made to the UI. Assistive tooltips and an onboarding tutorial were added to improve the widget's functionality for the student. Examples of these enhancements included keyboard shortcuts and better placement of walls of the created spaces that could be utilized to subdivide the space making it possible to create multipurpose rooms. Additionally, a virtual reality (VR) element was created to provide the student the ability to enter the created space with a first-person view. In the latest iteration, the widget provided rudimentary, experimental VR support when used in conjunction with a phone-based VR headset. However, the inclusion of VR was not considered a cornerstone of the user experience. Formalized feedback was desired to refine the widget (usability, perception) and to add to the science of teaching and learning with VR and the widget application.

Phase II: Study

Study Design

A descriptive evaluation study design was used.

Study Population/Sampling

Inclusion criteria included students over the age of 18 years old who were currently enrolled in the healthcare simulation operations course after the introduction of the widget. Previous students of the course were also invited to participate, which could have included those who had already graduated but who still checked their university email.

Instruments

Demographics. Demographic data including semester/year of the course; age (in intervals); program track enrolled in MSN-Simulation, Simulation Certificate, MSN-Education, DNP, PhD, or Other (write in requested); previous widget utilization (yes/no), and previous experience with simulation room design (yes/no).

System Usability Scale (SUS). To determine the usability of the widget, a 10-item questionnaire was used (Brooke, 1996). Participants recorded responses on a 5-point Likert scale: 5, Strongly Agree to 1, Strongly Disagree (Brooke, 1996). To interpret the tool, converted scores of 68 are considered average with scores below this meaning less than average (Sauro, 2011).

Open-ended Questions. Several open-ended questions related to the widget were included at the end of the SUS (Brooke, 1996). Questions related to what was most liked about the widget, suggested changes, and thoughts on further widgets for the program, including content, were added.

Data Collection

Institutional Review Board approval was acquired at the associated university, and the study was considered exempt. Students currently in the course were introduced to the study via a posted announcement in the course learning management system. All potential participants were emailed via their academic email address along with a description of the study which included the consent (Explanation of Research) and online survey links via Qualtrics® (n.d.). Completion of the instruments implied their consent. A follow-up email with the study information and link to the survey was sent two weeks later. The survey was closed after an additional two weeks. The total length of time the survey was open was one month. The contact person was not the instructor of the course decreasing the appearance of coercion.

Data Analysis

Quantitative data was analyzed with descriptive statistics. The mean, percentage, and standard deviation was calculated.

Qualitative data was analyzed via Krippendorff's (2004) approach. Sampling units were defined as the participants' written responses to the combined open-ended questions. Coding units are the contents within the sample that are categorized (Krippendorff, 2004). The coding units within this study were identified a priori: Positive attributes of widget, Improvements, and Future Applications.

Results

Demographics

Twenty-one participants completed demographics. Based on rounding, most participants were over 40 years of age (n= 16; 76%), in the MSN-Simulation track (n = 12; 57%), with no experience using a widget (n = 17 out of 20; 85%) or designing a simulation room (n = 17 of 20; 70%). The course was offered two times a year (Spring/Summer). There were participants from each of the associated six semesters up to the point of the survey (Spring 2017-Summer 2019). See Table 1 below.

Table 1
Demographics

Demographic Variable (n answered)	**n(% rounded to = 100%)**
Age (n=21)	
• 20-30 years	4(19)
• 31-40 years	1(5)
• 41-50 years	9(43)
• 51-60 years	5(24)
• > 60 years	2(9)
Program (n=21)	
• MSN-Simulation track	12(57)
• Simulation Certificate	8(38)
• PhD	1(5)
Previous experience with widget (beyond course) (n=20)	
• Yes	3(15)
• No	17(85)
Previous experience with simulation room design (beyond the course) (n=20)	
• Yes	6(30)
• No	14(70)

Usability

The SUS (Brooke, 1996) mean converted score was 61 (Standard Deviation [SD] 19.2) from 20 participants who completed the questionnaire. The range of converted scores spanned from 32.5-100.

Content Analysis

Content analysis of the open-ended questions explored themes and meanings described by the participants. A total of 56 sampling units were identified. A minimum of 16 units were identified within the three a priori coding units (see Table 2). Positive attributes were based on the VR and 3D aspects of the widget in a positive manner, i.e., 37.5% of the coding units. Improvement, a priori coding unit, 34% were overall specific to more detailed instructions, and 29% directly related to asset functionality, while future applications were not readily identified.

Table 2
Sampling and Coding Units

A Priori Coding Unit (n answered)	n(% overall/56; unit)
Positive Attributes (n=21) • Visual • Assets	9(16;43) 4(7;19)
Improvement (n=19) • Instructions • Asset functionality	5(9;26) 8(14;42)
Future Application (n=16) • No	0(0)

Discussion

The SUS (Brooke, 1996) is not meant to be used as a diagnostic instrument but rather to understand the usability of specific applications (Sauro, 2011). The converted mean score for the widget was under the average by seven (Sauro, 2011), but the span included some numbers over the average. This showed that while most of the students perceived the widget to have a degree of cumbersomeness, other students rated the application above average. This could be explained by changes made over time within the widget; however, this aspect was not explored.

Most student responses were overall positive which may have increased as improvements were made to the widget based on student feedback. Constructing virtual walls and adding the ability to switch perspective within the widget was noted as a major improvement. The application and use of the widget were a novel assignment for the students. The increased complexity of the interactions required of the student with the widget in the VR environment could have created increased frustration and confusion per some of the written responses. This may have been amplified when directions were not read prior to attempts of completing the widget. Anecdotally, when a short sample activity was added that required students to read the directions before practicing creating a space within the widget. Additionally, browser-native 3D rendering is resource intensive, and student users with lower-capability computers may have been partially responsible for students having an adverse experience.

Triangulation of the data was completed using the SUS (Brooke, 1996) score and content analysis. The results were consistent even with a relatively small sample. The widget allowed for the visualization of complex elements of content. Increasing the usage and functionality of the widget seemed to improve students' ability to embrace novel technology and to critically think. The application provided context to an abstract process with which most of the students were not familiar. Increased familiarity increased ease of use and provided a foundation for simulation design.

Limitations

The small sample size limits generalizability. Additionally, changes were made to refine the widget each semester, therefore, student experience from one semester to another may have differed. Changes over time were not explored.

Future Research

Future goals are to explore needs within the application and research student outcomes with technology use such as this and to evaluate the VR aspects further. VR is still in the early stages of evaluation in nursing (Aebersold & Dunbar, 2021), and further research is warranted (Aebersold & Dunbar, 2021; Chen et al., 2020; Plotzky et al., 2021). Also, VR is suggested in simulation room design to allow actual visualization of the space (Palaganas et al., 2020, Chapter 16). Additionally, there is already discussion within the team for the potential growth of this initiative with discussions taking place with other colleges at the university for other types of widgets. Future research should also look at iterative changes and outcomes of these.

Additional Information

The UCF Nursing Simulation Builder (UCF, 2018) is one of the Materia widgets created by LS&T. These widgets are all available via open source meaning they are publicly accessible for others to use, modify, and share. This includes the Nursing Simulation Builder (UCF, 2018). Additional information is available on the Materia Website.

Conclusion

As a result of the LS&T development team working directly with the CON, a widget for simulation room design was created and provided for use in one of the courses for the complete online healthcare simulation program. The benefits of this arrangement gleaned a benefit of experiential learning compared to a pen-and-paper assignment. It also provided the ability for rapid iteration changes. A close working relationship between LS&T and the nursing faculty allowed for swift changes within the prototype (Peterson et al., 2018).

Acknowledgements

The authors thank: Kylee Woodland, Sam Belcastro, Daniel Brinkman, Nathan Dabu, Ryan Eppers, and Bill Funk who worked on various pieces of the widget.

References

Aebersold, M., & Dunbar, D.-M. (2021). Virtual and augmented realities in nursing education: State of the science. *Annual Review of Nursing Research, 39*(1), 225-242. https://doi.org/10.1891/0739-6686.39.225

K.Adamson., & Rodgers, B. (2016). Systematic review of the literature for the NLN Jeffries Simulation Framework: Discussion, summary, and research findings. In P. R. Jeffries, *The NLN Jeffries Simulation Theory* (pp. 9-37). Wolters Kluwer.

Anderson, M., Guido-Sanz, F., Díaz, D. A., Lok, B., Stuart, J., Akinnola, I., & Welch, G. (2021, May). Augmented reality in nurse practitioner education: Using a triage scenario to pilot technology usability and effectiveness. *Clinical Simulation in Nursing, 54*, 105-112. https://doi.org/10.1016/j.ecns.2021.01.006

Basak, T., Unver, V., Moss, J., Watts, P., & Gaioso, V. (2016). Beginning and advanced students' perceptions of the use of low- and high-fidelity mannequins in nursing education. *Nurse Education Today*, *36*, 37-43. https://doi.org/10.1016/j.nedt.2015.07.020

Brooke, J. (1996). SUS-A quick and dirty usability scale. In P. W. Jordan, B. Thomas, B.A. Weerdmeester, & A. L. McClelland (Eds.), *Usability evaluation in industry* (pp. 189–194). Taylor and Francis.

Chen, F.-Q., Leng, Y.-F., Ge, J.-F., Wang, D.-W., Li, C., Chen, B., & Sun, Z.-L. (2020). Effectiveness of virtual reality in nursing education: Meta-analysis. *Journal of Medical Internet Research*, *22*(9), e18290. https://doi.org/10.2196/18290

Davies, A., & Davies, J. (2015). Initial steps in designing a simulation center and program to support the opening of a new women and children's hospital in Qatar. *Avicenna, 2015*(1). https://doi.org/10.5339/avi.2015.1

D'Errico, M. (2021). Immersive virtual reality as an international collaborative space for innovative simulation design. *Clinical Simulation in Nursing*, *54*, 30-34. https://doi.org/10.1016/j.ecns.2021.01.005

Donovan, L. M., Argenbright, C. A., Mullen, L. K., & Humbert, J. L. (2018). Computer-based simulation: Effective tool or hindrance for undergraduate nursing students? *Nurse Education Today*, *69*, 122-127. https://doi.org/10.1016/j.nedt.2018.07.007

Henri, D. A. (2011). Simulation based learning environment (SimBLE) architecture: Tailoring to the budget. *Clinical Simulation in Nursing*, *7*(6), e254. https://doi.org/10.1016/j.ecns.2011.09.038

Henri, D. A. (2012). Simulation based learning environment (SimBLE) architecture: The fidelity continuum. *Clinical Simulation in Nursing*, *8*(8), e396 https://doi.org/10.1016/j.ecns.2012.07.029

Hill, B. (2017). Research into experiential learning in nurse education. *British Journal of Nursing*, *26*(16), 932-938. https://doi.org/10.12968/bjon.2017.26.16.932

INACSL Standards Committee, Charnetski, M., & Jarvill, M. (2021, September). Healthcare Simulation Standards of Best Practice™ Operations. *Clinical Simulation in Nursing*, *58*, 33-39. https://doi.org/10.1016/j.ecns.2021.08.012

Kavanagh, S., Luxton-Reilly, A., Wuensche, B., & Plimmer, B. (2017). A systematic review of virtual reality in education. *Themes in Science and Technology Education*, *10*(2), 85-119. Retrieved July 8, 2021. https://www.learntechlib.org/p/182115/

Kim, S., Kim, H., & Han, S. (2013). A development of learning widget on m-learning and e-learning environments. *Behaviour & Information Technology*, *32*(2),190-202. https://doi.org/10.1080/0144929X.2011.605907

Krippendorff, K. (2004). *Content analysis: An introduction to its methodology* (2nd ed.). Sage.

Kutzin, J. M. (2016). Simulation design considerations 2.0: Optimizing space and operations. *Clinical Simulation in Nursing*, *12*(6), 187-196. https://doi.org/10.1016/j.ecns.2016.01.012

Laviola, E., Gattullo, M., Manghisi, V. M., Fiorentino, M., & Uva, A. E. (2021). Minimal AR: Visual asset optimization for the authoring of augmented reality work instructions in manufacturing. *The International Journal of Advanced Manufacturing Technology*, 119, 1769–1784. https://doi.org/10.1007/s00170-021-08449-6

Lioce, L. (Ed.)., Loprieato, J. (Founding Ed.), Downing, D., Chang, T. P., Robertson, J.M., Anderson, M., Díaz, D. A., & Spain, A. E. (Assoc. Eds.) and the Terminology and Concepts Working Group (2020, September). *Healthcare Simulation Dictionary* (2nd ed. [2.1].). Agency for Healthcare Research and Quality. AHRQ Publication No. 20-0019. https://doi.org/10.23970/simulationv2

McCarthy, C. J., & Uppot, R. N. (2019). Advances in virtual and augmented reality—Exploring the role in health-care education. *Journal of Radiology Nursing*, *38*(2), 104-105. https://doi.org/10.1016/j.jradnu.2019.01.008

McGaghie, W. C., Issenberg, S. B., Petrusa, E. R., & Scalese, R. J. (2010). A critical review of simulation-based medical education research: 2003-2009. *Medical Education*, *44*(1), 50-63. https://doi.org/10.1111/j.1365-2923.2009.03547.x

Motola, I., Devine, L. A., Chung, H. S., Sullivan, J. E., & Issenberg, S. B. (2013). Simulation in healthcare education: A best evidence practice guide. AMEE Guide no. 2. *Medical Teacher, 35*(10), e1511-e1530. https://doi.org/10.3109/0142159X.2013.818632

Palaganas, J. C., Ulrich, B. T., & Mancini, M. E. (2020). *Mastering simulation: A handbook for success* (2nd ed.). Sigma Theta Tau International.

Park, C. S., Murphy, T. F., & the Code of Ethics Working Group. (2018). *Healthcare simulationist code of ethics*. Society for Simulation in Healthcare. https://www.ssih.org/SSH-Resources/Code-of-Ethics

Peterson, C., Diaz, D., Anderson, M., Bastedo, K., & Jowallah, R. (2018, June). Presentation name: Collaborative Development of an Augmented Reality/Virtual Reality Simulation Space Creation Tool. Presentation presented at International Nursing Association of Clinical Simulation and Learning in Toronto, Canada

Plotzky, C., Lindwedel, U., Sorber, M., Loessl, B., König, P., Kunze, C., Kugler, C., & Meng, M. (2021). Virtual reality simulations in nurse education: A systematic mapping view. *Nurse Education Today*, *101*, 104868. https://doi.org/10.1016/j.nedt.2021.104868

Qualtrics®. (n.d.). *Qualtrics®XM.* https://www.qualtrics.com

Sanford, P. G. (2010, July 1). Simulation in nursing education: A review of the research. *The Qualitative Report*, *15*(4), 1006-1011. https://doi.org/10.46743/2160-3715/2010.1196

Sauro, J. (2011, February 3). *Measuring usability with the System Usability Scale (SUS)*. MeasuringU. https://measuringu.com/sus/

Seropian, M., & Lavey, R. (2010). Design considerations for healthcare simulation facilities. *Simulation in Healthcare*, *5*(6), 338-345. https://doi.org/10.1097/SIH.0b013e3181ec8f60

Smith, P. C., & Hamilton, B. K. (2015). The effects of virtual reality simulation as a teaching strategy for skills preparation in nursing students. *Clinical Simulation in Nursing*, *11*(1), 52-58. https://doi.org/10.1016/j.ecns.2014.10.001

Society for Simulation in Healthcare. (2018, July). *CHSE Certified Healthcare Simulation Educator®: Examination blueprint, 2018 version.* https://www.ssih.org/Portals/48/Certification/CHSE_Docs/CHSE_Examination_Blueprint.pdf

University of Central Florida. (2018). *Nursing simulation builde*r [Computer software]. Materia. https://materia.ucf.edu/widgets/94-nursing-simulation-builder

United States Department of Justice. (2010, September 15). *2010 ADA standards for accessible design*. Washington, D.C. https://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm