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Evaluating Advanced Nurse Clinicians' Readiness to Use Augmented Reality for Delivery of Simulated Teaching Sessions

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Evaluating Advanced Nurse Clinicians' Readiness to Use Augmented Reality for Delivery of Simulated Teaching Sessions

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Abstract

Background: Since the start of the COVID-19 pandemic, nurses have adapted numerous new processes and procedures. Keeping patients safe is dependent on the education and experience of providers caring for them. By utilizing the capabilities of augmented reality (AR), clinical nurse educators (CNEs)/advanced nurse clinicians (ANCs) can provide real-time learning while providing feedback to nurses during simulated instructional experiences. AR instructional methods hold promise for educators due to staff shortages, time constraints, and inadequate facility space for in-person teaching sessions.

Purpose: The purpose of this doctoral project was to evaluate the ANCs readiness to adopt new AR technology, the Microsoft HoloLens, as a teaching strategy.

Methods: In this pretest-posttest design, four educational sessions were employed to explore the ANCs perceived usefulness (PU) and perceived ease of use (PEU) of the HoloLens headset.

Results: Four educational sessions on AR, the Microsoft HoloLens AR headset, and its use for training of nurses were held. The total sample size of ANCs that attended a session was 14. The perception of the HoloLens PU and PEU as a teaching strategy total pre and post survey mean scores increased from 59.07 to 77 respectively ($p < .001$). This shows significance that the ANCs perceived the HoloLens to be easy to use and useful to their job performance.

Discussion: The study results were significant; however, it also implies that ANCs were likely to adopt this technology prior to the educational session(s). Both PU and PEU

increased after the educational sessions, which demonstrates ANCs readiness to adopt this new technology into their training of nurses.

Keywords: augmented reality, Microsoft HoloLens, simulation, clinical nurse educators

Evaluating Advanced Nurse Clinicians' Readiness to Use Augmented Reality for Delivery of Simulated Teaching Sessions

Background

In March 2020, the world of healthcare changed forever. Hospitals and other healthcare settings became a challenge for patients and staff. The COVID-19 pandemic not only changed the way healthcare providers practiced, but also limited the number of hands-on experiences that novice and experienced nurses were provided to improve and strengthen their skills and knowledge. The pandemic required nurse educators to transition teaching methods from in-person to digital and online platforms for staff and student instruction (Georgsson, 2020). This made training nurses more difficult for clinical nurse educators (CNE) to accomplish with the ever-changing healthcare environment that included disseminating new processes, equipment operation, and orienting new staff.

With supply back orders and the inability to acquire enough equipment to plan for the number of ill patients who were projected, hospital administrators sought alternative means of care management. This transition required just-in-time training to educate and train staff in the proper operation of new equipment and supplies. At a recommendation from the Quality Risk Department, the project director's health system halted all in-person classes, training, and skill development sessions. As a result, alternate methods were needed to educate staff on new techniques and strategies to keep patients and frontline staff safe.

The American Nurses Association (ANA) responded to the pandemic by championing "…evidence-based guidelines and sufficient resources to support our

nation's registered nurses and other frontline health care providers in safely and effectively responding to the virus and protecting the public" (ANA, 2021, para. 2). Patient safety is the main priority of all healthcare organizations and proper training and education of nurses reduces the likelihood of poor outcomes. Therefore, it is vital that other methods to enhance the proper education and training of nurses be examined.

To limit in-person learning, the utilization of technology rapidly expanded since the beginning of the pandemic. The capabilities of both virtual reality (VR) and augmented reality (AR) are applicable to nearly all areas for instructional use (Menon et al., 2021). Menon et al. (2021) reported a 70% higher memory retention when people learned through AR-structured events (Menon et al., 2021). This type of immersive learning experience allows for in-situ training so that the learner is comfortable in their working environment. The AR headset allows for interaction with advanced nurse clinicians (ANCs), who are clinical experts responsible for the education and development of nursing staff. The remote assist (RA) capability of the headset provides visual cues to be drawn on the image that the nurse wearing the headset is visualizing. This is one of the exceptional capabilities that AR offers over conventional learning.

To stay relevant in healthcare, registered nurses (RNs) need to continuously learn and adapt to their environment (Wilson, 2015). It is part of a nurse's professional practice to engage in continuing education. Instances supporting the use of an AR headset exist if the clinical task at hand needs to be timely, wireless, and requires continuous focus (Wüller et al., 2019). Numerous nursing functions include those attributes, such as performing procedures which require both hands of the clinician (i.e., foley or peripheral

intravenous insertion, central line dressing change, chest tube or tracheostomy care), therefore supporting the use of AR for learning.

There is evidence to support that when AR is used as an enhancement to training, clinical skills and theoretical comprehension are amplified (Dhar et al., 2021). Technology is needed to enhance professional growth and enable nurses to practice in a safe and supportive environment, while minimizing resources. The pandemic was a stimulus for innovation that required rapid adaptation of cutting-edge instructional technology (Barchielli et al., 2021). The Microsoft HoloLens is an example of this technology, an untethered headset which provides high-definition holograms superimposed onto the wearer's environment (Foronda et al., 2017). AR affords the learner the ability not only to comprehend the material but also to interact with the content. Therefore, perceived usefulness (PU) and perceived ease of use (PEU) will increase the acceptance of AR as a teaching instruction and assist ANCs/CNEs in assisting nurses reach these goals.

An example of innovation to deliver education during the pandemic involved the University of Michigan School of Nursing partnering with Microsoft developers. To adhere to social distancing guidelines, the HoloLens2 was utilized in the school's simulation lab, where the nursing student would wear the headset. Once the nursing application was opened, the student had access to actions to perform the chosen procedure, along with important prompts and step by step videos which the user can navigate with eye gaze technology, while practicing the skills on a manikin (Thomas, 2020).

Problem Statement

As a result of the COVID-19 pandemic, learning and teaching methodologies rapidly adapted to limit in-person instruction while delivering the same level of quality education. Trying to capture the learner's undivided attention often requires educators to discover new and innovative methods tailored to the different needs of the adult learner (Madden & Carstensen, 2019). To provide this training, CNEs were expected to quickly learn and to adapt new technology as a platform for instruction. AR is one of these newer technologies, which superimposes holographic images into real environments. Over two years later, these changes in learning techniques transformed how training is currently presented. Now learners come prepared to instructional sessions with blended learning, including online prework, allowing more meaningful in-person learning experiences. When AR is used as a teaching strategy, it incorporates this blended learning with its ability to access data such as the internet, journal articles, textbooks, and computer applications all in real time in any environment. Dhar et al. (2021) reported an increase in learning and fewer procedural related errors in medical students whose instruction incorporated AR.

Purpose

The purpose of this doctoral project was to evaluate the ANCs readiness to adopt new technology, the Microsoft HoloLens, as a teaching strategy.

Project Questions

What is the perceived usefulness of the advanced nurse clinicians to utilize the Microsoft HoloLens as a teaching methodology to train nurses?

What is the perceived ease of use of the advanced nurse clinicians to utilize the Microsoft HoloLens as a teaching methodology to train nurses?

Conceptual Definitions

The following definitions were used in this doctoral project.

- Simulation: "Simulation is a method whereby an artificial or hypothetical experience engages the learner in an activity that reflects real-life conditions but without the risk-taking consequences of an actual situation are created" (Rystedt & Lindstrom, 2001, as cited in Bastable, 2008, pp. 446-447); and that replaces real world experiences with a comparable one (Hunt et al., 2006). This experience allows the learner to practice skills and techniques without fear of patient harm. Simulation encompasses task trainers, low and high-fidelity manikins, virtual instruction, and standardized patients (Menon et al., 2021). Deciding which training technique to use depends on the objectives of the learning session.
- Virtual Reality (VR): "technologically generated representation of a three-dimensional (3D) environment"; a completely immersive surrounding that includes a 360-degree field of vision and can be manipulated (Aebersold and Dunbar, 2020, p. 227).
- Augmented Reality: Augmented Reality (AR) is a component of virtual reality (VR) in which digital content is placed onto the current environment (Mendez et al., 2020). The primary difference between AR and VR is that AR can merge the real world with the virtual one (Mendez et al., 2020). This is especially helpful to keep the simulated experience as real as possible, allowing the learner to suspend their disbelief and practice exactly as they would in the real world.

- Microsoft HoloLens: Microsoft HoloLens is a “self-contained,” untethered holographic computer in the form of a headset, that “allows users to leverage enterprise-ready mixed reality (MR) applications while working ‘heads-up’ and ‘hands-free’” (Microsoft, n.d.; Scooley, n.d.). The headset developed by Microsoft contains cloud storage, which allows data storage that is transferred via an internet/network, and numerous AR applications, which allows users to visualize a projected hologram placed onto the real-world environment. RA, alternatively referred to as Dynamics 365 Remote Assistance or Windows Remote Assistance, is a Microsoft Windows feature introduced with Windows XP that allows others to connect to a computer. RA is another capability of the HoloLens by which users can share their real-time view with an expert. The expert can then guide and support the learner wearing the headset, from anywhere in the world. For example, during the COVID pandemic Sheba Medical Center in Israel trained nurses on the use of a new ventilator in only 20 minutes using the HoloLens 2 Guides (cloud storage), which provided a tutorial for every function of the ventilator (Sheba Medical Center, 2020).
- Advanced Nurse Clinicians: Advanced Nurse Clinicians (ANCs) are graduate level trained nursing professionals who serve as clinical experts, responsible for the education and development of assigned staff, including nurses, unit secretaries (US) and patient care technicians (PCT). For this project, ANCs will focus on the educational needs of new-to-practice nurses. ANCs are an integral part of the leadership team and assist in research and all evidence-based practice initiatives for their designated unit(s).

- Clinical Nurse Educators: Clinical Nurse Educators (CNEs) are baccalaureate or Masters prepared nursing professionals with leadership expertise who work in healthcare facilities and are responsible for staff orientation, developing continuing education and new process/equipment training, policy and procedure development and modifications, and staff competencies (Brennan and Olson, 2018).

Review of Literature

Search Methods

As shown in Table 1, the preliminary search process initially produced 1,175 articles from four databases: CINAHL, Ovid, Inspec, and Medline. The search was based on the key terms from this project's problem statement and question. The initial search terms included: teaching method*, pedagogy, augmented reality, HoloLens comprising the Boolean operator "AND" to limit titles, abstracts, and keywords. The secondary search included teach, taught, pract*, nurse, nursing, nurses, virtual reality, augmented reality comprising the Boolean operator "OR" to include synonyms, abstracts, and keywords to fit inclusion criteria. The inclusion criteria for articles included a published date within 5 years, full text, peer reviewed, and English language. After the secondary search, 178 articles remained, in which 3 duplicates were removed narrowing the list to eleven articles that met all inclusion measures. Table 2 includes the articles that met the search criteria. The articles were evaluated utilizing the Johns Hopkins Nursing Evidence-Based Practice Tool, as shown in Table 2, appraising the Level of evidence (I-V) and Quality of evidence (A-B-C).

Appraised Studies

Wei et al. (2021) performed a quantitative study to evaluate academic educators' willingness to support AR as an adjunct teaching instrument to boost learning. The technology acceptance model (TAM) was utilized to analyze if new technologies have a direct impact on how effective the implementation of this new technology is during teaching. The sample consisted of five private universities in Malaysia, where the researchers included 223 questionnaires using a 5-point Likert scale in this study. The participants were between the ages of 31-35 years old, 63.68% were Masters prepared and 22.87% were Doctorate prepared non-nursing educators, working in academia.

The findings concluded that educators who perceived AR as useful and easy to use were more likely to embrace this technology. Wei et al. (2021) reported these findings were comparable to other research (Ibáñez et al., 2014; Kim et al., 2018; Lu & Liu, 2015; Savela et al., 2020) on AR in that this technology revolutionized learning by engaging the student and enhancing outcomes. Limitations of this study included that all academic educator respondents were from private colleges in Peninsular Malaysia and did not account for the respondents' position as an administrator as a variable (Wei et al., 2021). Other limitations noted were most of the respondents were educated at the graduate level (86.55%), and over 65% had a general understanding of the capabilities of AR prior to the study. The authors recommended to involve students in the future research evaluating AR, and to involve government, educators, and universities to educate on the benefits of implementing AR technology. Another limitation of this study was that the educators were not nursing professionals.

Sattar et al. (2019) piloted a quantitative study to investigate if instruction employing VR proficiency-based simulations to teach medical students functioned as a stimulus to learn. This research study consisted of 87 English speaking fourth year medical students with a mean age of 22.1 years attending one of the chosen five private and three public colleges/universities in Pakistan. The subjects completed a pre-validated questionnaire using a 7-point Likert scale to answer four questions about learning motivation and competency, modified from the intrinsic motivation inventory (IMI) instrument (Sattar et al., 2019).

Three hypotheses were tested in random order, applying a three-staged approach involving participants learning motivation (M) and learning competency (C), comparing VR learning motivation (VRLM), text-based learning motivation (TBLM), and video-based learning motivation (VBLM) educational approaches. The hypotheses were tested utilizing a paired sample *t*-test in SPSS ($p = 0.05$).

Results showed that motivation and competency mean values for learners were statistically significant when VR methodology was used, compared to text or video. Another finding was that text-based learning scored higher for motivation and competency than video-based learning. The authors did not report any limitations to this study, but recommended future studies comprise longitudinal research involving more areas in the medical sciences to replicate the study's value.

Barchielli et al. (2021) utilized The Unified Theory Of Acceptance And Use Of Technology (UTAUT) model to explore elements of technology acceptance for nurses working in technology exhaustive settings (i.e., intensive care settings, surgical settings), and investigated whether experience affects the model. UTAUT's framework was created

to assist in the description and interpretation of the subjects' willingness to embrace technology. This quantitative study analyzed survey data appraising nine items on a100-point scale, from nurses working in six technology intensive departments in the Tuscany region of Italy between the months of August-September in 2019. Administrators chose the nurse respondents to represent the most technology fluid environments. Out of 62 surveys completed, 54 were chosen due to completeness. The subjects were mainly female (70%) between 44-55 years old (57%), currently employed in the operating room (60%), with 20-30 years (37%), or more than 30 years (28%) of nursing experience.

The first five out of eight hypotheses tested focused on the nurses' affirmative relation to implement novel technology. The first hypothesis (H1) measured performance expectancy (PE) (how the individual perceives the advantages of new technology), H2 measured effort expectancy (EE) (how the individual perceives the ease of using new technology), H3 measured social influence (SI) (the positive influence that an individual has involving new technology utilization), H4 measured facilitating conditions (FC) (how the individual feels their organization can sustain new technology utilization), and H5 measured behavior intention (BI) (how the individual adapts and sustains new technology utilization). The last three hypotheses assessed relationships between BI and the nurses' age (Barchielli et al., 2021).

The results of the study illustrated the direct correlation of PE and EE on nurses BI regarding new technology utilization. If PE is considered adventitious and EE is considered simple, BI is improved. All hypotheses were statistically significant except for H3, that social influence has a positive influence on implementing new technology (Barchielli et al., 2021). Barchielli et al. (2021) noted experience level and age of the

nurse impacted social influence, as older nurses were not as concerned with the opinions of their peers as their younger counter parts, possibly related to having increased confidence levels. Limitations of the study included a small sample size related to the small number of nurses who worked in these technology intensive settings. Implications included improving nurses' satisfaction in their work environment, which increases the chance of positive BI and increased likelihood of adopting new technology.

Tilghman et al. (2018) conducted a quasi-experimental study evaluating nursing students' skill attainment after watching video education compared to performing the skills utilizing AR and a patient manikin. The study included 25 Coppin State University School of Nursing (Baltimore, MD) students (5 male, 20 female) during their junior level of the program. The equipment used were the Juxtopia CAMMRAD Medic prototype goggles. No prior AR learning experience was noted by the students, and they were randomly assigned into a control group (14 students) or experimental group (11 students). Both groups viewed a 30-minute video on intravenous (IV) access/medication administration and foley placement, then paused for 20 minutes to test for memory retention prior to completing the skills. The experimental group wore the AR goggles during the procedures. The Student Assessment of Learning Gains (SALG) was developed as the survey tool to gather the self-assessment data which included 34 Likert scale questions, comprising 4 areas: Interest and Attitudes, Understanding Class Content, Skills, and Integration of Learning (Tilghman et al., 2018).

SPSS statistical software was used to analyze the data. In both groups, males were slightly faster (5 minutes 5 seconds) than females (6 minutes 39 seconds) during IV access/medication administration. Students in the experimental group stated they felt

experienced with IV access/medication administration (M = 1.88, SD = 1.66) and foley placement (M = 1.88, SD = 1.16) after AR use. Confidence in information comprehension was reported as increased in the experimental group (M = 2.73, SD = 0.905) compared to the control group (M = 4.21, SD = 2.47), showing statistical significance. However, the control group completed the IV insertion faster (4 minutes 38 seconds) than the experimental group (6 minutes 13 seconds), but both groups completed the task successfully. This study supported technology as an invaluable asset to a learner's attainment of knowledge, skills, and perceived usefulness in training (Tilghman et al., 2018). A limitation to this study was that both groups reported that the 30-minute video tutorial increased overall basic nursing skills, which questions if the Juxtopia CAMMRAD goggles were significant in success of the task at hand. Implications to incorporate use of this technology as a learning tool adjunct assists in augmenting the clinical skills necessary to increase the confidence of the nurse.

AR can notably boost self-learning by intertwining reality with computerized content (Uymaz and Uymaz, 2022). A quantitative research study was performed by Uymaz and Uymaz (2022), to determine the acceptance that nursing students report about the addition of AR technology as an instructional method. The study participants were Turkish nursing students registered in an online internal medicine nursing class between November 2020 and January 2021. Out of 446 students who completed the survey, 27 surveys were excluded for not being fully completed. Demographics included 310 female and 109 male participants, 63 were graduate level and 356 undergraduate level, the median age was 21. The Unified Theory Of Acceptance And Use Of Technology (UTAUT) was chosen by Uymaz and Uymaz (2022) as the model for their framework to

examine both behavioral intention (BI) and user behavior (UB) towards technology. Other components tested influencing BI were performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC), social influence (SI), perceived value (PV) (return on investment for this technology), and anxiety (A) (the distress from using new technology). Components influencing UB comprise BI, usefulness (U) (meets users' needs while enhancing performance), and hedonic motivation (HM) (pleasure derived from technology usage). A total of 10 hypotheses were tested comprising the listed factors, using Structural Equation Modeling (SEM), which examines linear correlations among the components. This study had similarity to the Barchielli et al. (2021) study that reported PE's positive influence on accepting new technology.

The findings concluded that PE is the main element that affects nursing students BI. The second element is PV, as students believe there is value in AR applications due to the potential benefits of learning/performance improvement. SI is a factor only with newer technology and FC does not affect BI. The most important variable affecting UB is BI, secondly is HM. Negative consequences from over usage of mobile technology such as antisocial behavior and addiction to technology have been reported in the literature. Educators can employ AR technology to engage students in online educational sessions. Limitations of the study included the students voluntary use of AR, self-reported results about readiness to adopt AR technology, and only mobile phones were used as the platform for the AR technology.

Related Literature

To assist in the achievement of academic standards, teaching methodologies such as online instruction and new technologies are vital for the progression of nurses

obtaining a Bachelor of Science in Nursing (BSN) or other advanced degree. VR provides the user with an immersive environment in which immersion, perception, and interaction of the virtual environment exist, whereas AR incorporates the real world into the experience (Mendez et al., 2020). In nursing literature, studies focusing on AR and VR are scarce, with more studies focusing on VR technology. A literature review performed by Mendez et al. (2020) included researchers and authors who reported that both teaching methodologies, AR and VR, required training of the faculty and of the user for successful utilization. Even though documentation of AR is limited for its application in nursing instruction, many of the challenges documented for VR were reported, such as issues with internet connection, scanning quick response (QR) codes and problems with software. Mendez et al. (2020) reported that the main advantage to AR and VR education is the ability to "promote student-centered learning'' (p. 2). This is accomplished by engaging the student during the learning process and providing an immersive environment to complement their academic curriculum.

Wüller et al. (2019) performed a scoping review of research relating to AR and its application in nursing. AR usage has been published in literature pertaining to education, construction, marketing, manufacturing, and design but very limited in the nursing field (Wüller et al., 2019). A systematic search of multiple databases was critiqued, and 23 research articles met all criteria encompassing the research question regarding research studies evaluating AR utilization in nursing (Wüller, 2019). Sixteen articles included loosely interpreted aims or evaluated a single task or piece of equipment, and seven did not include a method of evaluation. Advantages of AR included in the literature were: hands-free capability, easy detail recall, decrease in patients' anxiety, more concise

documentation, better time efficiency, and aids with simulation training. The disadvantages included obstacles with communication, less attention on the patient, and missing cues related to the need for undivided attention to the device (Wüller et al., 2019). It was also noted that all studies centered on comprehension and implementation of AR rather than incorporating the technology into nursing bedside practice. Wüller et al. (2019) recommended further studies focus on long term appraisals and consequences of AR usage. Limitations reported were inadequate research on AR in nursing, the lack of study appraisals, publication bias potentially limiting disadvantages of AR, and lack of future implementations.

Menon et al. (2021) implemented a feasibility study that utilized AR to teach cardiac/pulmonary assessment to nursing students from Wright State University, Ohio (Menon et al., 2021). The literature search included in the study comprised uses of AR in nursing education utilizing a tablet, iPad, and HoloLens, for learning anatomy, physical assessment skills, and nasogastric tube (NGT) placement. Also included were other uses of the HoloLens for instruction, including endovascular training for line insertion which reduces the need for radiography and cardiopulmonary resuscitation (CPR) training with audiovisual feedback of blood flow during CPR maneuvers on a manikin (Menon et al., 2021). The authors reported that AR can be used in teaching critical physical and cognitive skills to aid in the training of nursing students (Menon, 2021). The AR application developed for this study also facilitated students with anatomical landmark recognition which assisted in the proper assessment of the cardiopulmonary system. The conclusion is that utilization of AR potentially enhances comprehension and recall, which boosts skills and assessments. Recommendations for future research included adding

different 3D organ systems including sounds to auscultate to expand training and having students' devices sync to the instructor's device so all students visualize the instructor's teaching activity (Menon, 2021).

Quqandi et al. (2022) performed a literature review of AR including articles from 2011 to 2020, reporting one or more benefits of AR utilization in healthcare education. A common theme in the literature was that AR was a "motivational learning strategy" that strengthens learning and aids in students' comprehension and motivation as a key factor for student success (Quqandi, 2022, p. 2). The three themes for AR usage explored by Quqandi et al. (2022) included learning anatomy, training and obtaining skills, and clinical nursing education. In conclusion, AR in nursing education is an adjunct to manikin training, which when combined with traditional learning provides the student with a more genuine training experience (Quqandi et al., 2022). The authors reported technical problems such as the time it took to train the users in the AR equipment, which may affect students perceived usefulness of AR. Also, the authors noted that further studies related to AR in education are needed to determine its usefulness in training and education (Quqandi et al., 2022).

Levy et al. (2021) performed a pilot study during the Covid-19 pandemic to measure the amount of personal protective equipment (PPE) used and staff exposure to Covid-19 during medical rounding on a 21-bed Nephrology unit in a London hospital (Levy et al., 2021). During the height of the pandemic, PPE was in short supply, so an alternate method was needed to preserve PPE as well as limit the staff's potential exposure to Covid-19. The HoloLens 2 uses AR to plot digital images onto the real environment while using cameras and microphones to allow two-way communication for

the user, permitting open communication to take place during the interaction (Levy et al., 2021). Since most of the patients on the unit had Covid-19, one consulting doctor wore the HoloLens 2 and went in the patients' rooms while the rest of the interprofessional (IP) team remained in a remote location. The Microsoft Teams application was used to host the interaction, which was displayed on a computer screen where the IP team could see and hear the entire interaction, and the HoloLens 2 wearing doctor was able to visualize content like progress notes that were being streamed from the IP team's desktop computer. This allowed for IP rounding and input into the patient's plan of care without unnecessary PPE usage or Covid exposure. Qualitative feedback was obtained from both the patients and the entire IP team about the HoloLens 2, and data about advantages on the prospective reduction in infection risk and exposure. The results exhibited a definite advantage to the reduction of Covid-19 exposure and PPE usage, and HoloLens 2 rounding was well received by both staff and patients. The authors recommended further evaluation to endorse the HoloLens 2 as an instructional tool (Levy et al., 2021).

Hou et al. (2022) conducted a randomized clinical trial in China to evaluate if AR through use of the HoloLens 2 could improve compression administration in the moment during cardiopulmonary resuscitation (CPR) self-training (Hou et al., 2022). Two groups were evaluated, instructor trained and self-trained via AR, which was assigned through randomization. An AR CPR application (app) was created for use through the HoloLens 2 utilizing the current American Heart Association (AHA) guidelines for CPR administration and a CPR manikin (Hou et al., 2022). Both groups performed 10 minutes of CPR during a simulated out-of-hospital cardiac arrest (OHCA). The AR CPR app provided the wearer of the HoloLens with an in-the-moment critique of CPR compression

depth and rate via visual and audio feedback. The Unified Theory of Acceptance and Use of Technology (UTAUT) survey was given to the participants in the AR trained group (Hou et al., 2022). Results showed no major difference in CPR administration between the AR self-trained or instructor-guided group. The authors also concluded that the AR CPR app via the HoloLens 2 was a sustainable tool for both self-training and in-the-moment CPR but indicated that future studies are needed to evaluate the efficacy of the AR CPR app (Hou et al., 2022).

Summary

Although the first attempt at a head mounted AR display was created in 1968 by Evan Sutherland, it was not until 1992 when Lois Rosenberg developed the first completely functional system (Patel, 2022). Since AR is a new and emerging technology, there is limited literature about AR and its use in the nursing profession. Most researchers focused on simulation as a teaching methodology and involved medical students/residents, educators, or nursing faculty. The articles appraised support that AR enhances the learning process and acquirement of skills. A potential limitation noted in the literature reviewed were several of the research studies were conducted in foreign countries where they may meet different barriers and facilitators than the US. Regardless of the technology used, the user's perception of its ease and usefulness influences behavior and the prospect of embracing AR and implementing it into practice.

With the influx of hospitalized patients and the everchanging supply and equipment shortages, orientation and training of new processes/procedures needs to be adaptable to all practice situations. AR can allow for this type of flexibility, whether with

one-on-one instruction or in a group, AR can be tailored to meet the educational needs of all ANCs with varying experience levels.

Theoretical Framework

Davis' Technology Acceptance Model (TAM) was the framework for this doctoral project. Fred Davis (1989) described measures that predict a person's likelihood to adapt technology. Davis proposed that a user's acceptance is based on two factors, perceived usefulness (PU) and perceived ease of use (PEU) (Davis, 1989). PU is defined as "the degree in which a person believes that using a particular system would enhance his or her job performance" (p. 320), PEU is defined as "the degree to which a person believes that using a particular system would be free of effort" (p. 320). While Davis focused his original research on information technology (IT), it has expanded over the past 30 years to include almost any technology (Davis, 1989; Lewis, 2019). The theoretical framework for this project was chosen based on Davis' validation that if the technology is perceived as uncomplicated to use and believed to improve performance than a person is more likely to adapt its usage.

The needs of the ANCs are similar even though each may have different experiences and attitudes towards new technology utilization. A pre/post questionnaire assessed the ANCs perceptions of utilizing AR via the Microsoft HoloLens. Comprehension of learning theories/philosophies, recognition of the most appropriate instructional approach, and incorporation of these learning theories, educational materials, and student perceptions were taken into consideration when developing an educational program (Mukhalalati & Taylor, 2019). The educational sessions utilized strategies to highlight the technology's benefits. The benefits for AR in nursing education

include bringing people together safely in an augmented environment, allowing practice and repetition of skills and aligning with problem-centeredness knowledge application.

The educational sessions enabled ANCs to apply new knowledge of AR and the HoloLens and its ability to train nurses. PU and PEU are necessary constructs that directly impact utilization of new technology (Davis, 1989). This is especially beneficial during situations where education and process changes are fluid, such as the need to learn new equipment on off hours. Creating a safe learning environment that allows for exploration and educating the ANCs on usage of the HoloLens, will strengthen perceptions of its usefulness and increase support for adoption of this technology.

The Microsoft HoloLens and AR technology can support the ANCs by utilizing AR via the HoloLens with staff nurses. Several examples of this include skills revalidation, debriefing after significant events, or providing step by step instruction in real time. Researchers have found that simulated scenarios as teaching methods, including AR, enhance students' critical thinking, clinical skills, knowledge, and confidence (Dhar et al., 2021; Menon et al., 2021; Meum et al., 2020; Tilghman et al., 2018).

Method

Design

This doctoral project was a pretest-posttest design consisting of four 2-hour educational sessions exploring the ANCs PEU and PU of the HoloLens as a teaching methodology. As shown in Table 3, a teaching plan outline was used to ensure the participants received the same information and learning methods during the four sessions. To develop contents of the teaching plan an extensive literature review was performed.

This included information about: the need for technology during the pandemic; conceptual terms used in technology; the key features of AR including examples (i.e., Snapchat filters, Pokémon Go, shopping); the many uses of AR; benefits of AR, Microsoft HoloLens capabilities; remote assist (RA), which is a platform that can be purchased to allow on demand consultation with visual cues (the remote user is able to see whatever the HoloLens user is visualizing and provide visual cues like symbols, pictures, product manual); and instructions on how to work the headset. A HoloLens content expert from Virtua reviewed the educational PowerPoint with imbedded videos and the HoloLens Return Demonstration Checklist for feedback prior to the first educational session. Since there is limited literature related to the use of the Microsoft HoloLens, the project director (PD) contacted this Virtua physician who gifted the HoloLens to Virtua. After reviewing the PowerPoint and HoloLens Return Demonstration Checklist, this content expert did not recommend any changes to the educational materials.

The learning methods included an informational PowerPoint on AR and the Microsoft HoloLens, videos of HoloLens capabilities/usage (i.e., hand gestures, current uses relevant to learning), illustration of how to work the HoloLens, and return demonstration by the ANCs on using the HoloLens. The educational sessions included an opportunity for the ANCs to wear the HoloLens device, to obtain feedback about the device and its PU and PEU. As shown in Appendix A, the return demonstration was guided by a checklist, in order for each ANC to follow the same steps to work the device. The ANCs completed a 12-question survey per Appendix B to measure PU (six

questions) and PEU (six questions) before and after the educational sessions. On the pre-survey, the participants also answered demographic questions.

Sample and Setting

This project consisted of a convenience sample of 14 ANCs who responded to an informal email for recruitment, as shown in Appendix C. The participants in this project were a purposive sample of 14 ANCs working in the Virtua Health system, which was approximately 35% of the team. Inclusion criteria for the sample were ANCs working primarily within the five hospitals (Marlton, Mount Holly, Voorhees, Willingboro, and Our Lady of Lourdes), and who may provide additional coverage to the health system's two free standing emergency departments (Berlin and Camden), or the system ANC role, which is not unit based but oversees all the specific specialty areas (i.e. emergency, critical care, medical surgical). ANCs working outside of a unit-based setting or outside of a system role or who were unable to attend the scheduled educational sessions were excluded from participation.

The original recruitment plan was to cease at 20 participants to cap the sessions at 6-7 attendees to allow time to trial the HoloLens. However, due to a delay in La Salle's IRB review, the first education session was rescheduled. Only four dates for the education sessions were offered. Many ANCs were unable to attend.

Ethical Considerations

The PD submitted the DNP project proposal to Virtua's Nursing Research Council for review. Virtua's Nursing Research Council determined the project was an evidenced-based quality improvement (QI) project and did not require institutional review board (IRB) approval. Appendix D includes the letter of support that was given

from Virtua's Clinical Learning Team. La Salle University's IRB characterized this project as an expedited review per Appendix E. Participants could withdraw from the project at any time. As seen in Appendix F, informed consent was obtained prior to the start of each educational session by having participants read and sign a paper consent. A signed copy was made for each participant to take home for future reference. Two continuing education credits (CEs) and pizza were provided for participation in this project. Data were collected and stored in a locked cabinet in a locked office as well as in a password protected laptop. Data will be kept secured for two years then destroyed.

Instrumentation

There were four 2-hour educational sessions held utilizing the concepts of Davis' Technology Acceptance Model (1989) that included: information about the benefits of simulated experiences on learning; descriptions of AR, capabilities of the HoloLens including information about the Remote Assist (RA) capability, and procedure for its use. Prior to the sessions, participants were asked to pick a 3-digit code as an identifier and take the pre-survey anonymously. The survey included questions assessing their baseline PU and PEU to adopt new technology. The questions were adapted from Davis' Technology Acceptance Model (TAM) questionnaire, shown in Appendix B, measuring Perceived Usefulness (PU) and Perceived Ease of Use (PEU) with permission from Dr. Davis as described in Appendix G. The TAM questionnaire measured 12 items total, six evaluated PU and six evaluated PEU (Davis, 1989). The numbers were scored on a 7-Point Likert Scale, with 1 being extremely unlikely, and 7 being extremely likely. The total highest score for the 12-item survey is 84, and 12 is the lowest score for PU/PEU. The participants completed the adapted TAM questionnaire before and after the

educational sessions. They also completed a demographic survey including, age, nursing degree, years of nursing experience, and years of ANC experience with the TAM pre-survey.

Procedure for Data Collection

Once signed paper consent was obtained, the participants used their smartphones to scan a QR code with the link to the TAM pre-survey and demographic questions. Anonymity was maintained by using a specific 3-digit code that was chosen from an envelope by each ANC before completing the pre-survey. The ANCs were instructed not to share their code and to use the 3-digit code on both the pre and post survey so results could be matched to each ANC. To safeguard survey results, only the PD and DNP committee members had access to the survey responses.

Data Analysis

Data from the 12 modified TAM questions was collected anonymously using a 7-point Likert scale via SurveyMonkey, with no identifying characteristics, only the chosen 3-digit code. The SurveyMonkey data were exported to an Excel spreadsheet and analyzed, and descriptive statistics was conducted. The 12 item pre and post survey scores were totaled, and a paired samples *t*-test compared the total mean scores of PU and PEU before and after the educational sessions, with an alpha set at .05. The PD then compared the 6 PU questions and 6 PEU questions pre and post survey using a *t*-test with an alpha set at .05, to differentiate if one was affected more than the other post educational session survey. To complete this, three different *t*-tests were performed: one comparing the total means of all 12 PU/PEU survey questions pre and post, one comparing the means of the six PU survey questions pre and post, and one comparing the

six PEU survey questions pre and post. All three *t*-tests results showed $p < .001$, indicating that both PU and PEU were improved after the educational sessions.

Results

To assist with describing all the capabilities of the HoloLens, five videos were imbedded in the educational PowerPoint presentation for the participants to observe features that the investigator was unable to display during the presentation. These videos included: two using Microsoft Dynamics 365 Guides in healthcare, where nursing students/biomedical engineering students are trained on how to perform procedures by showing step-by-step instructions through the HoloLens (YouTube, 2022; Sheba Medical Center, 2020); how the HoloLens is changing the way medicine is practiced at the Cleveland Clinic, where Interventional Radiologists are learning how to use the HoloLens and can superimpose diagnostic imaging results onto a task trainer to practice performing cancer eradicating procedures (*Hololens in-action at Cleveland Clinic*, 2023); Remote Assistance (RA), an online platform where the HoloLens user can remote in anyone in the world (as long as they have the RA paid license) for real time guidance (*Microsoft hololens, 2023*); and a brief guide on the common hand gestures used, which are necessary to operate the HoloLens (YouTube, 2016). The PD asked participants at the end of each session if they felt the videos highlighted how the HoloLens is making learning new skills/equipment easier with its software applications. All 14 participants verbally answered or shook their head yes to this question.

The main themes from the extensive literature review provided the outline for the teaching plan and content for the educational PowerPoint and checklist. The common themes involved the need for new technology in learning, which included the need for

social distancing as a result of the COVID-19 pandemic, and to improve patient safety measures (Georgsson, 2020). AR's typical features: presence, immersion, and interaction, and accessibility (Mendez et al., 2020; Yeung et al., 2021). How AR is being utilized including: training and virtual scenarios in nursing education, procedural training, and telehealth in the medical field, as a learning modality in academia, combat training simulation in the military, and maintenance and repairs assistance which can include the RA application (Dini & Mura, 2015; Microsoft, n.d.; XMReality, 2023). Benefits of learning through AR including: skills mastery, fear and anxiety reduction, increased mobility, and enhanced learning experience (Kurt & Ozturk., 2021; Uymaz & Uymaz, 2022; Wüller et al., 2019). HoloLens capabilities including: current use in healthcare, components of the HoloLens, RA, Dynamic 365 guides, and software applications (Microsoft, n.d.; YouTube, 2020; YouTube, 2022). And how to operate the headset (Microsoft, n.d.; Scooley, n.d.).

Also, 82 videos about the HoloLens were viewed to choose the best five for the PowerPoint. They were chosen for their detail about the key features that the PD was unable to display to the ANCs without RA capability, including Dynamics 365 guides and its ability to provide step-by-step instructions for procedures, RA usage in providing expert consultation whenever needed, what the hand gestures elicit during operation of the HoloLens, and current usage in healthcare and nursing education.

A total of 14 ANCs attended the four sessions. Five participants attended Session 1, three attended Session 2, one attended Session 3, and five attended Session 4. The sample (n= 14) consisted of registered nurses currently practicing in the role of an ANC throughout the Virtua health system. As shown in Table 4, most participants were

between 35-44 years of age (35.7%), with a Master of Science in Nursing (42.9%), between 6-15 years of nursing experience (42.9%), and had worked as an ANC from 1-3 years (50%).

Table 4

Demographics

Characteristic	*n*	%
Age		
25-34	1	7.1
35-44	5	35.7
45-54	4	28.6
55-64	3	21.4
Over 65	1	7.1
Educational Level		
Bachelor of Science in Nursing	3	21.4
Master of Science in Nursing	6	42.9
Doctorate in Nursing	5	35.7
Years of Nursing Experience		
6-15	6	42.9
16-24	3	21.4
25-30+	5	35.7
Years of ANC Experience		
1-3	7	50
4-6	3	21.4
7-9	1	7.1
10+	3	21.4

The highest possible score for the combined PU/PEU 12-item survey is 84 and the lowest possible score is 12. The highest possible score for the individual PU and PEU questions is 42 and the lowest possible score is 6. A higher score indicates greater PU/PEU. A two-tailed paired *t*-test was performed with an alpha set at .05 to compare the total mean score between the modified TAM pre-survey for PU and PEU and the modified TAM post-survey for PU and PEU. There was a significant difference in the total mean score of the modified TAM survey between the pre-survey ($M = 59.07$, *SD*

= 7.64) and the post-survey (M = 77, SD = 5.72); $t(13) = 4.58$, $p < .001$.

Then scale data from the 6 items scoring PU pre/post, and the 6 items scoring PEU pre/post were entered into Microsoft Excel using a two-tailed paired *t*-test and analyzed, alpha was set at .05. This was to evaluate whether PU or PEU was more affected by the knowledge provided in the educational session. The individual PU and PEU mean scores pre and post-survey were calculated. There was a significant difference in the PU mean score of the modified TAM survey between the pre-survey (M = 30.85, SD = 4.76) and the post-survey (M = 39.21, SD = 3.42); $t(13) = -7.05$, $p < .001$. There was a significant difference in the PEU mean score of the modified TAM survey between the pre-survey (M = 28.21, SD = 5.52) and the post-survey (M = 37.78, SD = 2.63); $t(13) = -5.09$, $p < .001$.

Table 5

T-Test Results for Individual PU and PEU

Group	Pre-Survey		Post-Survey		*t*(df)	*p*	*t*- value
	M	*SD*	*M*	*SD*			
PU Questions	30.85	4.76	39.21	3.42	13	<.001	-7.05
PEU Questions	28.21	1.05	37.78	2.71	13	<.001	-5.09

The PD developed a HoloLens checklist, based on Microsoft's directions for use, to ensure all participants completed the same steps for the HoloLens return demonstration. The checklist was reviewed for accuracy and approved by a content expert for use prior to the educational sessions. The checklist is outlined in Appendix A. All 14 participants successfully return demonstrated utilization of the HoloLens according to the checklist without issues. Four participants needed additional time

compared to other participants to complete the hand gestures skill. The PD also included four Poll Everywhere questions in the PowerPoint presentation to assess in real time if the information being presented was understood. The questions included: “What are the 3 features of augmented reality”; “Uses of augmented reality include”; “Benefits of augmented reality include”; and “Capabilities of the HoloLens are”. Out of the four questions, six participants answered one question incorrectly. That question asked about the 3 features of AR (presence, immersion, and interaction). The PD clarified these features for the participants before moving on to the next content area.

The last section of the four educational sessions included participants’ ideas for the HoloLens’ potential use in nursing. Participants suggested utilizing the HoloLens for procedures that require a second nurse to be present for such as high-risk procedures including central line dressing changes, foley insertions, and wound assessments. Other recommendations included trialing the HoloLens during orientation so nurses can locate procedures easily and practice at their own pace and using the HoloLens for skill revalidation while the ANC observes the skill via a smart device (i.e., computer, tablet, phone).

Discussion

The major findings in this QI project concluded that ANCs are ready to adopt new technology, the Microsoft HoloLens, as a teaching strategy. This was indicated by a total mean score of 59.07 on the TAM pre-survey for PU/PEU, and a total mean score of 77 on the TAM post-survey for PU/PEU (p <.001). The 6 PU items had a slightly higher post-survey mean score (M = 39.21) than the 6 item PEU post-survey mean score (M = 37.78). The ANCs perceived that the HoloLens was useful even before learning about its

functionality and trialing it. By demonstrating the numerous capabilities that the HoloLens offers for educating and training nurses, ANCs likelihood to adopt it as a teaching strategy increased.

A literature review performed by Mendez et al. (2020) included researchers and authors (Englund, 2017; Tilton et al., 2015) who reported that both teaching methodologies, AR and VR, required training of the faculty and of the user for successful utilization. This would require that all ANCs attend training for the HoloLens to learn how to properly operate it, so they could be the superusers and champion its utilization. AR has many benefits in its use for education, from engaging the learner to better learned content retention. A study performed by Andrew (2018) using steady state topography (SST), concluded that AR tasks practically doubled visual attention levels when compared to tasks not using AR (p. 2). There was also a strong connection between how performance expectancy of a piece of equipment directly affects the behavioral intention to adopt it into everyday use (Barchielli et al., 2021). The training can be completed on the learner's time and skills can be repeated until the learner feels confident that they can complete the task successfully. Although, there are numerous articles related to AR and the HoloLens, many included medical professionals or educators/nursing faculty. Also, the authors noted that further studies related to AR in education are needed to determine if it is useful for training and education (Quqandi et al., 2022). No literature was found that involved unit specific CNEs, which should be pursued in future studies.

As far as the PD is aware, this is the first QI project that included ANCs, nurses who educate nursing staff within a health care organization. Previous researchers included medical students (Sattar et al., 2019), university educators (Wei et al., 2021),

and nursing students (Mendez et al., 2020; Menon et al., 2021; Tilghman, et al., 2018, Uymaz and Uymaz, 2022). Similar to previous researchers (Uymaz and Uymaz, 2022; Wei et al., 2021), the ANCs in this current QI project reported via pre and post surveys that the HoloLens was easy to use and useful to educate; and after the educational session with return demonstration, that it would enhance their training of nurses. Similar to previous literature the participants in this QI project suggested that the HoloLens could be used for teaching of assessment skills (Menon et al., 2021), procedures like IV insertion (Tilghman et al., 2018), foley insertion and care (Tilghman et al., 2018), and to include central line insertion and maintenance (Menon et al., 2021).

Limitations

There were multiple limitations to this quality improvement project. Literature involving AR was scant compared to VR, and many of the researchers did not include clinical nurses or nurse educators in the studies. The participants in this current project included a small convenience sample of 14 ANCs. The goal was to have 20 ANCs, however, the first educational session date was rescheduled due to a delay in La Salle's IRB review. There were five ANCs scheduled to attend the first education session; three of them were unable to attend another session due to scheduling conflicts. A fourth educational session date was added, but only one ANC was able to participate. Thereby, potentially impacting anonymity since the date is displayed in the SurveyMonkey results. However, only the PD had access to these results.

Another limitation was that this project was only conducted at one site, Virtua Voorhees, which may have impacted ANC participation if working at another location since they had to attend on their own time. There were also technical issues noted during

two sessions in which the Poll Everywhere application did not display results on the PowerPoint presentation slide or save the answers. Consequently, the PD asked participants to verbally answer the questions and documented the number of wrong answers to trend. Another technical issue occurred in one session and involved the viewing of videos during the PowerPoint presentation. The PD was unable to initiate the video to play on the slide until exiting presenter mode. The video was eventually able to be viewed by the participants. After the project proposal defense, Virtua's Center for Learning Leadership Team requested 2 CEs and pizza be provided to the participants. The most significant limitation of this project was that the PD did not have access to the HoloLens Remote Assistance application. The licensing for this piece of equipment expired and Virtua would not renew the contract. Therefore, the PD was unable to display what was being viewed on the HoloLens during the demonstration of use for participants to follow.

Implications

Technology is essential for success in the nursing profession. To stay current and relevant in nursing, adapting to new technology is an expectation. It is especially important during times of crisis, like the COVID 19 pandemic, where guidelines and protocols changed daily. The HoloLens provides the platform to accomplish many of these tasks, such as the ability to view procedure manuals while wearing the headset, and step-by-step instructions for procedures (i.e., IV insertion, chest tube care, foley insertion). Since it is still considered a newer technology, studies are being conducted for the HoloLens potential usage in different nursing specialties, ranging from the operating room to the intensive care unit (Barchielli et al., 2021). However, in nursing future

studies should be conducted regarding its usage in educating nursing students, training nurses, and assisting nurses in real-time with patient care.

The ANCs are ready to adopt the HoloLens and any ANC who was unable to attend an educational session will need HoloLens training. As part of this QI project, the ANCs identified potential uses of the HoloLens for: nursing education, nursing skills validation (i.e. restraints, IV care and maintenance, chest tube care), potentially replacing the need for a second nurse (central line dressing changes, foley insertion, wound assessment, etc.), Dynamics 365 Guides for procedures (i.e. LP, chest tube care, IV insertion), RA (expert consultation in real time to help resolve an issue), and compatibility with certain manikins for simulated drills.

Future Projects and Plans

This is only the first phase of this QI project. The PD will present this QI project, its findings, lessons learned, and barriers at the next DNP Forum for the Virtua Health system. The PD also submitted an abstract for a poster presentation to the 2023 Philadelphia Area Simulation Consortium (PASC) Conference. Additionally, Virtua Health is in the planning phases of developing a state-of-the-art simulation center for its merger with a local school of medicine. The HoloLens could be used in the simulation center at a school of nursing affiliated with Virtua to assist with teaching nursing students. There has been administrative interest at Virtua in the potential use of AR for the training and development of staff.

The PD will present potential opportunities to improve hospital metrics by reducing birth injuries with the purchase of a Gaumard birthing manikin with HoloLens compatibility. Expanding upon the potential uses for AR in the training of nurses, nursing

students, medical residents, and medical students will be presented to the Nurse/Medical Executive Committees. RA and Dynamics 365 can be valuable in skills revalidation, the training of new equipment, and potentially reducing the need for a second licensed professional during certain procedures such as IV tubing changes in the Special Care Nursery/Neonatal Intensive Care Unit, central line dressing changes, and skin and wound assessment. The PD hopes there will be continued interest in this project, the opportunity to purchase more augmented reality headsets, and a process to incorporate training of nurses using the HoloLens. The PD will continue to advocate for AR headsets and the potential benefits to the organization for the training of nurses.

Conclusion

AR may be a newer technology but the possibilities for its application are limitless. AR can be utilized in every area of nursing from student learning to training nurses on the unit. By educating ANCs on the HoloLens capabilities, their PU and PEU increased, demonstrating their readiness to adopt the Microsoft HoloLens as a teaching strategy. As with any technology, there is a learning curve where the end user needs to gain comfort with the device before supporting its use. This is no different for the nurse educators who champion the new technology so nurses feel comfortable and confident that it will improve their workflow. Hands on trialing of the HoloLens allowed ANCs to gain comfort with the headset and its potential to enhance their job performance.

More research needs to be conducted involving clinical nurses in their unit setting as well as in nursing education. Patient safety is the top priority for healthcare organizations, and AR is a teaching strategy that may increase safety by allowing for repetition of skills, providing a safe environment to practice, accessing step-by-step

instructional guides, and enabling consultation by nursing experts from anywhere in the world through the HoloLens Remote Assistance platform.

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Table 1

Search Process Review of Literature

Database	Total Articles	Articles Remaining After Title Review	Articles Remaining After Abstract Review	Articles Retrieved and Examined	Articles that fit Inclusion Criteria
Cochrane Library	0				
Joanna Briggs Institute EBP Database	0				
CINAHL	28	16	13	12	9
Medline	99	12	8	2	0
Inspec	7	7	3	1	0
Ovid	1048	86	19	17	2
TRIP	0				
ProQuest Dissertations & Theses Global	0				

Note. Number of duplicate articles removed: 3

Table 2

Review of Literature Matrix Systematized Review

Database # Article First Author, Year (full citation in References)	**Purpose of Study Major Variables (IV, DV) or Phenomenon**	**Theory or Conceptual Framework**	**Design**	**Measurement Major Variables (Instrument)**	**Data Analysis (Name of Statistics, descriptive, Inferential and Results)**	**Findings**	**Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice**
CINAHL #1 Tilghman et al. (2018)	To evaluate nursing student's skill attainment after video education then performing the skills utilizing AR and a patient manikin. **IV**- simulation and AR used as a teaching modality **DV**- skill acquisition (IV access/medication administration & foley placement	None stated	Qualitative self-assessment surveys/Quasi-experimental	Student Assessment of Learning Gains (SALG) in Nursing survey tool was adapted, including 4 sections comprising Interest and Attitude, Course Comprehension, Skills, and Integration of Learning	Inferential statistics- Experimental group completed the procedures slower (6 minutes 13 seconds) than the control group (4 minutes 38 seconds), males slighter faster (5 minutes 5 seconds) than females (6	Use of AR and simulation are effective to train and improve skills.	Level IIB

Database # Article First Author, Year (full citation in References)	Purpose of Study Major Variables (IV, DV) or Phenomenon	Theory or Conceptual Framework	Design	Measurement Major Variables (Instrument)	Data Analysis (Name of Statistics, descriptive, Inferential and Results)	Findings	Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice
					minutes 39 seconds) during IV insertion. Confidence in information comprehension was reported as increased in the experimental group (*M*= 2.73, *SD*= 0.905) compared to the control group (*M*= 4.21, *SD*= 2.47)		
CINAHL #2 Sattar et al. (2019)	To investigate outcomes of video, immersive technology, and	None stated	Quantitative pre-validated questionnaire	Modified intrinsic motivation	Statistical *t*-test- Motivation and competency	Text-based learning scored higher for motivation and	Level IIB

Database # Article First Author, Year (full citation in References)	Purpose of Study Major Variables (IV, DV) or Phenomenon	Theory or Conceptual Framework	Design	Measurement Major Variables (Instrument)	Data Analysis (Name of Statistics, descriptive, Inferential and Results)	Findings	Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice
	text as instructional methods. **IV**- VR, video, and text-based learning methodologies **DV**- medical students learning motivation and learning competency			inventory tool (IMI)	mean values were better when VR methodology was used, compared to text or video based (p= 0.000)	competency than video-based learning	
OVID #1 Mendez et al. (2020)	To explain novel technologies such as VR and AR and suggestions for its utilization in nursing education. **IV**- VR and AR technologies **DV**- VR and AR application in nursing instruction	None stated	Literature review		Documentation of AR and VR in nursing literature is inadequate with more studies focusing on VR; documentation of AR is	Both teaching methodologies required training of the faculty and the user for a successful experience. Main advantage to AR and VR education is the ability to engage	Level VA

Database # Article First Author, Year (full citation in References)	Purpose of Study Major Variables (IV, DV) or Phenomenon	Theory or Conceptual Framework	Design	Measurement Major Variables (Instrument)	Data Analysis (Name of Statistics, descriptive, Inferential and Results)	Findings	Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice
					limited for its application in nursing instruction, with many of the challenges for VR reported	the student during the learning process	
CINAHL #3 Wei et al. (2021)	To evaluate educators' willingness to support augmented reality (AR) as an adjunct teaching instrument to boost learning. **IV**- educator's perceived usefulness and perceived ease of use of AR	None stated	Quantitative questionnaire	The technology acceptance model (TAM)	Partial Least Squares-Structural Equation Modelling (PLS-SEM) version 3.0- there is a direct relationship between educator's innovation cognizance on AR and perceived ease	Leadership support and support on the job both affect perceived usefulness (PU) of digital learning methods and staff's willingness to adopt. AR can revolutionize learning by engaging the	Level IIB

Database # Article First Author, Year (full citation in References)	Purpose of Study Major Variables (IV, DV) or Phenomenon	Theory or Conceptual Framework	Design	Measurement Major Variables (Instrument)	Data Analysis (Name of Statistics, descriptive, Inferential and Results)	Findings	Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice
	DV- educator's readiness to adopt AR				of use (PEU) and perceived usefulness (PU), (p= 0.05)	student and enhancing outcomes	
OVID #2 Barchielli et al. (2021)	To analyze approaches to nursing's acceptance and adoption of technology, and if age is a contributing factor. **IV**- nurse's age **DV**- acceptance and adoption of technology	None stated	Quantitative survey	Unified Theory Of Acceptance And Use Of Technology (UTAUT) model measuring performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating environment (FC), behavioral	Five hypotheses tested focused on the nurses' affirmative relation to implement novel technology. H1 measured performance expectancy (PE) (how the individual perceives the advantages of new technology),	Positive correlation between PE and EE on nurses BI regarding new technology utilization. When PE is considered adventitious and EE is considered simple, BI is improved. Social influence does not impact implementation	Level IIB

Database # Article First Author, Year (full citation in References)	Purpose of Study Major Variables (IV, DV) or Phenomenon	Theory or Conceptual Framework	Design	Measurement Major Variables (Instrument)	Data Analysis (Name of Statistics, descriptive, Inferential and Results)	Findings	Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice
				intention (BI, involving adaptation and consistent utilization)	H2 measured effort expectancy (EE) (how the individual perceives the ease of using new technology), H3 measured social influence (SI) (the positive influence that an individual has involving new technology utilization), H4 measured facilitating environment (FC) (how the	of new technology	

Database # Article First Author, Year (full citation in References)	Purpose of Study Major Variables (IV, DV) or Phenomenon	Theory or Conceptual Framework	Design	Measurement Major Variables (Instrument)	Data Analysis (Name of Statistics, descriptive, Inferential and Results)	Findings	Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice
					individual feels their organization can sustain new technology utilization), and H5 measured behavior intention (BI) (how the individual adapts and sustains new technology utilization). The last three hypotheses assessed relationships between BI		

Database # Article First Author, Year (full citation in References)	Purpose of Study Major Variables (IV, DV) or Phenomenon	Theory or Conceptual Framework	Design	Measurement Major Variables (Instrument)	Data Analysis (Name of Statistics, descriptive, Inferential and Results)	Findings	Evidence Level of Research & Quality Johns Hopkins Nursing Evidence-Based Practice
					and the nurses' age		

Table 3

Teaching Plan

Purpose: Establish an understanding of augmented reality (AR) for advanced nurse clinicians (ANCs) to expand knowledge, perceived usefulness, ease of use for the HoloLens, and to support their readiness to adopt the HoloLens for teaching.

Goal: To educate ANCs on the benefits, features, and uses of AR and to demonstrate the techniques to operate the Microsoft HoloLens

Teacher/Creator: Kelly Carbone, MSN, APN, PPCNP-BC

At the end of the teaching sessions, ANCs will:

Behavioral Objective	**Content Outline**	**Method of Instruction**	**Time Allotted in Minutes**	**Resources**	**Method of Evaluation**
1. Describe the origin for this quality improvement (QI) project	**Background** - Effects of COVID-19 pandemic - Patient safety	PowerPoint presentation slide (1) and Verbal presentation	5	Georgsson (2020)	Small Group Discussion
2. Recognize the differences in technology and its use as teaching strategies	**Conceptual terms** - Simulation - Virtual reality (VR) - Augmented Reality	PowerPoint presentation slide (2) and Verbal presentation	5	Bastable (2008)	Small Group Discussion

3. Recall the features of AR	Discuss participants experience with AR **Augmented Reality** -Real environment versus digital environment - Digital images, sounds, text - Examples • Pokémon Go, • Snapchat filters • Virtual shoes/clothing/glasses /furniture fitting - Accessibility - Typical features: presence, immersion, and interaction	PowerPoint presentation slides (3-8) and Verbal presentation	5	Hunt (2006) Aebersold & Dunbar (2021) Mendez et al. (2020) Kesim & Ozarslan (2012) Yeung et al. (2021)	Small Group Discussion Poll Everywhere
4. Recognize the uses of AR	-Nursing: training and virtual scenarios -Medical: training, telehealth -Education: learning modalities -Military: combat training simulation -Design & Modeling: visualize interior & exterior changes -Retail: customize & build -Repair & Maintenance: maintenance and repairs assistance -Tourism: virtual travel	PowerPoint presentation slide (6) and Verbal presentation	5	Microsoft (n.d.) Dini & Mura (2015) XMReality (2023)	Poll Everywhere
5. Cite the benefits of AR	-Untethered headset -Skill practice and validation -Benefits to learners • Handsfree	PowerPoint presentation slide (7) and	5	Wüller et al. (2019)	Poll Everywhere

	• Skill mastery • Reduces fear • Improves teaching outcomes • Decreases anxiety • Enhances learning -Safe learning -Enhanced learning experience	Verbal presentation		Kurt & Ozturk (2021) Uymaz & Uymaz (2022)	
6. Identify the benefits of utilizing the HoloLens	**HoloLens** - Overview of how two organizations use the HoloLens in their settings. - Components of HoloLens **Capabilities** -Remote Assist (RA) -Dynamics 365 guides • Application that can provide step by step instruction for specific procedures/skills/equipment -Software applications- clinical scenarios, HoloAnatomy **Remote Assistance** - Real-time guidance with remote experts	PowerPoint presentation slides (9-14) with embedded videos and Verbal presentation	15	YouTube (2022) Microsoft (n.d.) YouTube (2020) YouTube (n.d.)	Poll Everywhere
7. Verbalize the required techniques to operate the Microsoft HoloLens	**HoloLens Demonstration** - Review the steps on how to use the HoloLens	PowerPoint presentation slides (15-16),	15	Microsoft (n.d.) Scooley (n.d.)	Demonstration Checklist

	HoloLens **Requirements for Usage** - Proper fit - Powering device - Signing in - Hand gestures - Eye calibration - Tips - Cortona - How to charge device - Battery - Troubleshooting	Microsoft HoloLens, Verbal presentation, Demonstration (by you)			
8. Demonstrate the required techniques to operate the Microsoft HoloLens	**Return Demonstration** - Proper fit - Powering device - Signing in - Hand gestures - Eye calibration - Tips - Cortona - How to charge device - Battery - Troubleshooting	PowerPoint slide (17), demonstration, and Guided practice	45	Microsoft (n.d.) Scooley (n.d.)	Return demonstration Checklist
9. Discuss implications of AR and the HoloLens as potential teaching strategies	Potential usage for the HoloLens	Verbal presentation	5		Participant questions Open discussion

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Table 4

Demographics

Characteristic	*n*	%
Age		
25-34	1	7.1
35-44	5	35.7
45-54	4	28.6
55-64	3	21.4
Over 65	1	7.1
Educational Level		
Bachelor of Science in Nursing	3	21.4
Master of Science in Nursing	6	42.9
Doctorate in Nursing	5	35.7
Years of Nursing Experience		
6-15	6	42.9
16-24	3	21.4
25-30+	5	35.7
Years of ANC Experience		
1-3	7	50
4-6	3	21.4
7-9	1	7.1
10+	3	21.4

Table 5

T-Test Results for Individual PU and PEU

Group	Pre-Survey		Post-Survey		*t(df)*	*p*	*t*- value
	M	*SD*	*M*	*SD*			
PU Questions	30.85	4.76	39.21	3.42	13	<.001	-7.05
PEU Questions	28.21	1.05	37.78	2.71	13	<.001	-5.09

Appendix A
Checklist

HoloLens Return Demonstration

NAME: _____ **DATE:** _____/_____/____

VALIDATION METHOD: **A = Direct Observation** **B = Verbalization**

EVALUATION METHOD: **M = Meets expectation** **NI = Needs Improvement**

PERFORMANCE CRITERIA	Validation Method (May use more than one method)	Evaluation M/NI	Comments
1. Adjust the HoloLens to proper fit a. The brow pad should rest comfortably on the forehead with the back band resting on the middle-back of the head	A	M/NI	
2. Power on HoloLens a. Locate brightness buttons b. Locate volume buttons	A	M/NI	
3. Verbalize how to sign in using password	B	M/NI	
4. Perform the following hand gestures a. Open Start menu b. Close Start menu c. Air tap d. Drag e. Pin f. Scroll	A	M/NI	
5. Verbalizes that to eye calibration can be performed by going to Settings, air tap System, then Calibration	B	M/NI	
6. Find the HoloLens Tips App a. All Apps tab on the start menu, down arrow, click Learn Gestures app	A	M/NI	
7. Verbalizes how to use Cortona by saying “Hey Cortana, what can I say” for a list of available commands	B	M/NI	
8. Locate charging port	A	M/NI	
9. Verbalizes knowledge of battery life when fully charged	B	M/NI	
10. Verbalizes troubleshooting of hand gestures	B	M/NI	

Validated by: _____

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Appendix B
Pre-Survey

*The Post-Survey included the same New Technology Pre-Survey questions but did not include the four demographic questions.

New Technology Pre-survey

1. Enter your specific 3-digit code (PLEASE DO NOT SHARE OR LOSE AS YOU WILL NEED IT FOR THE POST SURVEY)

2. Using the Microsoft HoloLens as a teaching adjunct would enable me to accomplish tasks more quickly.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

3. Using the Microsoft HoloLens would improve my teaching performance.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

4. Using the Microsoft HoloLens to educate would increase my productivity.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

5. Using the Microsoft HoloLens would enhance my effectiveness as an educator.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

6. Using the Microsoft HoloLens would make it easier to educate.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

7. I would find the Microsoft HoloLens useful to educate.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

8. Learning to operate the Microsoft HoloLens would be easy for me.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

9. I would find it easy to get the Microsoft HoloLens to do what I want it to do.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

10. My interaction with the Microsoft HoloLens would be clear and understandable.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

11. I would find the Microsoft HoloLens to be flexible to interact with.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

12. It would be easy for me to become skillful at using the Microsoft HoloLens.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

13. I would find the Microsoft HoloLens easy to use.

Extremely Likely	Quite Likely	Slightly Likely	Neither Likely or Unlikely	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

14. Which category below includes your age?
    18-24
    25-34
    35-44
    45-54
    55-64
    65+

15. What is the highest degree that you have received?
    Bachelor degree
    Master's degree
    Doctorate degree

16. Which of the following categories best describes your years of nursing experience?
    1-5
    6-10
    11-15
    16-20
    21-24
    25-29
    30+

17. Which of the following categories best describes your years as an ANC?
    1-3
    4-6
    7-9
    10+

** Modified from Davis' Technology Acceptance Model (TAM) questionnaire (1989).*

Appendix C
Recruitment Email

Hello,

For those of you who may not know me, my name is Kelly Carbone, and I am the ANC for the Pediatric Pavilion, Special Care Nursey and Voorhees Pediatrics. I am currently enrolled in La Salle University's DNP program and ready to start my scholarly project. I am hoping that 20 ANCs (~5-6 in each session) would be willing to volunteer their time to assist me in completing my QI project. The name of my project is Evaluating Advanced Nurse Clinicians' Readiness to Use Augmented Reality for Delivery of Simulated Teaching Sessions. The purpose of this doctoral project is to evaluate the ANCs readiness to adopt new technology, the Microsoft HoloLens (an augmented reality headset), as a teaching strategy. Please note, this time cannot count toward your hours for the week. It is voluntary and you will be able to withdraw at any time. All data will be collected anonymously with a 3-digit code via a SurveyMonkey QR link, so a smartphone will be needed. Two new May dates were added (5/11 & 5/18). If you have emailed me previously, I have you scheduled for your requested date (and *thank you*).

All sessions will take place in Voorhees Learning Lab and the dates/times are as follows:
5/1/23→ 4p-6p
5/4/23→ 4p-6p
5/11/23→ 4p-6p
5/18/23→ 4p-6p

Pizza and beverages will be served at each session and 2 CEs will be provided for attending a session. If you are interested in participating, please email me back and let me know which date/session that you are interested.

If you have any other questions, please feel free to reach out. I thank you in advance for your consideration and I hope to see you there.

Regards,
Kelly

Kelly Carbone, MSN, APN, PPCNP-BC

Advanced Nurse Clinician
Pediatrics, Pediatric Pavilion & Special Care Nursery

Virtua Voorhees & Mount Holly

t: 856-247-2386
virtua.org

Appendix D
Letter of Support

March 30th, 2023

Dear Ms. Carbone,

This letter is to inform you that you have organizational support from Virtua to conduct your project entitled "Evaluating advanced nurse clinicians' readiness to use augmented reality for delivery of simulated teaching sessions" at Virtua. As the Nurse Scientist and Chair of the Nursing Research Council, I have the authority to approve projects at Virtua. I have reviewed the purpose, aims, and methods of your proposal, and I find that your quality improvement project is congruent with Virtua's goals and mission. Thank you for the opportunity to review your proposed project. As a quality improvement project, it has been determined that this project is not research and does not require IRB review at Virtua Health. You may use observational data as no identifying information will be shared outside of the organization. Participation in the observations will be voluntary. You have permission to collect, analyze, and report findings provided that participants will not be identified and results will be reported in the aggregate. You are required to report any substantive changes to the council for review. Virtua reserves the right to withdraw participation in the project if circumstances deem appropriate.

Sincerely,

Amy Glasofer, PhD, DrNP, RN, NE-BC
Nurse Scientist
Virtua Health, Clinical Learning Team
aglasofer@virtua.org

Appendix E
La Salle IRB

INSTITUTIONAL REVIEW BOARD
FWA #000023562
1900 W. Olney Avenue, Philadelphia, PA 19141
E-mail: IRB@lasalle.edu

IRB NUMBER: 23-04-016
(Reference this # on all future correspondence to the IRB)

Name of Investigator:	**Kelly Carbone, Dr. Kathleen Monforto**
Address of Investigator:	**Department of Nursing**
Protocol Title:	**Evaluating Advanced Nurse Clinicians' Readiness to Use Augmented Reality for Delivery of Simulated Teaching Sessions**

This is to certify that the above-referenced protocol, which does propose research activities involving human participants, was reviewed in accordance with La Salle University Institutional Review Board (IRB) guidelines for the protection for human participants.

PROTOCOL INFORMATION:

Application Type:	**Initial Review**
Review Category:	**Expedited review, under 45 CFR 46.110 Category 10**
Protocol Action & Date:	**Approved as Submitted April 28, 2028**
Protocol Expiration Date:	**N.A.**

The IRB reviewed and approved your research protocol, *with the following provisions*:

1. For the purpose of IRB electronic archives, **you are required** to **e-mail the final version of this protocol with ALL required documents (including the original protocol and decision letter) as a single PDF to mazzones2@lasalle.edu**; title the file as follows (no spaces):
    - **23-04-016_ARCHIVE_ Carbone_Monforto**
2. E-mail the updated version of the protocol to **mazzones2@lasalle.edu** and **include the archive title in the subject line.**
3. Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB in writing using the **Amendment Request Form**. You must receive IRB approval prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the participants.
4. Investigators are required to report within 5 business days to the IRB any injuries or other unanticipated or adverse events or problems involving risks or harms to human research participants or others that are discovered during the course of the research. Use the **Unanticipated Event Report Form**.
5. When you complete or discontinue the project, you must submit the ***IRB Closure Report Form***.

Susan Borkowski

Susan Borkowski, PhD
IRB Chair

Appendix F
Informed Consent

Rev 2/22/18

LASALLE UNIVERSITY

INFORMED CONSENT DOCUMENT TO PARTICIPATE IN RESEARCH

Title of Investigation: **Evaluating Advanced Nurse Clinicians' Readiness to Use of Augmented Reality for Delivery of Simulated Teaching Sessions**

Investigator: **Kelly Carbone, MSN, APN, PPCNP-BC, La Salle University graduate student (carbonek1@lasalle.edu)**

Faculty Sponsor: **Kathleen Monforto, PhD, RN, NPD-BC, CPN (monforto@lasalle.edu)**

Funding Statement: **This study is unfunded.**

PROCESS OF INFORMED CONSENT

You are being asked to participate in a quality improvement (QI) study. For you to decide if you want to volunteer for this project, you should make an informed decision based on an understanding of what this project is about and the possible risks and benefits. This process is known as Informed Consent. This document describes the purpose, procedures, possible benefits, and risks, as well as how your personal information will be used and protected. Once you have read this form and your questions about the study are answered, you will be asked if you want to take part in the study; if so, you will be asked to sign this paper consent form. This will allow your participation in this study. Participation is voluntary.

RESEARCH PURPOSE

In this study, I wish to better understand the readiness of advanced nurse clinicians' (ANCs) to adopt the use of augmented reality (AR) and the Microsoft HoloLens headset. This will be accomplished by analyzing the perceived usefulness (PU) and perceived ease of use (PEU) that you report before and after the educational session with return demonstration. I anticipate that approximately 20 ANCs will participate in this study, split into four sessions of 5-6 ANCs per session. Only ANCs working in the clinical setting of either an acute hospital, freestanding Emergency Department or the system role will be included.

PARTICIPATION

If you agree to participate in this study, you will be asked to participate in a 2-hour educational session with several other advanced nurse clinicians (ANCs). The session will take place around a table in Virtua's Learning Lab. Prior to the session after consent is obtained, a QR code will be available to scan to access the presurvey which will assess your readiness to accept new technology. Then a 30-minute educational session about augmented reality and the Microsoft HoloLens will be conducted with demonstration of the HoloLens. You will then be asked for a return demonstration using the HoloLens and an open discussion on its potential uses will be discussed. The session will finish with another QR code to scan for the postsurvey, which asks the same questions as the presurvey.

ANTICIPATED BENEFITS OF PARTICIPATION

Although there may be no direct benefit to you, results from this study will contribute to knowledge about augmented reality and the HoloLens, which may help future educators (ANCs) to utilize this emerging technology to train staff.

DESCRIBE ANTICIPATED RISKS AND DISCOMFORTS OF PARTICIPATION:

There are no more than minimal risks involved in participating in this study. For some ANCs, wearing the HoloLens maybe uncomfortable, cause eyestrain, headaches, and/or potentially cause motion sickness, dizziness, or disorientation while adjusting to the headset. Please note that if you do experience any discomfort while completing the study, you may sit down and remove the HoloLens immediately. You may also stop participating at any time with no penalty. If you want to discuss any issues that concerned you about the study, you may contact the principal investigator, Kelly Carbone, 609-605-7688. You may also seek medical advice from your personal physician.

DESCRIBE RISKS TO CONFIDENTIALITY AND DATA SECURITY

I will not ask you for your name or any other identifying information. Your anonymity is protected through the design of the *SurveyMonkey* survey. The only identifiable information gathered will be your e-mail address, which you responded to the recruitment email. Data will be stored on the principal investigator's password-protected computer in the locked room of Virtua Health and only this investigator and the PI's Chair will have access to the data. Electronic records will be stored for seven years after

the completion of the study and then will be permanently erased.

DISSEMINATION OF RESULTS

If you would like to know the overall findings of this study, you may contact Kelly Carbone at kcarbone@virtua.org; otherwise, you will not be informed of the results.

VOLUNTARY NATURE OF PARTICIPATION

Participation in this study is voluntary and anonymous. If at any time and for any reason you decide that you no longer wish to participate, you may end the session immediately with no negative consequences.

COMPENSATION:

It will not cost you to participate in this study. Pizza and beverages will be provided, and you will receive 2 continuing education credits (CEs) upon completion of the session.

RESEARCHER CONTACT INFORMATION:

If you have questions, concerns, or complaints; need to report an injury related to the research; or would like to know the results of the study, please contact the investigator:

Kelly Carbone
Virtua Health
100 Bowman Dr
Voorhees, NJ. 08043
609-605-7688

IRB CONTACT INFORMATION

The Institutional Review Board (IRB) of La Salle University is responsible for protecting individuals participating in this research project. If you have any questions or concerns regarding your rights as a research participant or any complaints about the research, please contact Sonni Rose Mazzone, Graduate Assistant at 267-902-3449 or irb@lasalle.edu. You may also write to the IRB Chair, Dr. Susan Borkowski, at the Department of Accounting, La Salle University, 1900 W. Olney Avenue, Philadelphia, PA 19141.

CONSENT STATEMENT

I have read and understand the statements about this study and have received a copy of the consent form. My signature below indicates that the procedure has been explained to me and that I agree to participate in this

quality improvement (QI) project. I understand that I may withdraw my permission and may discontinue participation at any time without penalty or loss of benefits. I understand that I will receive no compensation for this study (except pizza, beverages and 2 CEs).

Participant's Name (Please print)

Participant's Signature Date

Investigator's Signature

This study (IRB# 23-04-016) was reviewed and approved by the Institutional Review Board of La Salle University on 04-28-2023.

Appendix G
Modified TAM Approval

From: Davis, Fred <Fred.Davis@ttu.edu>
Sent: Friday, November 25, 2022 6:00 PM
To: Carbone, Kelly <KCarbone@virtua.org>
Subject: [EXTERNAL] RE: Clarifying questions r/t TAM for DNP project

Yes, scoring is from 1 (low) to 7 (high), computed by averaging the scores for the individual items/questions.

You are correct that the original wording was "flexible to interact with" not "flexible for multiple uses." It seems like the meaning of these two phrases may be overlapping but may also have some distinct meaning.

"Flexible for multiple uses" may actually tap somewhat into usefulness (can be used for may purposes). "Flexible to interact with" was meant to refer to not being rigid, inflexible, or restrictive to use for the tasks/purposes the system was intended to be used for. In the original 14-item set of candidate items, notice that the wording was reverse coded "rigid and inflexible to interact with" (p. 324). The content came from user interviews. When I got rid of reverse-coded items for psychometric reasons explained in the paper, the item became "flexible to interact with."

Among the 6 "final items" for the MISQ paper, that item (flexible to interact with) was somewhat weak, with the smallest loading on the EOU factor (0.63, see Table 7, p. 331). See the discussion in the first paragraph of p. 331 for a discussion about the psychometric weaknesses of the flexibility item.

Note that the flexibility item was omitted for the 4-item version of the EOU scale used in my 1989 Mgt Sci paper.

You have my permission to use and modify the items for your research on Microsoft HoloLens. I certainly cannot guarantee the psychometric reliability and validity of the items for your context. You should assess the convergent and discriminant validity and reliability in the data you collect for MS HoloLens.

Hope this helps
Best wishes
Fred Davis

From: Carbone, Kelly <KCarbone@virtua.org>
Sent: Monday, November 21, 2022 8:35 AM
To: Davis, Fred <Fred.Davis@ttu.edu>
Cc: kelly.carbone01@gmail.com
Subject: Clarifying questions r/t TAM for DNP project

Good morning Dr Davis,

Thank you for the two articles on reliability and validity! I do have several clarifying questions and should be good once answered.

I am sorry, I never attached my modified TAM questions to the previous email. Below are my modified questions to fit the role of the nurse educator. I am required to have your approval for the questions that I will be using in my project.

Would you explain question #10, as to what flexible for use means? I added flexible for multiple uses but am unsure if this is what the question was trying to ask, please advise.

I am going to use the same Likert scale as you used. How is it scored? I was going to use numbers 1-7 (with extremely likely 7 and extremely unlikely 1). So, the higher the total score, the more PU and PEU?

Perceived Usefulness Items

1. Using the Microsoft HoloLens as a teaching strategy would enable me to accomplish tasks more quickly.
2. Using the Microsoft HoloLens would improve my performance as an educator.
3. Using the Microsoft HoloLens to educate would increase my ability to enhance learning.
4. Using the Microsoft HoloLens would enhance my effectiveness as an educator.
5. Using the Microsoft HoloLens would make it easier to educate.
6. I would find the Microsoft HoloLens useful to educate.

Perceived Ease of Use Items

7. Learning to operate the Microsoft HoloLens would be easy for me.
8. I would find it easy to get the Microsoft HoloLens to do what I want it to do.
9. My interaction with the Microsoft HoloLens would be clear and understandable.
10. I find the Microsoft HoloLens to be flexible for multiple uses.
11. It would be easy for me to become skillful at using the Microsoft HoloLens.
12. I would find the Microsoft HoloLens easy to use.

Items will be scored using a 7-point Likert Scale, with Extremely Likely scored a 7 and Extremely Unlikely scored a 1

Thank you for all of your assistance,
Kelly Carbone