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Preparing Nursing Students to Manage Acculturative Stress Experienced During Study Abroad Experiences: Novel Use of Immersive Simulation and Cognitive Behavioral Strategies

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Abstract

This pilot study adds to the understanding of interventions to manage acculturative stress experienced during undergraduate study abroad programs. It was designed to evaluate the impact of cognitive behavioral strategy training combined with intentional practice during mixed reality (MR) simulations on acculturative stress. Participants included a convenience sample of undergraduate nursing students enrolled in a faculty-led study abroad course. Students participated in two MR simulations within a virtual environment over back-to-back days. Simulations were written by nursing faculty experts to reproduce realistic clinical situations students may encounter while studying in Peru. The Generalized Self-Efficacy Scale, State-Trait Anxiety Inventory, and Slater-Usoh-Steed questionnaire were administered. Quantitative biometric

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indices assessed during simulations included estimates of heart rate, blood pressure, respiratory rate, oxygen saturation and alterations in sweat gland activity reflective of changes in emotional state (galvanic skin response). There were changes in biometric indices within each simulation, but indices were not different between pre- and post- cognitive behavioral strategy training. Intentional reflective writing before, during, and after the study abroad program demonstrated an iterative cycle of reflection on action and mindfulness. These qualitative data suggest that pre-departure cognitive based behavior stress management strategies paired with simulated practice prior to departure may be one way to help nursing students deal with acculturative stress during study abroad experiences.

Keywords

Anxiety, immersive simulation, mixed reality, nursing education, virtual reality

Introduction

Study abroad experiences can provide experiential and transformative learning opportunities for university students (Strange & Gibson, 2017). For nursing students in particular, these experiences are important teaching strategies in which faculty can instill how social conditions and social structures impact the health of populations. However, these experiences can also provoke stress and anxiety in learners (Savicki, 2013). An interdisciplinary team including nursing faculty, engineering faculty, a counseling psychologist, and a study abroad director collaborated to design a pre-departure intervention targeted at ameliorating stress experienced by nursing students during a study abroad experience. The purpose of this pilot study was to understand if pre-departure cognitive behavioral strategy training with intentional practice during immersive mixed reality simulations improved experience and coping. An interdisciplinary research team used an existing on-campus immersive virtual environment to create clinical environments which students previously identified as stressful. Though study abroad experiences, simulation, immersive mixed reality, and cognitive behavioral therapy strategies have been used to enhance learning for many years, the integration of these modalities in this pilot is novel to the preparation of nursing students for a study abroad clinical (Halloran, 2017; LaDisa & Larkee, 2020; Sokolowski, 2014; Song & Lindquist, 2015; Strange & Gibson, 2017; Ratanasiripong et al., 2015). For this study, the research questions were: Among baccalaureate pre-licensure nursing students preparing for a faculty-led study abroad program, how does participation in an

immersive mixed reality simulation and cognitive behavioral strategy session impact (1) biometric measures, (2) self-assessment of anxiety, and (3) ability to manage acculturative stress?

Background

Anxiety and Acculturative Stress

In a national assessment of college students, 32.9% of college students were diagnosed with an anxiety disorder by a healthcare professional (American College Health Association, 2023). Additionally, students studying abroad encounter stress brought on by acculturation. Acculturative stress is defined as the stress reaction from encountering cultural conflict of values, expectations, or assumptions during acculturation (Berry, 2005; Savicki, 2013). Acculturative stressors that students experience during study abroad experiences may include language barriers, nonverbal communication such as time and space, academic stress, discrimination, and personal factors (Chen, 2014). Elevated stress and anxiety levels can move students out of zones that are optimal for growth and learning and into territory that might not only interfere with performance but might also be deleterious to their overall mental health and well-being (Chen, 2014).

In one study abroad clinical practicum in Peru for prelicensure nursing students, we as course faculty observed anxiety interfering with learning and impeding desirable outcomes of the study abroad experience. In this practicum, daily exposure to various economic, social, medical, and language challenges proved extremely stressful for several students. This stress compounds underlying anxiety for some students and may be severe enough to require premature departure from the program.

Clinical Simulation and Mixed Reality

Clinical simulation is a teaching strategy used in nursing and healthcare training, and it has been used for anxiety management in nursing students prior to entering a nursing clinical (Halloran, 2017; Sokolowski, 2014). In simulation, students encounter realistic patient case scenarios using mannequins or standardized patients which allows them to practice critical-thinking and problem-solving skills in a safe environment. As part of the undergraduate curriculum, the college of nursing spearheading this study already used clinical simulation experiences given the established evidence of the benefits of its reflective and experiential learning format (NLN Board of Governors, 2015). The

current study adds mixed reality in which immersive computer-generated digital information in the scenery enhances the reality of standardized patient simulations (Berryman, 2012).

Cognitive Behavioral Therapy Strategies

Cognitive Behavioral Therapy, commonly referred to as CBT, is a comprehensive approach to mental health treatment that examines the interplay between one's cognition, affect, physiology, and behavior, while also accounting for the filtering role that entrenched beliefs and rule-governed biases might hold over time and across varying contexts (Beck, 2011). Given the strong overlap between the component parts implicated in stress responses and a variety of anxiety-based disorders, CBT is commonplace as a front-line intervention for such areas of concern (Beck, 2011). Empirical studies suggest a strong evidence-base for the application of CBT in the management and treatment of stress, anxiety, and a variety of other mental health disorders with documented small to medium effect sizes for symptom reduction in both generalized anxiety disorder and social anxiety disorder that were maintained at 12-month follow-up (Beck, 2011; Division 12 of the American Psychological Association, 2016; Hollon & Beck, 2004; Jongsma et al., 2006).

Similarly, mindfulness-based approaches, such as mindfulness-based stress reduction, have proliferated in the past few decades, with a growing body of evidence suggesting that such approaches are viable alternatives for the treatment of both anxiety and stress-based disorders (de Abreu Costa et al., 2019; Evans et al., 2008; Kabat-Zinn et al., 1992). A commonly accepted definition of mindfulness describes it as, "paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 1994, p. 4). Given that CBT-based approaches often involve self-monitoring and identification of helpful and unhelpful patterns, the here-and-now attunement of mindfulness-based interventions has increasingly been integrated with a CBT approach, with mindfulness-based cognitive therapy also showing some promise with anxiety-based concerns (Evans et al., 2008; Segal et al., 2013).

While standardized protocols often entail individual therapy over the course of several weeks, group-level interventions have increasingly been turned to for the purposes of primary prevention efforts, including in more targeted populations like nursing students (Evans et al., 2008; Kabat-Zinn et al., 1992; Kang et al., 2009; Panagiotopoulou & Paschali, 2012; Ratanasiripong et al., 2015; Song & Lindquist, 2015). Such approaches are both prudent and effective,

given their ability to target the stress and anxiety-related symptoms that can adversely impact such students' learning integration, quality of patient care, and overall well-being (Ratanasiripong et al., 2015; Song & Lindquist, 2015). And yet, such broader reaching efforts can be time and resource-intensive, with the examination of more integrated, single workshop prevention efforts increasingly on the rise (Bentley et al., 2018). This study examines the efficacy of a mixed reality simulation and cognitive behavioral strategy intervention aimed at anxiety reduction and self-management by baccalaureate nursing students in preparation for a study abroad clinical experience.

Overview

This study was a mixed methods design, which included an inductive thematic analysis of all qualitative data and prospective quasi-experimental intervention with analysis of state anxiety, trait anxiety, and biometric indices during a mixed reality simulation conducted within a large-scale 4-walled CAVE-type (CAVE Automatic Virtual Environment) immersive environment. Participants were undergraduate nursing students from a Midwest Catholic Jesuit university. Institutional Review Board approval was obtained prior to the start of the study. Research questions included: how does participation of baccalaureate pre-licensure nursing students in an immersive mixed reality simulation and cognitive behavioral strategy session in preparation for a faculty-led study abroad program impact (1) biometric measures (2) self-assessment of anxiety, and (3) ability to manage acculturative stress?

Methods

Participants

The sample included a convenience sample of 13 third-year female pre-licensure baccalaureate nursing students participating in a faculty led community health study abroad summer course. The course took place in Lima, Andahuaylillas, and Cusco, Peru. Students were informed about the study by the faculty of record and student recruitment and consent were obtained by a simulation education specialist who was not involved with the course. Participation in the study was not required for the course and did not impact student grades. All students participated in the immersive simulation with mixed reality, cognitive behavioral therapy strategy training, and reflective writing as a part of the course, regardless of participation in the study. All students participating in the course consented to participation in the study, and

a unique alphanumeric code was generated for each participant for use in blinded data collection.

Setting

The setting for the study took place in two distinct environments. The first setting was the immersive simulation environment that was used for pre-departure training where quantitative data collection occurred. The term immersive refers to those experiences that allow for motion in a realistic environment to promote active learning, critical thinking, informed decision making and improved performance (Patel et al., 2006). Such technology has the potential to reduce anxiety through exposure therapy in other healthcare settings (Jimenez et al., 2018; Marquess et al., 2017). The setting for our simulations took place in the MARquette Visualization Lab (MARVL), which is a large scale 4-walled CAVE-type immersive environment (LaDisa & Larkee, 2020; www.eng.mu.edu). The nursing faculty worked closely with the engineering faculty to design immersive content (Figure 1) that closely replicated the in-country environment the students would experience. The engineering faculty used photos from previous study abroad experiences as reference photography to model the virtual environment to take place during a visit in a low resource Peruvian home using Quixel Megascans (<https://quixel.com/megascans>). This software providing an online library of 3D scanned objects and textures consisting of objects and materials scanned from a variety of locations around the world was leveraged for soils, metal, and plant life within the virtual environment that matched the source photographs. Chairs, walls, and other materials that were weathered and irregular in source images were recreated by the MARVL visualization technologist in Blender (Blender Foundation; Amsterdam, Netherland).

Study personnel were intentional in the design and created a mental border between the physical and virtual spaces. For example, the faculty considered the large-scale immersive environment as performance space that students were kept out of until it was their time to enter the simulation. As students entered the environment, they crossed a border into a distinct space that was set at a temperature reflective of the in-county experience via local thermostat and filled with a bustling soundscape made from field recordings. Projection of the immersive environment dominated the room, but study personnel also added black curtains within the remainder of the facility to block student view of regions where study personnel were conducting data

acquisition. The desired effect was to feel teleported to an unfamiliar, foreign place despite staying on campus, and ultimately so that the in-country study abroad environment would feel familiar.



FIGURE (1): LARGE-SCALE MIXED REALITY IMMERSIVE SIMULATION ENVIRONMENT USED FOR THE CURRENT STUDY

In Figure (1) above, source images from previous study abroad experiences (A) were used to create a representative immersive mixed reality environment within a large-scale 4-walled CAVE (B). Participants within the immersive computer-generated environment interacted with a trained actor of Peruvian descent who only spoke Spanish as a standardized patient during the simulated experience. Simulations were written by faculty experts to perform clinical tasks including addressing high blood pressure, medication knowledge and wound care (C & D), aligning with realistic clinical situations.

The virtual space consisted of a single, contiguous location with pauses in virtual movement throughout the virtual environment that generally corresponded with times from which the biometric indices described below were measured. The simulation started with an establishing view of an open dirt road, with handmade houses made of brick and corrugated metal panels on both sides. With a key press by the operator of the virtual environment (i.e., visualization technician or other study personnel), the camera (i.e., student perspective) slowly moved forward and turned a corner to face a door on one of the houses in the virtual environment. The students had been trained to announce themselves, which prompted the camera to move through the door

and provide the student with a perspective viewing the living room of the house. The living room was a bare wood structure containing a wood fired kitchen, furniture, and religious artwork on the wall. The general shape of the living room matched the physical dimensions of the environment (20 feet by 10 feet), with the living room having windows looking out to a field where some trees could be seen. A standardized patient was then seated on a plastic chair in the immersive environment, and the scene began with additional movements or scene resets triggered remotely by the operator of the virtual environment. The standardized patient was a trained actor of Peruvian descent who only spoke Spanish during the simulated experience.

In-country experiences consisted of various home and clinical settings in Lima, Andahuaylillas, and, Cusco, Peru in which the students participated in their community health clinical rotation for four weeks. Students participated in home stays while in Lima and lived with other small groups of students while in Andahuaylillas and Cusco. They participated in community health clinicals at a variety of settings ranging from early childhood, maternity, and community health outreach to government run clinics focused on providing services to marginalized populations. Students completed a series of focused reflective writing during this time which was used for qualitative analysis of their experiences.

Measures

The Generalized Self-Efficacy Scale (GSE) is a self-reported measure of perceived self-efficacy, to predict participant coping abilities (Schwarzer & Jerusalem, 1995). Perceived self-efficacy is a positive internal resource and allows for persistence during challenges. This 10-item measure was designed for the adult and adolescent population. Scores can range from 10 to 40, and higher scores indicate higher self-efficacy. Cronbach's Alpha for this measurement tool ranged from 0.76 to 0.90.

The State-Trait Anxiety Inventory (STAI) is a self-report measure of anxiety (Spielberger, 1983/2015). Trait anxiety (T-anxiety) is based on individual differences and perception of stress and anxiety, whereas state anxiety (S-anxiety) refers to situational reactions to stress. Higher T-anxiety can potentiate higher S-anxiety. The STAI has been used in many clinical and research applications, including use with college students (Spielberger, 1983/2015). The tool includes a 20-item form to assess T-anxiety (TAI) and a 20-item form to assess S-anxiety (SAI). For college students, internal consistency coefficients are

0.59 (S-anxiety) and 0.55 (T-anxiety) while test-retest reliability ranges are 0.73-0.86 (T-anxiety) and 0.16-0.62 (S-anxiety) (Spielberger, 1983/2015).

To measure the participants' feelings of presence in the immersive simulations, the Slater-Usch-Steed (SUS) questionnaire was administered. This 6-item questionnaire measures subjective feeling of presence in virtual environments (Slater et al., 1994). This measure is scored on a scale from 1-7, where 1 indicates "not very much" and 7 indicates "very much". An example question related to presence is "During the experience I often thought that I was standing in the location portrayed."

Multiple biometric indices were obtained. Biometric indices measured estimates of heart rate (HR), blood pressure (BP), respiratory rate (RR), and oxygen saturation (SpO₂) via a fitness tracker (Dosmix D6) paired to the FitCloud app installed on Apple or Android devices used by study personnel during participant simulations. Study personnel cycled through the measurement of these indices using the FitCloud application so that measurements were obtained throughout the simulation experience.

Galvanic skin response (GSR) (i.e., skin conductance) is a measure of changes in the skin's conductivity due to moisture on the skin in response to a stimulus. Since sweat glands are controlled by the sympathetic nervous system, GSR systems relate psycho-activity to sweat gland activity upon the release of small amounts of sweat when a stimulus is presented. For the current study, changes in sweat gland activity measured via GSR were interpreted as being reflective of changes in participant emotional state. The GSR system used for the current study had a range of 0-10 micro siemens (uS), a 1 nS resolution, and maximum sampling rate of 100 S/sec. For the current study, GSR readings were continuously monitored and digitized every 2 seconds for the duration of simulations. GSR was obtained with the NeuLog GSR sensor system (NUL-217) with its associated battery (BAT-200) and WiFi (WIFI-202) modules and a standard commercially available laptop computer.

Simulation and Debriefing Experience

Students were scheduled to participate in two immersive mixed reality simulations in the virtual environment over two back-to-back days. These simulations were written by nursing faculty experts to address high blood pressure and medication knowledge (Day 1) and wound care (Day 2). The scenarios were designed to align with realistic clinical situations while studying

in Peru and were previously implemented in the nursing curriculum. Consistent with simulation as part of the nursing curriculum in a physical environment, students were expected to appropriately interact with the patient while performing environmental assessments, patient assessments, and correct interventions. A standardized patient, or a person trained to consistently follow a scripted scenario (INACSL Standards Committee et al., 2021b), played the roles of the Spanish-speaking patients in two simulations, allowing for students to have a realistic hands-on patient encounter in a home visit. Additional realism was created with background sounds of children, motorcycles, and dogs barking. Simulation encounters lasted approximately 10 minutes.

Following all simulation experiences, nursing faculty used best practice standards to debrief students on their simulation experience. Debriefing is important to encourage reflection, facilitate new perspectives, and stimulate understanding (INACSL Standards Committee et al., 2021a). Faculty used Debriefing for Meaningful Learning (DML), which uses Socratic questions driven by student actions during the simulation to review the scenario, discover thinking behind actions, discuss similarities and differences from previous experiences, and reflect upon how this experience applies to future situations (Dreifuerst, 2015).

Cognitive Behavioral Strategy Session

After completing the first simulation and debrief on the first day, the second day began with a 2-hour interactive session on cognitive behavioral strategies. Students learned about cognitive behavioral connections, recognition of their own thought processes, stress management, and strategies to manage stress from a licensed psychologist from the university's counseling center. Following the cognitive behavioral strategy session, students participated in the second simulation.

Data Collection

Quantitative Data Collection

Prior to the start of the intervention, a self-assessed baseline was established by participants through the completion of the STAI, measuring both S-anxiety and T-anxiety, as well as the General Self-Efficacy scale. Figure (2) displays the timeline of study events and data collection.

The biometric indices of heart rate (HR), blood pressure (BP), respiratory rate (RR), oxygen saturation (SpO₂), and galvanic skin response (GSR) were

measured while in simulation. Prior to arriving, participants washed their hands and sat in a comfortable armchair in a room. The fitness tracker and GSR system were carefully applied by study personnel. GSR probes were wiped with 70% IPA before each new participant (Villanueva et al., 2016). The probes of the GSR system were constantly placed on the pointer finger and ring finger of participants. The right hand was used for all participants (Smith et al., 1981), who were instructed to remove all rings prior to applying the probes. To establish a biophysical baseline, participants sat quietly for 3 minutes with their eyes closed, head down, legs uncrossed, and arms resting on the supports of the armchair or on their lap, without placing pressure on the finger probes. This baseline period was defined as the last minute of physical time following application of the monitoring equipment before they entered the immersive environment. Measurements reported for baseline each day constitute a consistent duration when considering the baseline periods for all participants.

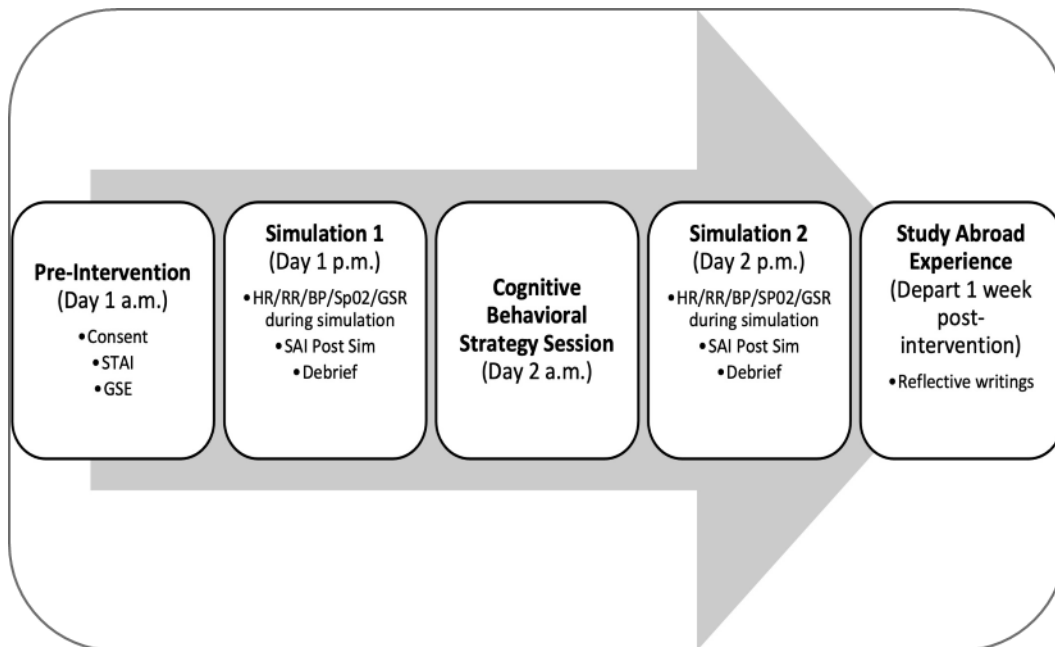


FIGURE (2): TIMELINE DESCRIBING INTERVENTION EVENTS AND DATA COLLECTION. STAI= STATE TRAIT ANXIETY INVENTORY; SAI=STATE ANXIETY INVENTORY; GSE= GENERAL SELF-EFFICACY; HR= HEART RATE, RR= RESPIRATORY RATE, BP= BLOOD PRESSURE, SPO2= OXYGEN SATURATION; SUS= SLATER-USOH-STEED INVENTORY

The biometric indices were measured at four time points generally corresponding with the pauses in movement through the virtual environment described above. First, the baseline measurement was taken prior to the start of the simulation as described above. Time point 1 was taken at the beginning of the simulation upon entering the CAVE. Time point 2 corresponded with

students entering the living room of the house, and Time point 3 corresponded to the time when students were conducting their clinical task for simulations on day 1 and day 2. The time point corresponding to the student entering the house was omitted on day 2 in the interest of time. GSR values were taken as the average of 10 seconds during each time point.

Upon completion of the simulations, measurement equipment was removed, and students were taken to a debrief room to complete the SAI tool. Following the cognitive behavioral strategy session, this data collection process was repeated for a second immersive mixed reality simulation. After the second simulation the SAI tool was administered again, along with the SUS, to measure subjective feelings of presence in the setting. Figure (2) illustrates the study interventions and data collection process.

The study sample was described using appropriate descriptive statistics. For example, all numeric continuous variables were described as means and standard deviations. Change scores of S-anxiety scores were compared using the paired samples t-test. Biometric indices from baseline to time points during the immersive simulations were compared using a general linear model. An alpha level of 0.05 was used for all statistical analyses. All statistical analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC).

Qualitative Data Collection

The primary source for qualitative data was student written reflections including one pre-trip reflection, two reflections completed during the faculty led study abroad experience, and one post-trip reflection. The students were asked to write four entries specifically reflecting on their experiences with cognitive based interventions and how they were able to implement the strategies during times of stress. Reflection prompts were standardized (Figure 3), and all writing was uploaded to the university's online learning management system. Prompts for the intra-trip reflections were based on the 'Reflective Self-Assessment' activity described by Armstrong and colleagues (2017). All reflective writing was reviewed by the co-investigators and assessed for any references to cognitive behavioral strategies, stress, or anxiety. Data were analyzed to gain insight into the perception of student stress and anxiety and their perceived ability to manage these feelings with cognitive behavioral strategies. The analytic techniques used were those recommended by Braun and Clarke (2006) and primarily included an iterative thematic analysis approach. An interactive reading of the texts for patterns of cognitive schema and thematic

trends occurred, first independently and then collectively by two of the co-investigators familiar with qualitative analysis. The co-investigators then conducted an inductive thematic analysis of all qualitative data. First, general thematic codes were identified, followed by the addition of subcodes to each theme, and finally, codes were collapsed into the limited number of themes reflected in the results section.

Pre-trip Reflection Prompts
<ol style="list-style-type: none"> 1) What am I most excited for during this clinical? What am I most apprehensive about related to this clinical? 2) How does stress or anxiety manifest in my own body? How frequently do I notice it in my life? How do I currently manage stress? 3) From the cognitive behavioral group session, what strategy (or strategies) do I find most helpful for my own practice and lifestyle? How will I incorporate it into my lifestyle?
<p style="text-align: center;">Intra-Trip Reflection Prompts (Armstrong et al., 2017)</p> <p>Think about a meaningful clinical situation during the week and apply the following questions:</p> <ol style="list-style-type: none"> 1) Describe: Objectively describe the event. 2) Appreciate: What went well? How did this help me meet the course objectives? 3) Self-management: How did I respond in the situation? What mindfulness techniques have I learned that I incorporated into this situation? 4) Civic engagement: How did others in the situation respond? 5) Professional Knowledge: What did I learn from this event to change my usual behavior or attitudes? 6) Self-assess: How is this different from how I have acted in previous events? 7) Transform: How can I apply this to my future practice?
<p style="text-align: center;">Post-trip Reflection Prompts</p> <ol style="list-style-type: none"> 1) What were your expectations, hopes, and fears before the trip? 2) Review major themes and motifs that describe your experience. 3) Identify highlights, transformational moments and changing points <p>As you make this review, note significant associated feelings, issues, questions, and unfinished business you may have.</p>

FIGURE (3): REFLECTION PROMPTS BEFORE, DURING, AND AFTER THE STUDY ABROAD EXPERIENCE

Results

Quantitative Results

Baseline GSE ($M=31.69$, $SD= 2.29$), baseline T-anxiety ($M=39.15$, $SD=9.86$), and baseline S-anxiety ($M= 38.58$, $SD=9.39$) demonstrated baseline self-efficacy, trait-based anxiety, and situational or state-based anxiety prior to any interventions. Descriptive statistics of the GSE, T-anxiety, and S-anxiety scores

are described in Table (1). GSE scores were relatively high, meaning participants believed they could cope with life challenges. Change scores of S-anxiety were calculated from baseline, or before any intervention, to SAI Time 1, after the first simulation. Then change scores were calculated from the baseline, before any intervention, to SAI Time 2, or after the cognitive behavior strategy session and the second simulation. One set of baseline S-anxiety scores were missing, therefore comparative statistics were calculated with 12 participants. The difference in change scores using a paired samples t-test were not statistically significant ($p=0.40$) and therefore did not demonstrate a change in state anxiety while participating in simulations before the cognitive behavioral strategy session or after (Table 2). To answer research question 2, among baccalaureate nursing students preparing for a faculty-led study abroad program, participation in an immersive mixed reality simulation and cognitive behavioral strategy session did not change participant self-assessment of anxiety.

Characteristic		<i>M</i>	<i>N</i>	Range	<i>SD</i>	<i>SEM</i>
GSE	Baseline	31.39	13	27-35	2.29	0.63
	T-Anxiety	39.15	13	24-57	9.86	2.73
S-Anxiety	Baseline	38.58	12	26-59	9.39	2.71
	SAI 1	51.50	12	33-63	9.10	2.63
	SAI 2	50.92	12	38-65	8.15	2.35

TABLE (1): DESCRIPTIVE STATISTICS OF GSE, T-ANXIETY, AND S-ANXIETY SCALES

Characteristic	<i>M</i>	<i>N</i>	<i>SD</i>	<i>SEM</i>	<i>M for difference</i>	<i>SD for difference</i>	<i>t</i>	<i>df</i>	<i>p</i>
Baseline to	12.92	12	9.40	2.71	0.59	7.70	0.26	11	0.40
SAI 1	12.33	12	7.67	2.21					

TABLE (2): DESCRIPTIVE STATISTICS OF S-ANXIETY CHANGE SCORES BETWEEN SIMULATION 1 AND SIMULATION 2. NOTE. CHANGE SCORES SELF-RATINGS MEASURED FROM BASELINE BEFORE INTERVENTIONS TO AFTER THE FIRST SIMULATION (SAI 1) AND BASELINE TO AFTER THE SECOND SIMULATION (SAI 2).

Baseline biometric data before the first simulation on the first day included HR ($M=80.9$, $SD=16.9$), systolic blood pressure (SBP) ($M=119$, $SD=9.25$), RR ($M=15.9$, $SD=2.82$), and SpO₂ ($M=97.1$, $SD=1.04$) for 13 participants. Baseline GSR ($N=11$, $M=4.95$, $SD=1.88$) was unfortunately unavailable from two participants on the first day of simulation due to technical difficulties. The general linear model was used to compare biometric indices from baseline values to time points during each simulation on both the first and the second day. Statistically significant changes from baseline to specific time points were noted in the biometric indices of HR, SBP, and GSR during the simulation conducted on day 1, but only GSR during the simulation conducted on day 2

(Table 3). Significant differences in biometric data were not noted between the first simulation and the second simulation, which was after receiving the cognitive behavioral strategy session. A single-factor, repeated measures design with a sample of 12 subjects, measured at 3 time points, achieves 82% power to detect differences among the means using a Geisser-Greenhouse Corrected F Test at a 0.05 significance level. To answer research question 1, with participation in this study abroad preparatory intervention by nursing students, some biometric measures changed within simulations, but biometric measures were not different between pre- and post- cognitive behavioral strategy training session.

Day 1 Simulation	HR (bpm)	SBP (mmHg)	DBP (mmHg)	RR (brpm)	SpO2 (%)	GSR (uS)
Baseline	80.9 ± 16.9	119 ± 9.25	74.3 ± 3.75	15.8 ± 2.82	97.1 ± 1.04	4.95 ± 1.88
Time point 1 - Entering the virtual environment	86.1 ± 13.6	124 ± 11.1	73.0 ± 4.26	16.2 ± 2.44	97.8 ± 1.14	5.92 ± 2.48 *
Time point 2 - Entering the home within the virtual environment	83.9 ± 12.3	125 ± 9.50 *	75.1 ± 3.71	16.0 ± 2.12	97.8 ± 1.01	5.96 ± 2.15 *
Time point 3 - Performing the clinical task within the virtual environment	94.5 ± 13.2 *	121 ± 10.8	73.8 ± 3.26	16.0 ± 2.20	97.8 ± 0.99	5.87 ± 2.40 *

Day 2 Simulation	HR (bpm)	SBP (mmHg)	DBP (mmHg)	RR (brpm)	SpO2 (%)	GSR (uS)
Baseline	88.0 ± 10.5	125 ± 8.50	73.2 ± 2.85	16.2 ± 2.34	97.2 ± 1.28	7.34 ± 2.60
Time point 1 - Entering the virtual environment	91.8 ± 13.1	123 ± 5.56	73.7 ± 3.25	17.2 ± 2.28	97.5 ± 1.13	8.04 ± 2.57 *
Time point 3 - Performing the clinical task within the virtual environment	90.4 ± 17.3	125 ± 8.15	75.3 ± 3.12	17.1 ± 1.66	97.8 ± 0.90	7.56 ± 2.83

Simulation Day	Biometric Index	Time Point Relative to Baseline	F	df	p
1	Heart Rate	Time point 3 - Performing clinical task	5.725	1	0.034
	Systolic Blood Pressure	Time point 2 - Entering the virtual home	5.752	1	0.034
	Galvanic Skin Response	Time point 1 - Entering the virtual environment	10.175	1	0.010
		Time point 2 - Entering the virtual home	10.598	1	0.009
		Time point 3 - Performing clinical task	5.215	1	0.046

2	Galvanic Skin Response	Time point 1 - Entering the virtual environment	8.626	1	0.015
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TABLE (3): DESCRIPTIVE STATISTICS FOR BIOMETRIC INDICES OBTAINED FROM DAY 1 AND DAY 2 SIMULATIONS AND SIGNIFICANCE BETWEEN TIME POINTS RELATIVE TO BASELINE USING THE GENERAL LINEAR MODEL DENOTED BY *. THE CLINICAL TASK FOR THE DAY 1 SIMULATION INCLUDED ADDRESSING HIGH BLOOD PRESSURE AND MEDICATION KNOWLEDGE, WHILE THE CLINICAL TASK FOR THE DAY 2 SIMULATION WAS TO PERFORM A DRESSING CHANGE FOR WOUND CARE. DATA ARE EXPRESSED AS MEANS \pm STANDARD DEVIATION (SD). HR=HEART RATE; SBP=SYSTOLIC BLOOD PRESSURE; DBP=DIASTOLIC BLOOD PRESSURE; RR=RESPIRATORY RATE; SpO2=OXYGEN SATURATION; GSR= GALVANIC SKIN RESPONSE

The SUS, which measures the feeling of presence in virtual environments on a scale from 1-7, is reported as both means and count (Slater, Usoh, & Steed, 1994). The SUS Count (N=13, M=1.77, SD=1.30) demonstrates the mean of the SUS with scores of either '6' or '7' amid the 6 questions. The SUS Mean (N=13, M=4.67, SD= 1.04) demonstrates the mean across the 6 questions. Of the six questions, Q1 (M=4.77, SD=1.48), Q2 (M=4.46, SD=1.71), Q3 (M=4.38, SD=1.71), Q4 (M=5.23, SD=1.42), Q5 (M=4.46, SD=1.71), and Q6 (M=4.69, SD=1.65), Question 4 "I had a stronger sense of being in the location portrayed" had the highest rating (Table 4). These results mean that the CAVE provided an acceptable alternative environment to simulate community nursing clinical experiences.

	Q1	Q2	Q3	Q4	Q5	Q6	Total
1	1	1	2	1	1	1	8
2	0	1	0	0	1	0	2
3	0	1	0	0	0	1	2
4	4	3	3	0	5	4	19
5	4	3	6	6	3	3	25
6	3	3	1	5	1	2	15
7	1	1	1	1	2	2	8
Mean	4.77	4.46	4.38	5.23	4.46	4.69	
Median	5	5	5	5	4	5	
Mode	4	4	5	5	4	4	
Sum	62	58	57	68	58	61	

TABLE (4): FREQUENCY OF PARTICIPANT RESPONSES TO SLATER-USOH-STEED INVENTORY ON SCALE OF ONE TO SEVEN. RATED ON A SCALE OF 1-7 WITH 7 FEELING THE MOST IMMERSIVE. Q1. SENSE "BEING THERE"; Q2. IMAGERY AS REALITY; Q3. SENSE OF SPACE AS PLACES VISITED; Q4. SENSE OF LOCATION PORTRAYED; Q5. LOCATION PORTRAYED AS REALITY; Q6. SENSE OF STANDING IN THE LOCATION PORTRAYED

Qualitative Results

In the qualitative data analysis, thematic analysis was completed for the pre-departure, intra-trip, and post-trip reflections discretely. Key themes are outlined in Table (5). Four key themes emerged in the pre-reflection writing including 1) manifestations of stress, 2) novel experiences as sources of stress, 3) stress management strategies, and 4) internal locus of control. Within the

theme of manifestations of stress, students were explicitly able to link their own feelings of stress and anxiety to concrete expressions of stress including lack of sleep, tense shoulders, hyper-activity, jitters, decrease in healthy food consumption, stomach aches, headaches, and insomnia. Students identified many novel experiences that increased their anxiety including challenges speaking a foreign language, being away from home, uncertainty, new skill acquisition, and lack of control. Students wrote extensively about the specific strategies around anxiety management that they planned to use while in-country. These strategies included daily reflection, breathing exercises, mindfulness meditation, exercise, grounding techniques, journaling, sharing feelings with trusted peers, and reframing strategies. Many of these strategies reflected the cognitive based behavior strategy training that they completed as part of the pre-departure training.

Three key themes emerged in the intra-trip reflective writing including 1) recognition of stress, 2) implementation/action, and 3) confidence. The students demonstrated awareness of when they were feeling anxious as well as consistently identified key triggers that made them feel anxious. There were several similarities between triggers with most cited stressors of reality not matching expectations, seeing individuals in pain, and feeling unable/underprepared to help individuals encountered during clinical experiences. Within the theme of implementation/action, the students identified several strategies to address their anxiety including focusing on what was happening in the moment, using mindfulness to be more intentionally present, focusing on their posture and their outward demeanor, taking a step back to reframe what they were experiencing, and simply noting how they were feeling. These strategies were associated with the third theme of confidence as reflected in student writing describing how they believed these strategies helped them to face and overcome feelings of anxiety which made them more confident in their ability to self-regulate and manage their feelings of anxiety.

In the final post-trip reflection, the students were asked to reflect on their experiences, feelings, and points of transformation while studying abroad, however most of the students also described how the experiences would inform them moving forward. The key themes that emerged in the final post-trip reflection included 1) self-awareness, 2) forward-looking, and 3) sense of purpose. The results of the final reflection were somewhat surprising to the investigators as the specific prompts asked the students to reflect back on their

experiences, yet most of them described how their increased self-awareness and active assessment of their own stress responses with appraisal of strategies that worked to manage that anxiety would deeply inform their future practice. Students noted the reflection on action not only allowed them to see the bigger picture, but also be mindful of connections and how their experiences were transforming them as individuals and as nurses. To answer research question 3, participants detailed in their reflective journals how the preparatory immersive simulation and cognitive behavioral strategy session increased their awareness and ability to manage acculturative stress during the study abroad clinical experience.

	Pre-departure	Intra-trip	Post-trip
Key Themes	Manifestations of stress	Recognition of stress	Self-awareness
	Sources of stress	Implementation/action	Forward looking
	Strategies/management of stress	Confidence	Sense of purpose
	Internal locus of control		

TABLE (5): QUALITATIVE ANALYSIS THEMES FROM WRITTEN REFLECTIONS

Discussion

This novel interdisciplinary pilot project was aimed at reducing anxiety and managing acculturative stress in students studying abroad. Annual trends in mental health data demonstrate that anxiety is on the rise in college students (Lipson et al., 2022). Acculturative stress is a known phenomenon of psychological adaptation in an unknown culture which may be adaptive or maladaptive (Berry, 2005), and it can be experienced by study abroad students (Chen, 2014). Anecdotal evidence from a nursing study abroad program at our institution aligned with literature on learner acculturative stress (Berry, 2005; Chen, 2014; Savicki, 2013). Our own faculty have witnessed student maladaptive behaviors related to anxiety and acculturative stress. This study describes a pre-departure intervention that includes cognitive behavioral management training paired with the opportunity to practice using learned strategies in a simulated environment prior to travel to the study-abroad country.

Simulation has been used as a pre-departure measure in nursing education to mitigate negative effects of acculturative stress (Nadeau et al., 2020). Mixed reality simulations can be helpful for practicing clinical nursing scenarios in preparation for study abroad situations. Results of the study

demonstrate that nursing students preparing for their study abroad clinical course had relatively high generalized self-efficacy score, meaning they believed they could cope with upcoming challenges. While the intra-simulation measurements were associated with significant differences for five biometric indices/time points as noted in Table (3), intra-simulation differences on day two were only noted for one index/time point, and there were no differences between the first and second simulations. Of note, the CBT strategy training was conducted between the two simulations. We interpret these results as the experience being worthwhile as demonstrated by the meaningful change in some biometric indices from the first to the second simulation, suggesting that students were able to self-regulate with increased efficiency during the experience. The learning of new CBT strategies and feeling expected to apply these in the second simulation, or even the cognitive load required to try to integrate these strategies, might have interfered with the ability to capture state anxiety changes. This pilot study may be used to effectively power a larger study that may demonstrate physiologic differences.

Intentional reflective writing before, during, and after a study abroad program suggests that students were aware of their own feelings and demonstrated an iterative cycle of reflection on action and mindfulness to be able to take a step back and reframe stressful situations. Post-trip reflections demonstrated a self-awareness and thoughtful engagement with how the students would incorporate their experiences into their professional development. The qualitative data suggests that ongoing practice using cognitive behavioral strategies with intentional reflection may be valuable tools in addressing acculturative stress during study abroad.

There were a few limitations in this study. First, there was a small sample size at a single institution. This was a pilot study, and thus there were no data to do an a priori power analysis. Hence, the small sample size may have resulted in an underpowered study. In college students, internal consistency for the S-anxiety and T-anxiety scales are below 0.6 (Spielberger, 1983/2015), suggesting that these results should be interpreted with caution. Follow up data collection with additional participants was inhibited by the CoViD-19 pandemic. Missing data also decreased sample size and generalizability of results. Also, participants were from a homogenous group of all female traditional undergraduate nursing students following their third year of study. Investigators are unsure if there would be different results with a more diverse

student group. Finally, a small, unobtrusive wrist monitor was used to collect data of biometric indices. Nonetheless, it is possible that there could be inconsistencies with equipment usage between students. There are prior studies using virtual reality as exposure therapy for a variety of applications. This factor was impossible to omit from the study design and thus may be a factor in the lack of changes in biometric indices from day 1 to day 2. However, the other reported survey measures are suggestive of conscious implementation of cognitive based behavior stress management strategies.

Implications

While this was a small pilot study, our data suggests that pre-departure cognitive based behavior stress management strategies paired with simulated practice prior to departure may be one way to help students deal with acculturative stress and more successfully incorporate the experiences into positive growth experiences. However, because this was a single site with a small and homogenous sample, this study needs to be replicated and tested across disciplines and institutions. In subsequent studies, the use of a validated tool to measure acculturative stress should be used as it may add more quantitative assessment to support the qualitative findings. Additionally, this study used cognitive behavioral strategies for a specific study abroad situation, but there should be further evaluation for long-term benefits.

The current results suggest the methods implemented may help study abroad students to deal with acculturative stress. Not all institutions have access to a CAVE, but careful selection of the workflow and processes implemented to create the current experience has resulted in cross-functionality with current head-mounted displays available at a fraction of the cost of a CAVE-based system. Members of the MARquette Visualization Lab (MARVL) have used these head mounted displays to remotely deliver content created for MARVL's large-scale immersive virtual environment (LaDisa & Larkee, 2020). Specifically, members of MARVL have experience developing exceptional content for the Oculus Rift, Oculus Quest, Samsung GearVR and Microsoft HoloLens, among others. With adequate interest and support, the current experience could be tailored to be delivered via low-cost head-mounted display with the content available for download via repository.

This study examines the efficacy of a mixed reality simulation and cognitive behavioral strategy intervention aimed at anxiety reduction and self-

management by baccalaureate nursing students in preparation for a study abroad clinical experience. The research questions were: among baccalaureate pre-licensure nursing students preparing for a faculty-led study abroad program, how does participation in an immersive mixed reality simulation and cognitive behavioral strategy session impact (1) biometric measures, (2) self-assessment of anxiety, and (3) ability to manage acculturative stress? Among these students, participation in the interventions did not change participant self-assessment of anxiety. Additionally, there were some biometric measure changes within each simulation, but no meaningful differences pre- and post-cognitive behavioral strategy training sessions. However, students detailed in their reflective writing several ways in which the cognitive behavioral strategy session increased their awareness and ability to manage acculturative stress during a study abroad experience. Overall, this pilot study suggests there may be some benefit to students participating in a combined immersive simulation with cognitive behavioral strategy training, but more research is needed. For example, this approach to pre-departure preparation could be used across many disciplines as well as known contexts that may cause stress to students within their various study abroad courses. Additionally, this approach could be used to study other important concepts in student learning, such as intercultural competence, cultural humility, and the development of global perspectives.

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Karli Webster, MS, has been an international education professional since 2004. She became the Manager of Education Abroad at Marquette in 2014 and the Director of the Office of International Education in 2022. Her main responsibilities focus on emergency response and risk management, as well as management of the Sibanye Cape Town program and oversight of Marquette's various education abroad options. She also oversees exchange student mobility and serves as an ARO.

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