

Escape Cardiac Arrest in Pregnancy: An Experimental Education Approach in a Concurrent
Maternal and Neonatal Emergency Response

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This dissertation investigates the pressing issue of education in cardiac arrest during pregnancy, an emergency of life-threatening significance that necessitates a coordinated response from maternal and neonatal healthcare teams. The study encompasses three primary chapters, each addressing a crucial facet of this intricate scenario.

In the chapter titled "Cardiac Arrest in Pregnancy: A Scoping Review on Knowledge and Confidence in a Maternal & Neonatal Response," an extensive examination of existing literature illuminated substantial knowledge gaps in the resuscitation of pregnant individuals, a concern that has persisted for over a decade. These gaps encompass critical domains, including a dearth of high-quality research with a heavy reliance on limited experimental designs, small sample sizes that curtail the generalizability of findings, a lack of comprehensive comparisons among various teaching strategies for enhancing knowledge and confidence, an emphasis on short-term outcomes without adequate longitudinal assessments of knowledge retention and clinical impact, a need for tailored education programs catering to diverse healthcare professionals, and a scarcity of research on collaborative learning experiences, particularly concerning neonatology teams. These identified gaps offer valuable opportunities for future research aimed at fortifying the evidence base, refining educational approaches, and ultimately enhancing the management of cardiac arrest during pregnancy and neonatal resuscitation. This manuscript underscores the pressing need to expand educational initiatives beyond obstetrical units and to foster interdisciplinary collaboration among healthcare teams.

The chapter titled, "Escaping PowerPoint: Enhancing Knowledge, Satisfaction, and Self-Confidence in Cardiac Arrest in Pregnancy," introduces an innovative teaching strategy known as the Virtual Escape Room (VER). The randomized controlled study compares the effectiveness of this virtual gamified approach with a traditional online PowerPoint method in improving knowledge acquisition, learner satisfaction, and self-confidence. The findings demonstrate the statistically significant superiority of the VER in enhancing these critical outcomes, highlighting the potential of immersive learning experiences in healthcare education. Notably, the data reveal a substantial increase in mean scores from the knowledge pre-test ($M = 59.58$, $SD = 16.30$) to the knowledge post-test ($M = 68.24$, $SD = 17.42$), $t(64) = 5.635$, $p < .001$. The assessment tools employed included a knowledge quiz and The National League for Nursing (NLN) Student Satisfaction and Self-Confidence instruments.

The chapter titled "Puzzling Out the Correlates of Learner Engagement and Exploring Motivational States within a Virtual Escape Room," delves into the intricate aspects of learner engagement within the gamified learning environment of the VER. It uncovers the relationships between engagement, learner satisfaction, and specific engagement components such as enjoyment, creative thinking, and dominance. This manuscript underscores the multifaceted nature of engagement and highlights the imperative need for further research to achieve a more profound comprehension of its role in shaping learning outcomes. The study employed the Gameful Experience Scale (GAMEX) and the Telic/Paratelic State Measure (TPSI) instrument. Notably, statistically significant positive correlations were observed, including $r = 0.346$ ($p = 0.005$) between the Enjoyment Score and knowledge post-test, $r = 0.305$ ($p = 0.013$) between the Creative Thinking Score and knowledge post-test, and $r = 0.255$ ($p = 0.04$) between the Dominance Score and knowledge post-test. Additionally, a significant interaction effect emerged

between the T/PSI score (pre vs. post) and the educational intervention (VER vs. control group). T/PSI score increased from 35.83 (SD = 8.67) before the intervention to 38.86 (SD = 9.91) after the intervention, indicating a substantial change. In contrast, there was no statistically significant difference in T/PSI scores before and after the traditional PowerPoint intervention for the control group, where the mean scores changed from 35.89 (SD = 7.02) to 35.57 (SD = 7.94). These findings strongly suggest that the VER condition contributes to a paratelic state among participants when compared to the control condition.

This dissertation underscores the paramount importance of effective education in managing cardiac arrest during pregnancy, given the persistent knowledge gaps among resuscitation teams. The introduction of the VER as an innovative educational strategy represents a significant advancement in addressing these deficits. Furthermore, the exploration of engagement and motivational states within the gamified learning environment offers valuable insights into the complexities of learner engagement, paving the way for more effective educational strategies in healthcare settings. Ultimately, these findings have the potential to empower healthcare teams, potentially reducing maternal mortality rates and improving neonatal outcomes in the face of this critical emergency.

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I hope that this work improves our understanding of education in cardiac arrest in pregnancy and contributes to better outcomes for future mothers and their little ones. For it is ultimately for them that this work is dedicated.

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Chapter 1

Introduction

Background

Cardiac arrest during pregnancy is a rare but complex emergency demanding immediate, synchronized intervention from adult and neonatal resuscitation teams within a challenging four-to-five-minute timeframe. The urgency of this dual-patient scenario is compounded by documented deficits in pregnant individuals' resuscitation during simulated arrests, regardless of the healthcare providers existing resuscitation certifications (Lipman et al., 2010). Further heightening this issue, the occurrence of cardiac arrest in pregnancy is escalating, impacting 1 in 12,000 hospital admissions, with a noted 5.9% annual increase (Goyal et al., 2021). The infrequent nature of such events leaves interdisciplinary teams with limited opportunities for hands-on clinical experience.

Maternal mortality rates have seen a concerning rise, climbing to 32.9 deaths per 100,000 live births in 2021 from 23.8 in 2020 and 20.1 in 2019 (Hoyert, 2019). In 2020, the American Heart Association (AHA) responded to this unique challenge by providing a new “Cardiac Arrest in Pregnancy” algorithm. The algorithm emphasizes maternal resuscitation as key to optimal outcomes for both mother and infant, and it includes the potential for an early perimortem cesarean delivery (Panchal et al., 2020). The successful implementation of these strategies hinges on interdisciplinary collaboration, healthcare professionals' knowledge, and their self-confidence in handling such emergencies. The teams' grasp of the latest principles of advanced cardiac life support (ACLS) directly affects maternal and neonatal outcomes.

Amid rising maternal mortality and morbidity rates in the United States, The Joint Commission, a healthcare regulation body, has prioritized educational initiatives in obstetrics.

Central to their efforts is the implementation of rigorous educational initiatives aimed at elevating the standards of care provided by healthcare professionals, especially in the context of maternal health. Two key performance standards that have been emphasized in this endeavor are PC.06.01.01 and PC.06.03.01 (The Joint Commission, 2020). The Joint Commission standard PC.06.01.01, with EP (elements of performance) Five, mandates annual drills as an integral part of ongoing quality improvement efforts. These drills, featuring participation from various healthcare disciplines as delineated in the organization's hemorrhage response procedure, serve as a vital component of the strategy. These strategies are designed not only to identify system issues but also to promote a culture of continuous improvement (The Joint Commission, 2020). Similarly, Standard PC.06.03.01 with the implementation of EP Four requires the annual conduct of drills specifically tailored to address severe hypertension/preeclampsia scenarios. Just like their hemorrhage counterparts, these drills serve as an opportunity to uncover system-level issues that may impede the provision of optimal care.

Moreover, comprehensive education in managing cardiac arrest during pregnancy can complement the Joint Commission standards in improving maternal health. Given that both hemorrhage and severe hypertension/preeclampsia can potentially lead to cardiac arrest in pregnancy, this additional educational component ensures that healthcare professionals are not only well-prepared to address these specific complications but also equipped to respond effectively to the broader spectrum of obstetric emergencies, including cardiac arrest. Despite global declines, the U.S. ranks 65th among industrialized nations in maternal deaths, reinforcing the urgency of these initiatives (Chinn et al., 2020). As of July 1, 2020, these multifaceted measures collectively aim to elevate the quality of care throughout all stages of pregnancy and

postpartum, ultimately contributing to the reduction of maternal mortality and morbidity rates in the United States.

PowerPoint is currently the leading education program worldwide, and studies continue to demonstrate increased student outcomes with its use (Bakcek et al., 2020). This dissertation introduces the innovative Virtual Escape Room (VER) as an educational strategy to address the identified knowledge gap in concurrent maternal and neonatal resuscitation in cardiac arrest in pregnancy. The approach seeks to enhance the knowledge of nurses in efficiently managing cardiac arrest during pregnancy and boost their self-confidence—a key determinant of clinical performance (Porter et al., 2013). Furthermore, this study seeks to understand learner engagement and the influence of motivational states by innovative teaching strategies such as the VER. By fostering knowledge, and instilling self-confidence, the VER aims to strengthen the resilience of nurses responding to this complex emergency. By enhancing educational strategies, we aim to foster resilient teams ready to handle cardiac arrest during pregnancy effectively, potentially helping reverse the alarming trend in maternal mortality rates and reducing disparities in our healthcare system. Enhancing educational strategies is a crucial step toward this goal.

Specific Aims of the Dissertation

Aim # 1

To evaluate different teaching strategy interventions (PowerPoint with voiceover and Virtual Escape Room) in increasing knowledge in cardiac arrest in pregnancy.

Aim # 2

To evaluate the effect of two different teaching strategies (PowerPoint with voiceover only or Virtual Escape Room) on increasing student satisfaction with the educational strategy on cardiac arrest in pregnancy.

Aim # 3

To evaluate the effect of two different teaching strategies (PowerPoint with voiceover only or Virtual Escape Room) on increasing self-confidence in managing cardiac arrest in pregnancy.

Aim # 4

To determine if a post-test response is influenced by demographic variables (years of experience and nursing specialty) by nurses receiving the education on cardiac arrest in pregnancy.

Aim # 5

To investigate the correlates associated with learner engagement in the Virtual Escape Room (VER).

Aim # 6

To examine the influence of the VER on learners' Telic/Paratelic motivational state.

Changes in Methods Since Proposal Hearing

There were no changes in methods since proposal hearing through completion of study.

Organization of the Dissertation

This dissertation has four chapters following this introductory chapter.

Chapter 2- Cardiac Arrest in Pregnancy: A Scoping Review on Knowledge and Confidence in a Maternal & Neonatal Response

Chapter 2 is a scoping review addressing the question: What are the current practices for improving knowledge and/or self-confidence in simultaneous maternal and neonatal resuscitation during cardiac arrest in pregnancy?

Chapter 3- Escaping PowerPoint: Enhancing Knowledge, Satisfaction and Self-Confidence in Cardiac Arrest in Pregnancy

Chapter 3 is a manuscript providing a comprehensive examination of whether an innovative teaching strategy, the Virtual Escape Room (VER), significantly improves outcomes in nursing education. The focus is to compare the effectiveness of the traditional PowerPoint approach, often utilized in healthcare education, against the more interactive VER method, specifically in the context of teaching about cardiac arrest in pregnancy. The study evaluates the impact of these two different teaching methods on several critical aspects of nursing education: the enhancement of knowledge, the level of student satisfaction, and the changes in self-confidence among the nursing participants.

Chapter 4 – Puzzling Out the Correlates of Learner Engagement and Exploring Motivational States within a Virtual Escape Room

Chapter 4 is a manuscript exploring the complex dynamics of learner engagement within the context of an innovative Virtual Escape Room (VER), while further exploring its relationship with motivational states (telic/paratelic).

Chapter 5- Conclusion

This chapter gives a comprehensive overview of the study's findings and outlines potential avenues for future research. It aims to disseminate the study's contributions to the nursing education community and the broader community involved in managing cardiac arrest during pregnancy.

Dissemination Plan

This dissertation will be disseminated as follows:

Chapter 2- Cardiac Arrest in Pregnancy: A Scoping Review on Knowledge and Self-confidence in a Maternal & Neonatal Response

Journal: *Resuscitation*

Planned Submission Type: Feature Article

Chapter 3- Escaping PowerPoint: Enhancing Knowledge, Satisfaction and Self-confidence in Cardiac Arrest in Pregnancy

Journal: *Journal of Obstetric, Gynecologic, & Neonatal Nursing (JOGNN)*

Planned Submission Type: Major Research Article

Chapter 4 – Puzzling Out the Correlates of Learner Engagement and Exploring Motivational States Within a Virtual Escape Room

Journal: *Journal of Continuing Education in Nursing*

Planned Submission Type: Feature Article

Conferences- Abstracts have been or will be submitted to:

ANPD Aspire Convention, taking place April 9-12, 2024 in Chicago, IL.

The 2024 ANPD Convention Content Planning Committee welcomes abstracts on research, evidence-based practice, and new, innovative, and practical approaches that are inclusive in nature and can be used in a variety of nursing professional development (NPD) settings.

AWHONN Convention taking place June 21-25, 2025 in Orlando, FL

As the leading convention for women's health, obstetric and neonatal nurses, the AWHONN Annual Convention helps to advance the nursing profession by providing nurses with critical information and support to help deliver the highest quality care for women and newborns.

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Chapter 2

Cardiac Arrest in Pregnancy: A Scoping Review on Knowledge and Self-Confidence in a Maternal and Neonatal Emergency Response

Background

Cardiac arrest in pregnancy presents a challenging resuscitation compared to cardiac arrest in nonpregnant adults, due to the additional considerations necessary to achieve optimal maternal and neonatal outcomes. Population-based research from the United States, Canada, the United Kingdom, and the Netherlands show the occurrence of maternal cardiac arrest during pregnancy ranging from about 1 in 12,000 to 1 in 36,000 cases (Enomoto et al., 2022). The incidence of maternal cardiac arrest and related mortality has been on the rise in several countries and although a rare event, it is a leading cause of maternal death (Jeejeebhoy et al., 2015). Timely and high-quality cardiopulmonary resuscitation (CPR) is crucial for increasing the chances of survival. As a result, it is essential for healthcare providers to be well-versed and confident in managing cardiac arrest in pregnancy. The research question for this scoping review is: What are the current practices for improving knowledge and/or self-confidence in simultaneous maternal and neonatal resuscitation during cardiac arrest in pregnancy?

Knowledge deficits in responding clinical teams can contribute to poor maternal and neonatal outcomes once an arrest has occurred (Jeejeebhoy et al., 2015). To improve the care and response to cardiac arrest in pregnancy, educational approaches need to be evaluated. The purpose of this scoping review is to identify educational approaches that optimize knowledge and self-confidence in cardiac arrest in pregnancy and neonatal resuscitation. Educational methodologies improving the self-confidence of participants can promote appropriate resuscitative interventions and can contribute to achieving expertise (Monod et al., 2014).

Twenty-eight quantitative studies were identified and reviewed to understand educational methods with outcome measures in knowledge or self-confidence for this comprehensive maternal and neonatal emergency. Knowledge and self-confidence are essential for various reasons, particularly in the context of decision-making, problem-solving, and enhanced performance. Confidence enables individuals to trust their abilities and judgment, leading to improved performance in various tasks (Bandura, 1997). When individuals and teams believe in themselves, they are more likely to take on challenges, work efficiently and persist in challenging situations such as cardiac arrest in pregnancy.

Beyond self-confidence, several other components play a pivotal role in shaping behavior and clinical practice. By concentrating on reinforcement and conditioning to influence behavior, behaviorism lays the groundwork for creating effective educational interventions that encourage adherence to established guidelines. Behaviorism asserts that through operant conditioning, which involves reinforcement or punishment, learners can enhance their confidence and knowledge (Merriam & Bierema, 2014). In the context of cardiac arrest in pregnancy and concurrent maternal and neonatal resuscitation, the anticipated behavioral responses involve adhering to the recommended algorithms provided by the American Heart Association (AHA) instead of relying solely on individual instincts. Advanced Cardiac Life Support (ACLS), Basic Life Support (BLS), and Neonatal Resuscitation Program (NRP) offers practitioners a standardized approach to managing emergencies, ensuring that all healthcare providers exhibit the expected behaviors during critical situations. This behaviorist approach fosters a consistent and efficient response, enhancing the effectiveness of emergency interventions and ultimately contributing to better patient outcomes.

Nurse confidence, a pivotal element in nursing theory, encompasses various perspectives of nursing practice, encapsulating crucial attributes such as compassion, honesty, and character (Suandika, 2021). In contrast, self-confidence is a multifaceted attribute molded by cognitive and behavioral abilities and influenced by one's environment (Suandika, 2021). Recognizing that self-confidence can be multifaceted, and its presence can vary depending on the context, limitations were encountered during the search process in limited articles being found. This led to including both "confidence" and "self-confidence" as search terms, intended to ensure a comprehensive examination of articles. This approach designed to enhance the robustness of the review unveiled a common use of the terms across all articles: a practitioner's belief in their ability to deliver care effectively.

Method

Initially, a literature search on current practices aimed at enhancing knowledge and self-confidence in maternal and neonatal resuscitation during cardiac arrest in pregnancy revealed only a limited number of relevant studies (less than five). To broaden the scope and increase the pool of studies for review, the search strategy was modified. To capture a more comprehensive set of studies, the keyword "confidence" was used in place of "self-confidence" in the search query. Additionally, to encompass both maternal and neonatal resuscitation aspects, a dual-pronged approach was employed. First, a search was conducted using the keywords "cardiac arrest," "pregnancy," and "confidence." Subsequently, a second search was performed, replacing "cardiac arrest" and "pregnancy" with "neonatal resuscitation." All of these searches were limited to the specified timeframe of 2012 to 2022. The two databases used were Pubmed and Medline where 355 studies were initially identified, resulting in 187 articles after duplicates were removed. The PRISMA diagram (Figure 2.1) illustrates the disposition of the articles (Page et al.,

2021). Articles were screened by title to determine potential relevance to knowledge and confidence and 35 articles were excluded. A total of 152 articles were assessed for eligibility for review. The determined inclusion criteria were quantitative study, outcome measure including knowledge or confidence, full-text availability and article written or translated to the English language. A total of 124 did not meet criteria resulting in 28 articles included in the synthesis. The final date of this search strategy was October 28th, 2022. Selection bias was addressed in utilizing a standardized approach in article selection which adhered to defined inclusion criteria. Additionally, pertinent information was systematically evaluated from each of the 28 selected studies in ascending chronological order. Categories suggested by the Matrix Method were used in coding 11 out of the 19 variables, including author, year, title, journal, purpose, instrument, study design, independent variable, dependent variable, statistics and findings (Garrard, 2017). The remaining 8 variables were recorded but not coded. Table 2.1 lists all variables in the matrix, excluding author(s), year, title, and journal.

Table 2.1*Variables in Matrix and Codes Assigned*

Nursing Journal: 1 = Yes 0 = No	Purpose: Recorded, not coded	Resuscitation Focus: Cardiac Arrest in Pregnancy (CAP), Neonatal Resuscitation Program (NRP), Both Cardiac Arrest in Pregnancy and Neonatal Resuscitation	Region of Samples 1 = North America 2 = South America 3 = Europe 4 = Africa 5 = Asia 6 = Australia
Country: Recorded, not coded	Instrument: Recorded, not coded	Validity and Reliability of Instruments 1 = Provided 2 = Not Provided	Study Design: Experimental, Observational, Quasi- Experimental
If Experimental or Quasi-Experimental, # of studied groups? 2-groups, 3-groups	Study Design Specifics: Recorded, not coded	Independent Variable: Recorded, not coded	Dependent Variable: Recorded, not coded
Type of Participants: Interdisciplinary Team, Midwifery, Nurses, Nursing Students, Residents/Medical Students	Sample Size: Recorded, not coded	Objective of Study 1 = Staff Development 2 = Academic 3 = Resident/Medical Student	Outcome Measure: Knowledge, Self- Confidence, Both knowledge and self- confidence
Statistics Used: Recorded, not coded	Findings: Recorded, not coded	Limitations: Recorded, not coded	

All selected studies measured self-confidence and/or knowledge through a valid and reliable instrument or an author-developed scale. Table 2.2 presents a detailed description of the coding process employed for articles using the review matrix.

Results

Types of Studies

This scoping review synthesized findings from 28 articles, of which five were sourced from nursing-focused journals and 23 from medical journals. Out of these, nine studies were solely centered on knowledge-based outcome measures, eight focused exclusively on self-confidence levels, and the remaining 11 investigated both knowledge and self-confidence. These articles explored multiple facets of this complex emergency, including cardiac arrest during pregnancy (10 studies), neonatal resuscitation practices (14 studies), and a combination of both (four studies). Geographically, the participant demographics were diverse, encompassing 14 studies from North America, one from South America, five from Europe, four from Africa, and four from Asia.

Study Designs

The reviewed studies consisted of five experimental designs, five quasi-experimental designs, and 18 observational designs. Furthermore, only 10 studies included a comparison or control group, either through a 2-group or 3-group design. Notably, among the experimental and quasi-experimental studies, eight utilized a 2-group design while two employed a 3-group design. Regarding the validity and reliability of the research instruments, 15 studies failed to provide this information, while 13 explicitly indicated the use of valid and reliable tools.

Interdisciplinary Focus

Maternal cardiac arrest requires a comprehensive approach and involves multiple disciplines to adequately achieve care decisions (Jeejeebhoy et al., 2015). The study participants category included five studies with nurses, two with nursing students, eight with residents or medical students, two with midwives, and 11 with interdisciplinary teams. Fifteen of the studies

were coded as interdisciplinary when they included more than one medical specialty (i.e., physicians and nurses). Overall, the literature demonstrates a focus on teams in clinical practice (11 studies), followed by studies completed resident/medical students (5 studies). Lastly, six studies use the term “gap” or describe deficits in knowledge or practice as findings in managing cardiac arrest in pregnancy including four studies with residents/medical students as participants and one study with a large interdisciplinary team as participants.

Teaching Strategies and Evaluation Methods

The studies encompassed in this review predominantly center on staff development, with 16 studies influencing hospital practices, academic education methodologies (2 studies), and resident or medical student training (8 studies). Two studies notably integrated innovative gamification techniques tailored for neonatal resuscitation training, while another three adopted the Objective Structured Clinical Examination (OSCE) approach. Simulation emerged as the most prevalent teaching strategy, manifested through in-situ, in-person, or virtual formats in 14 studies. Such a diverse spectrum of studies highlights the myriad approaches and contexts examined in cardiac arrest and neonatal resuscitation education and training. Of the 28 studies reviewed, 10 were either experimental or quasi-experimental with three measuring only knowledge, three measuring only self-confidence and the remaining four measuring both knowledge and self-confidence. Statistically significant increases in knowledge were found in two of the three studies measuring knowledge as an outcome measure. Statistically significant increases in self-confidence were found in two of the three studies measuring self-confidence as an outcome measure. Statistically significant increases in knowledge and self-confidence were found in four out of the four studies measuring both knowledge and self-confidence.

Limitations of Studies Reviewed

Noteworthy limitations of the studies in this review encompass several areas. First, 11 studies were constrained by small sample sizes, limiting the generalizability of their findings and the power to detect effects. Second, as previously indicated, 18 of the studies employed observational designs, which inherently lack a control group and thereby reduce the internal validity of the study outcomes.

Discussion

Cardiac arrest occurs in 1 in 30,000 pregnancies and although relatively rare, optimal outcomes are dependent on the team's understanding of the latest recommendations and principles (Zelop et al., 2018). Additionally, confidence is considered an essential characteristic of responding teams, as increased confidence has been linked with improved abilities to manage emergencies (Carolan-Olah et al., 2016). Furthermore, the American Heart Association (AHA) (2015) advised that responding teams to a maternal cardiac arrest, "must identify that two critically ill patients (mother and fetus) must be resuscitated" (p.1754). Remarkably, only four articles in this review cohesively examine both maternal and neonatal response strategies; of these, two originate from North America, but none are from the United States. The remaining twenty-four articles study knowledge or self-confidence in either maternal cardiac arrest or neonatal resuscitation independent of each other.

Knowledge & Self-confidence

Cardiac arrest in pregnancy appears to be on the rise as pregnancy coupled with high-risk conditions is increasing (Goyal et al., 2021). Knowledge and self-confidence are essential characteristics to effectively respond to the emergency of cardiac arrest in pregnancy. Knowledge is an essential trait of individuals and teams; self-confidence can support the transfer

of knowledge to clinical practice. Multiple studies in the literature highlight knowledge deficits and practice challenges in successfully managing the complexity of maternal cardiac arrest (Panchal et al., 2020). In the last ten years there have been five quantitative studies that focus on cardiac arrest in pregnancy focusing on concurrent maternal and neonatal resuscitation. Of the five studies, only one provides instrument validity and reliability, an adequate sample size, and data demonstrating statistical significance. This scoping review demonstrates a limited number of high-quality studies addressing the intricacy of this emergency in responding to a maternal and neonatal emergency response. Although this is a rare emergency, individual and team knowledge should be evaluated periodically to determine if additional education is necessary. Furthermore, it is vital that educators utilize evidence-based educational methodologies that can enhance knowledge and self-confidence to improve competency in optimizing maternal and neonatal outcomes.

Study Design

With limited studies having a 2-group or 3-group design, a need for increased rigor in the current body of literature on knowledge and/or self-confidence in cardiac arrest in pregnancy and/or neonatal resuscitation is identified. A 2-group design generally consists of an experimental group and a control group. The control group serves as a benchmark, helping to establish the effects of a treatment or intervention by comparing these effects against a group that did not receive the treatment (Polit, 2021). This comparison enhances the internal validity of the study, offering stronger evidence of a cause-and-effect relationship between the variables (Polit, 2021). A 3-group design adds another layer of rigor by incorporating an additional control or comparison group, which might receive an alternative treatment or a different level of the experimental treatment (Polit, 2021). This design allows researchers to compare the effectiveness

of multiple interventions or to better isolate the variable of interest, thereby providing a more nuanced understanding of the research question. By incorporating more studies that employ either a 2 or 3-group design, the literature would become enriched with more comprehensive insights and nuanced interpretations, thereby facilitating more effective decision-making education practices amongst the healthcare community.

Teaching Strategies and Evaluation Methods

Evaluating educational methodologies plays a crucial role in assessing the learning outcomes resulting from a range of teaching strategies. This scoping review highlights various approaches, including but not limited to simulation, in influencing learning outcomes. Simulation encompasses a variety of methods, including human simulation, manikin utilization, computer-based or virtual simulations, as well as simulations designed to enhance psychomotor skills or facilitate role-playing (Jeffries, 2020). The utilization of diverse teaching strategies is advocated by the AHA as a means of knowledge translation, employing a multifaceted approach to cater to the multidisciplinary requirements of healthcare (Jeejeebhoy et al., 2015).

In one study, it was suggested that educational initiatives should be centered on the practical, everyday tasks of healthcare professionals, aiming to strengthen knowledge and induce behavior changes in clinical practice, rather than solely relying on theoretical or general concept-based instruction lacking sufficient emphasis on practical application (Bolan et al., 2018). An example of this shift from theory to practical focus could involve replacing a slide detailing anatomical changes in pregnancy with information about the placement of defibrillation pads in the code cart and a review of their correct positioning during pregnancy. According to the AHA, while teaching strategies contribute to increased knowledge, it is equally important to consider institutional readiness, which involves testing existing systems and processes (2015). For

instance, reviewing the consistent placement of a scalpel in code carts and ensuring uniformity throughout the institution exemplifies the testing of systems. Questioning established processes and assessing institutional preparedness can pinpoint areas requiring education, thereby enhancing team performance.

Effective knowledge acquisition is influenced by numerous variables, underscoring the necessity of considering innovative educational methodologies and continuously evaluating existing teaching strategies to keep pace with evolving healthcare and learner needs. An emergence of innovative approaches in recent studies include utilizing digital applications (apps), gamification (application of game elements to motivate and engage learners), and objective structured clinical examination (OSCE). In one study, implementing the use of an application called “Safe Delivery App” was noted to increase knowledge scores (Bolan et al., 2018). Another study demonstrated use of virtual reality increasing knowledge, problem-solving ability, self-confidence, and learning motivation in neonatal resuscitation (Yang & Oh, 2022). In another study utilizing OSCE for neonatal resuscitation, they were able identify increased neonatal resuscitation knowledge, skill and self-confidence with successful retention 6 weeks afterwards (Hakimi et al., 2021). In recent years gamification has emerged where a study identified a significant difference in skills including ventilation and chest compression compared to the control group (Sarvan & Efe, 2022). These innovative teaching strategies demonstrate creative and effective educational modalities that can further engage the learner and advance practices in education.

Interdisciplinary Education

Cardiac arrest in pregnancy requires an interdisciplinary approach requiring unique and distinct coordination amongst teams (Jeejeebhoy et al., 2015). The rapid interventions necessary to have optimal outcomes involve multiple collaborating specialties inclusive of physicians (obstetricians, neonatologist, anesthesiologists) nurses from various departments (obstetrics, critical care, emergency), and interprofessional teams (respiratory therapist, patient support teams, etc.) Although the literature demonstrates interdisciplinary education (n=11), most studies do not include neonatology teams in studying cardiac arrest in pregnancy. A possible justification for this exclusion could be that the initial procedures of neonatal resuscitation are invariably executed in a consistent, sequential order, irrespective of the maternal circumstances. For instance, regardless of whether the maternal event is a hemorrhage, a seizure, or a cardiac arrest, the initial steps as per the Neonatal Resuscitation Program (NRP) remain the same. These initial steps are (Pediatrics, 2021):

1. Determine gestational age, ensure the newborn is breathing or crying, and observe good muscle tone. If the newborn meets these criteria, they can stay with the mother with routine care.
2. Provide warmth: Immediately dry the newborn, replace wet linens to prevent evaporative heat loss, and assess the newborn's color.
3. Position: Clear airway as necessary, position the infant in a 'sniffing' position, and suction mouth and then nose if necessary.
4. Clear Airway: If the infant is not breathing, provide tactile stimulation by rubbing the newborn's back.
5. Evaluate: Continually assess heart rate, respiration, and color.

These steps persist as constant in the initial approach to neonatal resuscitation, providing a structured path for healthcare providers to follow, which can enhance confidence and efficiency, even in challenging and variable situations. Regardless, the presence of neonatology teams is imperative as concurrent and simultaneous maternal and neonatal resuscitations increase the complexity for responding teams. A study investigating preparedness of neonatal resuscitation amongst pediatric residents demonstrated incorrect assembly of laryngoscopes, drawing of epinephrine from a vial, securing of endotracheal tubes or umbilical venous catheters in high-fidelity simulations (Cordero et al., 2013). Maternal cardiac arrest recommends delivery of a neonate within five minutes (Jeejeebhoy et al., 2015). Team performance may be impacted when the intricacies of simultaneous proximity maternal and neonatal resuscitations are encountered. Examples of these intricacies can include, increased volume of team members entering and leaving a room with two different teams being led by two different team leaders in a space designed for one resuscitation. Limiting a study to one controlled resuscitation may not demonstrate a team's ability to perform the same in a maternal cardiac arrest. One study identified that medical performance was significantly correlated with teamwork and communication (Detlefs et al., 2022). Including neonatology teams to education in cardiac arrest in pregnancy is necessary to foster optimal communication and teamwork practices.

Literature Gaps

The literature has consistently identified multiple gaps in knowledge concerning the resuscitation of pregnant individuals. This review corroborates the persistence of these gaps, as more than a decade ago, significant deficits were observed in the resuscitation of pregnant women during simulated arrests, despite all participants holding current resuscitation

certifications (Lipman et al., 2010). The gaps in the literature are inclusive of the following domains:

1. **Quality of research:** This scoping review has revealed a lack of high-quality research. Many studies synthesized rely on quasi-experimental or observational designs, which are often limited in their ability to establish causal relationships. More robust experimental designs are needed to provide stronger evidence and validate the efficacy of various educational interventions. Furthermore, many studies had limited sample sizes, which may lead to limited generalizability of findings. Larger or multi-center studies with diverse populations of healthcare professionals ideally draw more reliable conclusions.
2. **Effectiveness of teaching strategies:** The scoping review highlights prevalence in simulation-based education, however there is a limited approach to comparing the relative effectiveness of different teaching strategies in enhancing knowledge and confidence.
3. **Retention of Knowledge and Clinical Impact:** Most studies focus on short-term outcomes such as immediate knowledge gains and self-reported confidence levels. Longitudinal research is needed to assess the long-term retention of knowledge and the impact of educational interventions on clinical practice and patient outcomes.
4. **Tailoring education to diverse needs:** The literature lacks an in-depth exploration of the unique needs and challenges faces by different healthcare professionals, and identifying the potential benefits of tailored education programs, considering factors such as experience, roles and shift worked (day vs night).

5. Interprofessional collaboration: This review emphasizes the importance of interdisciplinary education but reveals limited research on collaborative learning experiences, particularly for neonatology teams.

As recently as 2020, the American Heart Association (AHA) continued to discuss a major scientific gap in cardiac arrest in pregnancy (Panchal et al., 2020). The identified gaps outlined above present opportunities for future research to strengthen the evidence base, refine educational strategies, and ultimately improve the management of cardiac arrest in pregnancy and neonatal resuscitation.

Limitations Of the Review

Limitations in this review extend to the reliance on a single coder for identifying relevant studies and attributing categories to each of them, which might potentially introduce bias. Furthermore, the limited number of studies synthesized ($n = 28$) underscores the necessity for additional research to further inform and enhance clinical practice.

Implications of Findings

Vital statistics from the Centers for Disease Control and Prevention presented increased maternal morbidity and mortality rates in the United States (Hoyert, 2019). With cardiac arrest in pregnancy having increased, promoting knowledge and self-confidence of interdisciplinary teams is critical. Carefully considering factors impacting acquisition of knowledge and self-confidence is also vital to the successful management of maternal cardiac arrest. One study identified night nurses having lower knowledge and self-confidence scores than day nurses, a discussion point omitted in all other studies in this review (Fritz et al., 2020). Furthermore, the literature largely demonstrated an obstetrical and critical care perspective with limited discussion for neonatal team integration. Although the American Heart Association recommended

performing drills, most of the studies in this review primarily held a simulation or drill in an obstetrical unit, highlighting the need to consider these drills in units such as emergency departments or critical care units. The literature demonstrated sub-optimal knowledge and self-confidence in cardiac arrest in pregnancy amongst supporting teams with a concentration of studies in obstetrical teams. To best improve team dynamics in this interdisciplinary comprehensive emergency, it is essential that simulations and drills be inclusive of all responding team members. Moreover, only one third of the studies included in this review provided information regarding the validity and reliability of the instruments utilized, potentially leading to less precise data. A further constraint pertained to the inadequate sample sizes in several studies, which impinged on the generalizability of the findings and posed a risk to the statistical conclusion validity (Polit, 2021). The insights from this review may contribute to the evolution and expansion of future research in this field.

Conclusion

Cardiac arrest in pregnancy is an emergency requiring rapid resuscitations by adult and neonatal response teams to achieve optimal outcomes for both mother and neonate. This scoping review contributes to the understanding of educational approaches and teaching strategies that optimize knowledge and self-confidence in cardiac arrest in pregnancy and neonatal resuscitation. This review of 28 studies, reveals that various factors influence the effective management of maternal and neonatal emergencies, including the need for interdisciplinary education, innovative teaching methodologies, and addressing the current gaps in the literature. Firstly, this review highlights the importance of interdisciplinary education, as cardiac arrest in pregnancy requires a coordinated response from different medical specialties, including physicians, nurses, and other healthcare professionals. It demonstrates that while there is some

focus on interdisciplinary education in the literature, this is still a need for more comprehensive and inclusive training that involves all members of the response teams, particularly neonatology teams, to ensure effective communication and teamwork in high-pressure situations.

Secondly, this review identifies simulation as the predominant teaching strategy, encompassing various modalities such as human simulation, manikin-based simulations, computer or virtual simulations, and role play. Nevertheless, emerging innovations in digital applications, gamification, and objective structured clinical examination (OSCE) have demonstrated promising results in enhancing knowledge, problem-solving abilities, self-confidence and learning among healthcare professionals.

Thirdly, despite these advancements in education, critical gaps in literature remain. The limited number of high-quality studies, inadequate sample sizes, and a lack of instrument validity and reliability in some studies highlight the need for further research to better understand effective teaching strategies and to evaluate their impact on knowledge acquisition and self-confidence in clinical teams.

In addition to the overview provided above, it is crucial to underscore a critical gap in current practices within the context of maternal and neonatal emergencies: the lack of drills or comprehensive education for simultaneous resuscitation of pregnant women and neonates in the presence of cardiac arrest during pregnancy. The limited literature is particularly concerning given the intricacies involved in managing such complex scenarios. Cardiac arrest in pregnancy necessitates a highly coordinated response from both adult and neonatal response teams to ensure the best possible outcomes for both the mother and the neonate. However, this scoping review identified a deficiency in education specifically tailored to address this simultaneous resuscitation. While the review identifies the importance of interdisciplinary education and

various teaching strategies, including simulation, gamification, and digital applications, it is essential to emphasize the urgency of incorporating drills and education focused on the unique demands of resuscitating both the pregnant woman and the neonate during a cardiac arrest event.

Addressing this gap in education is paramount, as it directly impacts the ability of healthcare professionals to respond effectively in these high-pressure situations. Furthermore, the need for regular assessment of individual and team knowledge is necessary to identify needs for supplementary education. By integrating drills and comprehensive education for simultaneous resuscitation, healthcare teams can develop the necessary skills, coordination, and confidence required to manage these critical emergencies, ultimately improving the chances of optimal outcomes for both mothers and neonates.

In conclusion, this scoping review emphasizes the need for a more comprehensive and inclusive approach to education in managing cardiac arrest in pregnancy and neonatal resuscitation. By identifying the leading teaching strategies, innovative methodologies, and areas for improvement, it offers valuable insights for educators, researchers, and healthcare professionals to develop more effective education programs and interventions, which will ultimately contribute to better outcomes for both mothers and neonates in these critical emergencies.

Table 2.2

Scoping Review Matrix

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument V&R of Instrument	Study Design Study Design Specifics	IV	DV	n	Outcome measure		Findings
										Statistics Used	Participants	
Berkenstadt , H., Ben- Menachem, E., Dach, R., Ezri, T., Ziv, A., Rubin, O., & Keidan, I. (2012)	Deficits in the provision of cardiopulmonary resuscitation during simulated obstetric crises: results from the Israeli board of anesthesiologist	Anesthesia and Analgesia	Assess competence in the simulated scenario of cardiorespirator y arrest in the parturient.	CAP	Israel Board Examination in Anesthesiology	Observational	Simulation	Knowledge and Competence	25	Knowledge	Significant knowledge disparities identified in the resuscitation of pregnant patients in senior anesthesiology residents.	
		No			V&R provided	Not discussed						McNemar Test
Hards, A., Davies, S., Salman, A., Erik-Soussi, M., & Balki, M. (2012)	Management of simulated maternal cardiac arrest by residents: didactic teaching versus electronic learning	Canadian Journal of Anesthesia	Evaluate anesthesia residents' management of maternal cardiac arrest through high- fidelity simulation	CAP	Technical skills were assessed using a checklist developed by study investigators; The Anesthetists' Non-Technical Skills	Experimental	Didactic vs. E-Learning	Technical and nontechnical skills scores (performanc e), Knowledge	20	Knowledge	Technical and nontechnical skills scores significantly improved after teaching in both groups. Gaps in knowledge identified similar benefits in early knowledge retention between e- learning and didactic.	
		No			V&R provided	Prospective, assessor- blinded, observational cohort study						Residents/ Medical Students
Hensel, D., Kathman, J., Hendricks, R., & Ball, S. (2012)	Building partnerships using student role models for neonatal resuscitation simulation	Journal of Continuing Education in Nursing	Investigate the role of students in enhancing simulation- based learning among experienced nurses new to simulation.	NR	Student Satisfaction and Self-Confidence in Learning Instrument	Quasi- Experimental	Simulation	Satisfaction, Self- confidence	67	Self- Confidence	There was no significant difference in satisfaction or confidence with the simulation between the two groups.	
		Yes			V&R provided	Pilot Study						Nurses

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument V&R of Instrument	Study Design Study Design Specifics	IV	DV	n	Outcome measure		Findings
										Statistics Used	Participants	
Cordero, L., Hart, B. J., Hardin, R., Mahan, J. D., Giannone, P. J., & Nankervis, C. A. (2013)	Pediatrics Residents' Preparedness for Neonatal Resuscitation Assessed Using High-Fidelity Simulation	Journal of Graduate Medical Education	Assess pediatric residents' procedural skills, team performance and confidence in neonatal resuscitation.	NR	Author Developed: Team behavior, performance confidence checklist	Observational	High-Fidelity Simulation	Procedural skills, Team performance, Self-confidence	26	Self-Confidence	Simulation revealed skills gaps, especially in timeliness. Significant increase in self-confidence didn't match actual performance, indicating a need for more training and practice.	
		No			Not provided	Not discussed		Residents/ Medical Student	McNemar test, Krippendorff K coefficients			
Monod, C., Voekt, C., Gisin, M., Gisin, S., & Hoesli, I. (2013)	Optimization of competency in obstetrical emergencies: a role for simulation training	Archives of Gynecology and Obstetrics	Examine the impact of simulation training on self-confidence, emergency handling, algorithm knowledge, and team communication	CAP & NR	Author-developed: Self-Confidence, General acceptance of simulation training	Observational	Simulation	Knowledge, self-confidence, team communication	168	Both Knowledge & Self-Confidence	Statistically significant improvement in self-perceived competency 3 months after the course compared to directly after the training.	
		No			Not provided	Not discussed		Interdisciplinary Team	Fisher's exact test			
Surcouf, J., Chauvin, S., Ferry, J., Yang, T., & Barkemeyer, B. (2013)	Enhancing residents' neonatal resuscitation competency through unannounced simulation-based training	Medical Education Online	Evaluate if unannounced, high-fidelity in-situ mock resuscitations improve residents' self-confidence and performance in neonatal resuscitation.	NR	Author Developed, Pre and post training questionnaire	Observational	In-situ Simulation	Self-confidence and observed performance	32	Self-Confidence	In-situ simulation leads to significant gains in confidence and observed skills. The findings support use in residency and ongoing education.	
		No			Not provided	Pretest-Posttest Design		Residents/ Medical Student	Wilcoxon signed rank test, paired t test, correlational analysis			

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument V&R of Instrument	Study Design Study Design Specifics	IV	DV	n Participants	Outcome measure		Findings
										Statistics Used		
Walker, D., Cohen, S., Fritz, J., Olivera, M., Lamadrid-Figueroa, H., Cowan, J. G., Hernandez, D. G., Dettinger, J. C., & Fahey, J. O. (2014)	Team training in obstetric and neonatal emergencies using highly realistic simulation in Mexico: impact on process indicators	BMC Pregnancy Childbirth	Evaluate if team training with PRONTO (Programa de Rescate Obstétrico y Neonatal: Tratamiento Óptimo y Oportuno) program optimizes emergency response and care.	CAP & NR	Behavioral skills checklist by the Center for Advanced Pediatric and Perinatal Education (CAPE). Author developed: Knowledge and self-efficacy	Quasi-Experimental	PRONTO program	Knowledge, Self-efficacy, Teamwork	450	Knowledge	Significant knowledge and self-efficacy increases were observed in both physicians and nurses.	
		No			V&R provided	Pretest-Posttest Design			Interdisciplinary Team	Linear regressions, correlational analysis		
Xu, T., Wang, H., Gong, L., Ye, H., Yu, R., Wang, D., Wang, L., Feng, Q., Lee, H. C., McGowan, J. E., & Zhang, T. (2014)	The impact of an intervention package promoting effective neonatal resuscitation training in rural China	Resuscitation	Evaluate an intervention package promoting effective neonatal resuscitation training at county-level hospitals across China.	CAP	Confidence, Self-Knowledge, Confidence Questionnaire	Experimental	Implementation of Neonatal Resuscitation Program	Knowledge, Self-Confidence, Incidence of birth deaths from asphyxia	8 countries	Both Knowledge & Self-Confidence	Decreased mortality and morbidity from birth asphyxia. Statistically significant increase in self-confidence and knowledge.	
		No			V&R provided	Post-test only Experimental Design			Interdisciplinary Team	Cochran-Armitage Trend Test, Independent t test, One-way ANOVA		
Green, M., Rider, C., Ratcliff, D., & Woodring, B. C. (2015)	Developing a systematic approach to obstetric emergencies	Journal of Obstetric, Gynecologic, and Neonatal Nursing	Determine the effect of standardized education specific to maternal resuscitation on nurses' confidence and competence	CAP	Author Developed: Questionnaire on Confidence and Competence	Observational	Obstetric Drills	Confidence and Competence	67	Self-Confidence	Improvements in confidence and competence in managing obstetric emergencies. Significant cost savings, no p-value.	
		Yes			Not provided	Pretest-Posttest Design			Nurses	Descriptive Statistics		

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument	Study Design		IV	DV	n	Outcome measure		Findings
						Study Design	Study Design Specifics				V&R of Instrument	Statistics Used	
Roth, C. K., Parfitt, S., & Brewer, M. (2015)	Effectiveness of an obstetrics-based advanced cardiac life support education program	Journal of Obstetric, Gynecologic, and Neonatal Nursing Yes	Assess the efficacy of an ACLS OB program on L&D nurses' satisfaction and self-confidence in executing ACLS algorithms.	CAP	NLN Student Satisfaction and Self Confidence in Learning Scale, AHA Megacode checklist V&R provided	Observational Pre-post educational intervention study with 1-year follow-up	Maternal Mock Code Drills	Satisfaction and Self-Confidence	96 Nurses	Self-Confidence Cronbach's alpha, Wilcoxon signed-rank test	Statistically significant improvement in performance and a significant increase in satisfaction and self-confidence.		
Adams, J., Cepeda Brito, J. R., Baker, L., Hughes, P. G., Gothard, M. D., McCarroll, M. L., Davis, J., Silber, A., & Ahmed, R. A. (2016)	Management of maternal cardiac arrest in the third trimester of pregnancy: A simulation-based pilot study	Critical Care Research & Practice No	Evaluate confidence, knowledge, and competence after a simulation-based curriculum on maternal cardiac arrest in a residency program.	CAP	Author developed: confidence and knowledge, resuscitation and TeamSTEPS checklist V&R provided	Observational Pretest-Posttest Design	Simulation	Knowledge, Confidence, Competence	9 Residents/ Medical Student	Both Knowledge and Self-Confidence Wilcoxon signed rank and McNemar's test	OBGYN resident knowledge, confidence, and competence in managing third-trimester maternal cardiac arrest significantly improved.		
Kc, A., Wrammert, J., Nelin, V., Clark, R. B., Ewald, U., Peterson, S., & Måliqvist, M. (2017)	Evaluation of Helping Babies Breathe Quality Improvement Cycle (HBB-QIC) on retention of neonatal resuscitation skills six months after training in Nepal	BioMed Central Pediatrics No	Evaluate the impact of multi-faceted strategy for HBB on the retention of neonatal resuscitation skills in a tertiary hospital of Nepal.	NR	Author Developed Knowledge Questionnaire, Objective Structured Clinical Exam, Self-evaluation checklist, and Peer-Evaluation checklist. Not Provided	Observational Time-series Design	Multi-faceted implementation strategy for Helping Babies Breathe (HBB)	Knowledge, Skills	137 Nurses	Both Knowledge and Self-Confidence Paired t test	Bag-and-mask skills significantly improved post-training and were significantly retained at 6 months.		

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument V&R of Instrument	Study Design Study Design Specifics	IV	DV	n	Outcome measure Statistics Used	Findings
Bolan, N. E., Sthresley, L., Ngoy, B., Ledy, F., Ntayingi, M., Makasy, D., Mbuyi, M.-C., Loba, G., Nemeth, L., & Newman, S. (2018)	mLearning in the Democratic Republic of the Congo: A Mixed-Methods Feasibility and Pilot Cluster Randomized Trial Using the Safe Delivery App.	Global Health: Science and Practice No	Evaluate the feasibility, acceptability, and potential impact of the Safe Delivery App on emergency obstetric and newborn care practices among health workers.	CAP & NR	Author Developed: Demographic, Self-Confidence & Knowledge Not provided	Experimental Pilot study, Cluster Randomized Control Trial	Safe Delivery Application	Knowledge, Self-confidence	62 Interdisciplinary Team	Both Knowledge and Self-Confidence t test, ANOVA	Knowledge scores in postpartum hemorrhage and neonatal resuscitation significantly improved among intervention participants compared to controls at 3 months post-intervention. Significant gains in self-confidence were observed, with the largest improvement in treating neonatal respiratory arrest, followed by code supervision and umbilical venous catheter placement.
Hossino, D., Hensley, C., Lewis, K., Frazier, M., Domanico, R., Burley, M., Harris, J., Miller, B., & Flesher, S. L. (2018)	Evaluating the use of high-fidelity simulators during mock neonatal resuscitation scenarios in trying to improve confidence in residents.	SAGE Open Medicine No	Examine the impact of high-fidelity simulators and multidisciplinary teaching on residents' self-reported confidence.	NR	Survey as a modification of one published for confidence, post-survey questionnaire identical to pre-survey Not provided	Observational Pretest-Posttest Design	High-fidelity pediatric simulation	Self-reported confidence	26 Residents/ Medical Student	Self-confidence Unpaired t test and Mann-Whitney test	Significant gains in self-confidence were observed, with the largest improvement in treating neonatal respiratory arrest, followed by code supervision and umbilical venous catheter placement.
Lee, A., Sheen, J.-J., & Richards, S. (2018)	Intrapartum maternal cardiac arrest: A simulation case for multidisciplinary providers	MedEdPORA TAL: The Journal of Teaching and Learning Resources No	Evaluate the ability to initiate high-quality CPR and conduct a perimortem cesarean delivery within 5 minutes, focusing on team communication	CAP	Behavioral Skills checklist Not provided	Observational Not discussed	In-situ simulation	Performance and confidence	9 Interdisciplinary Team	Both Knowledge and Self-Confidence None	Positive feedback and non-significant improved self-confidence were reported post-training. In-situ drills identified, and systems issues were subsequently corrected.

Author & Year	Title	Journal		Purpose	RF	Instrument	Study Design		IV	DV	n	Outcome measure		Findings
		Nursing Journal? Y/N					V&R of Instrument	Study Design Specifics				Statistics Used		
Barré, J., Michelet, D., Truchot, Screen-based simulation sessions J., Cabon, P., & Tesnière, A. (2020)	Midwifery students' retention of learning after screen-based simulation training on neonatal resuscitation: A pilot study	British Medical Journal Simulation & Technology Enhanced Learning	No	Assess learning retention in midwives after screen-based neonatal resuscitation training.	NR	Knowledge and self-efficacy quiz, Anaesthetists' Non-Technical Skills, Neonatal Resuscitation Performance Evaluation	Observational	Screen-based simulation sessions	Knowledge, self-efficacy	14	Knowledge	Self-efficacy and scores significantly increased. No significant difference was observed in performance scores.		
Fritz, J., Montoya, A., Lamadrid-Figueroa, H., Flores-Pimentel, D., Walker, D., Treviño-Siller, S., González-Hernández, D., & Magaña-Valladares, L. (2020)	Training in obstetric and neonatal emergencies in Mexico: effect on knowledge and self-efficacy by gender, age, shift, and profession.	BMC Emergency Medicine	No	Evaluate the impact of emergency training in obstetrics and neonatology in Mexico on knowledge and self-efficacy, considering variables like gender, age, shift, and profession.	CAP & NR	Self-efficacy scales (Bandura), Pre/Post knowledge questionnaires	Observational	PRONTO program intervention	Knowledge, Self-Efficacy and confidence	351	Both Knowledge and Self-confidence	Significant knowledge and self-efficacy gains were observed across various areas. Night-shift workers scored lower overall. Interns had high knowledge but low self-efficacy.		
Leonardsen, A.-C. L., Svendsen, E. J., Heitmann, G. B., Dhayyat, A., Morris, A., Sjøborg, K. D., Olsen, R. M., & Hardestrand, C. (2020)	Development and validation of a questionnaire to assess healthcare personnel competence in cardiac arrest and resuscitation in pregnancy	PLoS One	No	Create and validate a questionnaire to gauge experience, self-rated competence, and role perception in managing cardiac arrest during pregnancy.	CAP	Development of instrument	Observational	Questionnaire	Questionnaire Score	251	Knowledge	The ComCA-P questionnaire is validated for assessing healthcare staff competence in cardiac arrest and resuscitation during pregnancy.		
						V&R provided	Cross-sectional design					Meyer-Olkin (KMO) and Bartlett's test, Cronbach's alpha		

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument	Study Design		IV	DV	n	Outcome measure		Findings
						Study Design	Study Design Specifics				V&R of Instrument	Statistics Used	
Nickerson, J. E., Webb, T., Boehm, L., Neher, H., Wong, L., LaMonica, J., & Bentley, S. (2020)	Difficult Delivery and Neonatal Resuscitation: A Novel Simulation for Emergency Medicine Residents	Western Journal of Emergency Medicine	Assess the impact of in situ simulation on residents' knowledge, confidence, and skills in shoulder dystocia and neonatal resuscitation.	NR	Author Developed Checklist	Observational	Simulation	Knowledge, Confidence, Clinical Performance	23	Both Knowledge and Self-Confidence	Knowledge and confidence gaps in shoulder dystocia and managing neonatal resuscitation. Significance in findings not disclosed.		
		No	Not provided	Pre-post educational intervention study with 1-year follow-up	Not provided	Descriptives, Inter-rater reliability	Residents/ Medical Student	Knowledge of anesthesiologists on CPR in parturient is not high enough to ensure optimal results for the patients. Therefore, education programs about this topic should be planned and repeated frequently. Statistically significant findings.					
Akesen, S., & Goren, S. (2021)	Cardiopulmonary resuscitation in parturients: Assessment of anesthesiologists' knowledge	Annals of Medical Research	Assess anesthesiologists' knowledge on parturient resuscitation.	CAP	European Resuscitation Council CPR guidelines and the Society for Obstetric Anesthesia and Perinatology Consensus	Observational	Knowledge Quiz	Knowledge	356	Knowledge	Knowledge of anesthesiologists on CPR in parturient is not high enough to ensure optimal results for the patients. Therefore, education programs about this topic should be planned and repeated frequently. Statistically significant findings.		
		No	Not provided	Not discussed	Not provided	Interdisciplinary Team	Kolmogorov-Smirnov, Kruskal Wallis, Mann Whitney U, Spearman's Correlation	Significant increase in knowledge and resuscitation skills over time after a 9-month period.					
Ding, X., Wang, L., Msellem, M. I., Hu, Y., Qiu, J., Liu, S., Zhang, M., Zhu, L., & Latour, J. M. (2021)	Evaluation of a neonatal resuscitation training programme for healthcare professionals in Tanzania: A pre-post intervention study	Frontiers in Pediatrics	Evaluate a neonatal resuscitation program for healthcare professionals in Zanzibar	NR	Author Developed: Knowledge & skill performance assessment	Observational	Neonatal Resuscitation Program	Knowledge and performance	23	Both Knowledge and Self-Confidence	Significant increase in knowledge and resuscitation skills over time after a 9-month period.		
		No	V&R provided	Pretest-Posttest Design	V&R provided	Pretest-Posttest Design	Interdisciplinary Team	t test, Chi square and Fischer's exact test					

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument V&R of Instrument	Study Design Study Design Specifics	IV	DV	n Participants	Outcome measure Statistics Used	Findings
Meza, P. K., Bianco, K., Herrarte, E., & Daniels, K. (2021)	Changing the landscape of obstetric resident education in low- and middle-income countries using simulation-based training.	International Journal of Gynecology and Obstetrics No	Examine the impact of simulation-based training in LMICs on long-term knowledge retention and self-efficacy.	CAP	Multiple-choice questionnaires V&R provided	Observational Pre-post intervention with 6-month follow-up	Simulation	Knowledge and self-efficacy	46 Residents/ Medical Student	Knowledge A paired t test	Simulation significantly improved both short- and long-term knowledge and self-efficacy in obstetric emergencies.
Umoren, R., et.al (2021)	eHBB: a randomized controlled trial of virtual reality or video for neonatal resuscitation refresher training in healthcare workers in resource-scarce settings	British Medical Journal No	Evaluate the effectiveness of mobile VR simulations with eHBB in maintaining neonatal resuscitation skills.	NR	Objective Structured Clinical Examination (OSCE) V&R provided	Experimental Randomized controlled trial with 6-month follow-up	eHBB VR simulation or neonatal resuscitation video	Knowledge and Skills Assessment	274 Nurses	Knowledge Fisher's exact, Kruskal-Wallis and Wilcoxon rank-sum tests	Significant decline in performance on neonatal resuscitation skills assessments with variable degree of recovery by 3-month and 6-month assessments.

Author & Year	Title	Journal Nursing Journal? Y/N	Purpose	RF	Instrument V&R of Instrument	Study Design Study Design Specifics	IV	DV	n	Outcome measure		Findings
										Statistics Used	Participants	
Dettels, S. E., Goffman, D., Buttle, R. A., Crump, C. M., Thornburg, L. L., Foley, M. R., & Deering, S. (2022)	Correlation between medical management and teamwork in multidisciplinary high-fidelity obstetrics simulations.	American Journal of Obstetrics & Gynecology MFM	Evaluate the association between teamwork and medical management in high-fidelity critical care simulations.	CAP	Simulation Rubric; Teamwork & Communication Scale	Observational	Standardized pre-recorded lectures before attending high-fidelity simulations	Medical management; teamwork; communication	354	Knowledge	Significant correlation between medical management and teamwork/communication scores across all simulations, emphasizing the significance of total teamwork scores.	
		No			Not provided	Correlational			Interdisciplinary Team	Spearman correlation; Chi-square correlation		
Sarvan, S., & Efe, E. (2022)	The effect of neonatal resuscitation training based on a serious game simulation method on nursing students' knowledge, skills, satisfaction, and self-confidence levels: A randomized controlled trial	Nurse Education Today	Assess the effects of incorporating serious game simulation into neonatal resuscitation training on nursing students' knowledge, skills, training satisfaction, and learning confidence.	NR	Student Satisfaction and Self-Confidence Scale; Neonatal Resuscitation Knowledge Assessment; Neonatal Resuscitation Skill Assessment Form	Experimental	Training program	Skills, Knowledge, Self-Confidence	90	Both Knowledge and Self-Confidence	The intervention group significantly improved in ventilation and chest compressions. Both groups gained knowledge and skills. High satisfaction and confidence scores were noted for both groups.	
		Yes			V&R provided	Randomized controlled, 2-group pre-test post-test, single-blind			Nursing Students	McNemar's, Mann-Whitney U, Cronbach alpha		
Yang, S.Y., & Oh, Y.H. (2022)	The effects of neonatal resuscitation gamification program using immersive virtual reality: A quasi-experimental study	Nurse Education Today	Assess the impact of a VR-based neonatal resuscitation game on knowledge, problem-solving, self-confidence, anxiety, and motivation.	NR	Problem-solving questionnaire, Nurses Clinical Reasoning Scale, State-Trait Anxiety Inventory (STAI)	Quasi-Experimental	Virtual Reality	Knowledge, clinical reasoning, self-confidence, anxiety, and learning motivation	83	Both Knowledge and Self-Confidence	The VR-based neonatal resuscitation game significantly boosted nursing students' knowledge, problem-solving, self-confidence, and learning.	
		Yes			V&R provided	2-group Pretest-Posttest Design			Nursing Students	Chi-square, Fisher's exact, ANOVA		

Author & Year	Title	Journal		Purpose	RF	Instrument	Study Design		IV	DV	n		Outcome measure	Findings
		Nursing Journal? Y/N					V&R of Instrument	Study Design Specifics			Participants	Statistics Used		
Zanno, A., Melendi, M., Cutler, A., Stone, B., Chipman, M., Holmes, J., & Craig, A. (2022)	Simulation-Based Outreach Program Improves Rural Hospitals' Team Confidence in Neonatal Resuscitation.	Cureus		Examine if in situ neonatal resuscitation training boosts delivery room team confidence in rural hospitals.	NR	Author Developed: Confidence Survey, NRP Adherence Tool Not provided	Quasi-Experimental	In-situ simulation	Team confidence	123	Self-confidence	Simulation training significantly boosted self-confidence in neonatal resuscitation, but the actual performance of key skills remained sub-optimal. A gap between perceived confidence and demonstrable skill, suggests a need for more intensive or targeted training.		
		No					2-group Pretest-Posttest Design			Interdisciplinary Team	Cochrane-Armitage trend test			

Note: RF= Resuscitation Focus, V&R= Validity & Reliability, IV= Independent Variable, DV= Dependent Variable

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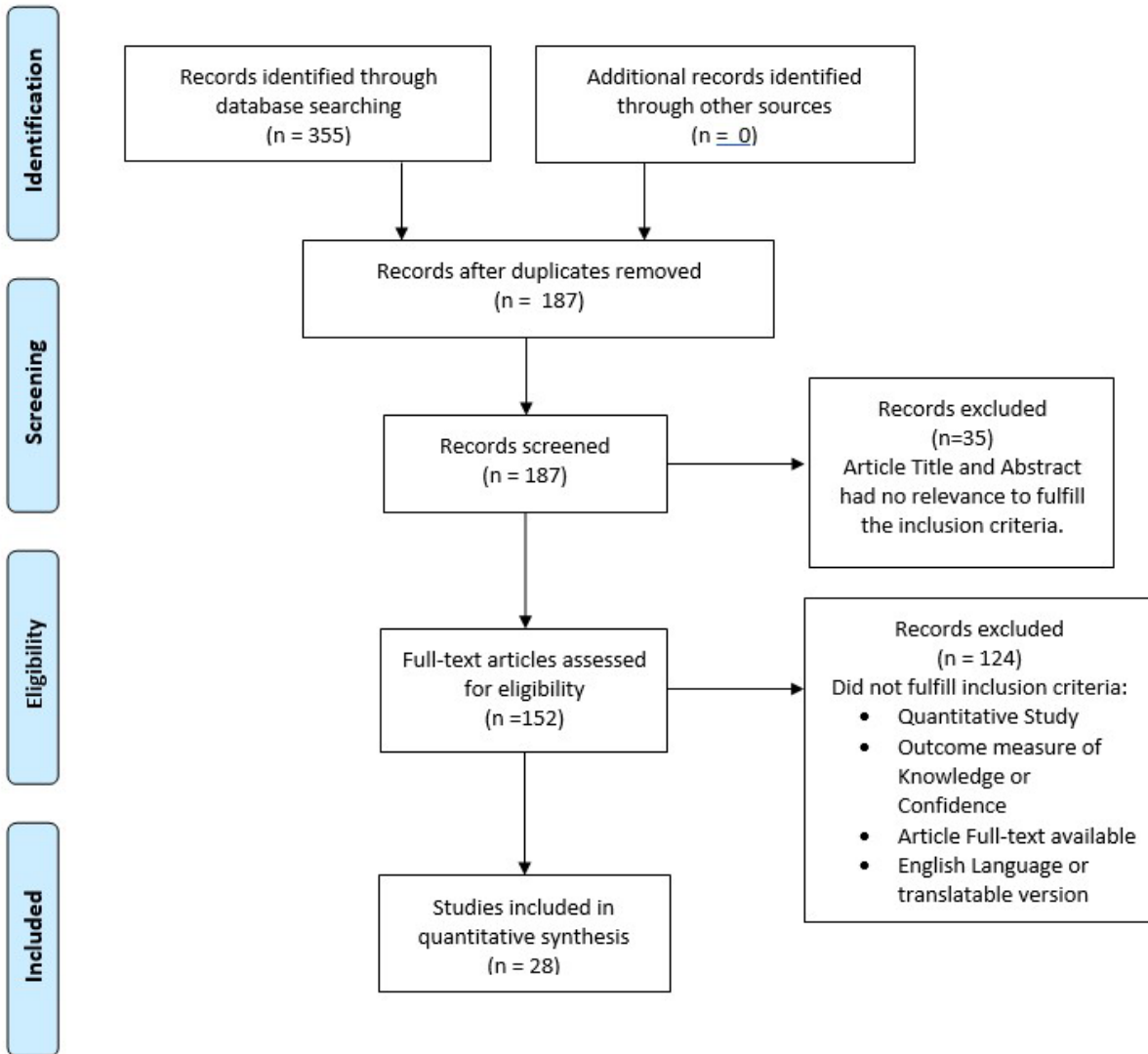
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Figure 2.1

PRISMA Flow Diagram



Chapter 3

Escaping PowerPoint: Enhancing Knowledge, Satisfaction, and Self-Confidence in

Cardiac Arrest in Pregnancy

Background

Cardiac arrest in pregnancy is a complex medical emergency that demands immediate, coordinated responses from both adult and neonatal resuscitation teams. Despite the urgency and high stakes, a knowledge gap persists for healthcare professionals to effectively handle such intricate emergencies (Enomoto et al., 2022). In an endeavor to address this educational conundrum, this study delves into contrasting two pedagogical methodologies: the conventional PowerPoint presentation with voiceover and the innovative Virtual Escape Room (VER) teaching strategy. The primary objective is to discern the more effective approach for cultivating knowledge, self-confidence, and satisfaction within nursing professionals.

PowerPoint has been a longstanding application software utilized in education, serving as an information conduit in teaching sessions. However, its passive learning nature may not cater to the active learning requirements inherent in high-pressure, fast-paced medical emergencies such as cardiac arrest during pregnancy. There is a growing interest in transitioning from traditional didactic methods to more dynamic, engaging teaching strategies, thus stimulating effective learning in complex clinical scenarios. The VER teaching strategy represents an innovative shift in this direction. Offering an interactive, immersive online experience, VER involves participants in a series of challenges and puzzles that promote active learning, critical thinking, and problem-solving skills. As digital technology continues to permeate healthcare, incorporating such tech-enabled, innovative methods into educational approaches is a crucial step toward preparing healthcare professionals.

Furthermore, it is essential to recognize the potential impacts of demographic variables on learning outcomes. These variables, including factors such as years of clinical experience, or prior exposure to analogous situations, may influence participants' responses to the educational intervention. The utilization of innovative teaching strategies like escape rooms has the ability to improve knowledge acquisition but also to enhance learner satisfaction and self-confidence (Morrell & Eukel, 2020). This study aims to offer valuable insights into the effectiveness of an innovative teaching strategy like VER in improving knowledge, satisfaction, and self-confidence in nursing education.

Literature Review

Virtual Escape Room

As educational paradigms continue to evolve, timed problem-solving activities have emerged as a potent tool for stimulating learner engagement and enhancing critical thinking abilities (Reinkemeyer et al., 2022). Over recent years, these activities have been seamlessly integrated into the pedagogical landscape inspiring educators and captivating learners. These digital environments, carefully crafted to simulate problem-solving under pressure can foster vital skills such as teamwork, communication, and critical thinking, however, their optimal use lies in an educational ecosystem where they complement, not substitute, traditional educational activities (Antón-Solanas et al., 2022). Thus, the advent of VER's has prompted significant discourse in the education community, particularly regarding whether they should serve as a complementary strategy to traditional educational activities or act as a substitute for them. Discussions revolve around the careful design and strategic implementation of VERs to ensure they enhance the learning experience without undermining established educational methods.

Gamification

Gamification, which incorporates game design elements into non-game contexts, has demonstrated its validity as a tool for acquiring professional competencies in higher education (Anguas-Gracia et al., 2021). The concept of turning learning into a game, with points, levels, and competitive elements, brings a sense of engagement and motivation to the learning process that can often be missing from traditional didactic methods. A particular form of gamification, escape rooms, stands out as a remarkably effective approach (Antón-Solanas et al., 2022). As immersive experiences, escape rooms require participants to solve puzzles or challenges within a certain timeframe. This approach encourages learners to apply their theoretical knowledge in practice, therefore reinforcing their understanding while also developing skills like problem-solving, teamwork, and critical thinking.

Focusing on the field of nursing education, gamification becomes particularly relevant. Nursing professionals often need to make rapid and well-informed decisions in high-stakes situations. Gamification, therefore, constitutes a significant element in the promotion and practice of decision-making skills (García-Viola et al., 2019). Integrating gamification into nursing education not only stimulates knowledge acquisition but also cultivates practical skills indispensable to the nursing profession (Morrell & Eukel, 2020). Moreover, these gamified approaches have been shown to enhance student knowledge and have been positively received by students, affirming their effectiveness and appeal (Reed & Ferdig, 2021). In addition to its utilization in academic settings, escape rooms have been successfully implemented in nursing professional development within the field of nursing (Adams et al., 2018). Research is emerging and integrative reviews demonstrate knowledge improvement in a variety of nursing education topics both in academia and in clinical professional development (Reinkemeyer et al., 2022).

Nonetheless, the initial applications and emerging research suggest that gamification by means of escape rooms is paving the way for more interactive, engaging, and efficient teaching and learning methodology.

Knowledge, Satisfaction and Self-Confidence:

The impact of VER on knowledge and educational outcomes warrants further investigation, given its rising popularity and promising results. Studies have suggested that nursing participants derive considerable satisfaction and self-confidence from these virtual sessions (Lyman, 2022). Lyman (2002) also identified that the virtual format appears to be as effective for imparting education as traditional in-person sessions. In another study by Adams et al. (2018), both nurse residents and experienced nurses achieved impressive success rates, with all participants effectively ‘escaping’ the room. This achievement signified more than merely game triumph—it also indicated elevated knowledge and increased confidence among participants, thereby underscoring the educational value of the VER (Adams et al., 2018).

Moreover, fields such as behavioral health have also begun harnessing the potential of VERs as a powerful instructional approach to effect changes in perspectives about severe mental illness (SMI) among students. Evidence from research in this discipline indicates that escape room utilization results in a statistically notable decrease in stigmatizing attitudes toward SMI, as compared to control groups who did not engage in the escape room (Rodríguez-Ferrer et al., 2022). From the available evidence, it is apparent that VERs can significantly enhance participants' knowledge, satisfaction, and self-confidence. Beyond its instructional value, this tool also effectively raises awareness about stigmatizing attitudes toward severe mental illnesses among healthcare students (Rodriguez-Ferrer et al., 2022). Hence, VERs prove to be a substantial addition to contemporary educational strategies.

Theoretical Framework

The theoretical framework for this research is anchored in two learning theories: Behaviorism and Mayer's Cognitive Theory of Multimedia Learning. The interface between these two theories forms the conceptual foundation of the VER, the educational intervention employed in this study.

Behaviorism

Behaviorism, focusing on observable behaviors and the influence of conditioning, provides crucial insights for the development of effective educational interventions. This theory suggests that operant conditioning, involving reinforcement or punishment, can foster improvements in learner confidence and knowledge (Merriam & Bierema, 2014). Within the context of managing cardiac arrest in pregnancy, behaviorism provides guidance on the expected behavioral responses, encouraging learners to follow the established guidelines provided by the American Heart Association (AHA) rather than relying solely on intuition. These guidelines, including Advanced Cardiac Life Support (ACLS), Basic Life Support (BLS), and the Neonatal Resuscitation Program (NRP), offer a standardized response protocol for emergencies. Behaviorism promotes consistency and predictability in responses, enhancing the effectiveness of these critical interventions, ultimately contributing to improved patient outcomes.

In the VER setting of this study, participants delved into a simulated environment where the principles of behaviorism took center stage. One of the key premises of behaviorism is that if a behavior's outcome is satisfying or rewarding, the behavior itself is likely to be reinforced and repeated (Ansar et al., 2021). This principle, known as operant conditioning, supports the learning objectives within the VER.

The learning objectives for the VER were:

1. Describe the appropriate management and care of cardiac arrest in pregnancy.
2. Illustrate anatomical differences in administering cardiopulmonary resuscitation between pregnant and non-pregnant individuals.
3. Recognize the indications for a perimortem cesarean delivery.
4. Identify management of the neonate necessitating resuscitation after delivery.

Operant conditioning is a learning process where behaviors are shaped through a system of rewards or punishments. Within the VER of this study, this principle comes to life as participants navigate through the room. As participants correctly respond to questions, their behavior is positively reinforced, allowing them to advance further in the room. Conversely, incorrect responses aren't reinforced, preventing participants from advancing until the correct response is provided. Thus, the environment serves as a clear and interactive example of operant conditioning, reinforcing knowledge acquisition while concurrently stimulating learner engagement.

Mayer's Cognitive Theory of Multimedia Learning

Complementing behaviorism is Mayer's Cognitive Theory of Multimedia Learning, which played a significant role in the conceptual development of the Virtual Escape Room. The "multimedia principle" that emerges from this theory is that effective learning is related to using words and pictures rather than words alone. In addition, learning is an active process of filtering, selecting, organizing, and integrating information (Mayer, 2009). Mayer's cognitive learning theory has one "multimedia principle" and three main assumptions. The three main assumptions are: (a) There are two separate channels for processing information (auditory and visual), (b) each channel has limited capacity, and lastly (c) learning is an active process (Mayer, 2009). This

study determined the overall effectiveness of a VER as a means for content dissemination in nursing education, exploring Mayer's theory is necessary to ensure an optimal learning environment for participants.

Multimedia content dissemination in nursing education has grown in recent years encouraging a closer examination of the learning outcomes of virtual platforms. Multimedia is distinct as it is the combination of sounds, graphics, text, and animations with computer technology to develop effective instructional material (Clark & Mayer, 2016). A pivotal concept arising from the multimedia principle and its underlying assumptions is that of cognitive load; overloading either the verbal or visual channel can impair the learning process (McAlpin et al., 2019). Balanced content dissemination is critical to ensure effective and meaningful learning. In this context, maintaining a balance means providing sufficient multimedia content to facilitate learning without overwhelming the learner's cognitive capacity, thereby ensuring the learning experience is both effective and meaningful. Too much information in either the verbal or visual channel can lead to cognitive overload and hinder learning, while too little may not adequately convey the instructional material. The delicate equilibrium in content dissemination is crucial to foster effective and meaningful learning. Recognizing the importance of balanced multimedia content, Chin-Soon (2020) conducted a literature review and unequivocally found that the effectiveness of multimedia learning materials in the education field is undeniable. The review demonstrated that learning experiences utilizing multimedia, with animations and simultaneous narration of explanations, are more effective than those relying solely on on-screen text explanations. However, Chin-Soon's literature review suggests that on-screen text needs to be removed and omitted to prevent overloading of the working memory and the visual channel. These concepts and elements were considered with the development of short video animations

(30 -60 seconds) embedded in the VER. Likewise, another study used multimedia to present the informed consent process, and identified higher overall satisfaction, lower perceived time to complete consent, and higher comprehension than the control group participants (Abujarad et al., 2021). Multimedia has allowed education to continue by providing flexibility beyond the physical classroom setting and at designated times. Although it is essential to understand the potential of multimedia learning for promoting education, further studies like this one are needed in measuring its effectiveness to determine future use and development (McAlpin et al., 2019).

The integration of behaviorism and Mayer's Cognitive Theory of Multimedia Learning offers a robust theoretical framework for the educational intervention in this study. The VER, incorporating these theoretical principles, serves as an engaging, interactive, and effective learning platform for managing cardiac arrest in pregnancy.

Purpose

This study examined the efficacy of two distinct instructional strategies, PowerPoint with voiceover and VER, relating to cardiac arrest in pregnancy. The intention was to assess the relative impacts of these modalities on knowledge acquisition, learner satisfaction, and self-confidence in managing concurrent maternal and neonatal resuscitation. Furthermore, this study also aimed to understand the influence of various demographic factors on knowledge. By conducting these focused inquiries, the study may contribute substantial insights to nursing education. The four principal aims this research were focused on is:

Aim 1 - To evaluate different teaching strategy interventions (PowerPoint with voiceover and VER) for increasing knowledge in cardiac arrest in pregnancy.

Aim 2 – To evaluate the effect of two different teaching strategies (PowerPoint with voiceover only or VER) on increasing learner satisfaction with the educational strategy on cardiac arrest in pregnancy.

Aim 3 - To evaluate the effect of two different teaching strategies (PowerPoint with voiceover only or VER) on increasing self-confidence in managing cardiac arrest in pregnancy.

Aim 4 - To determine if a post-test response is influenced by demographic variables (years of experience and nursing specialty) by nurses receiving the education on cardiac arrest in pregnancy.

Method

Study Design

This research adopted a quantitative approach, utilizing a randomized-controlled trial (RCT) design to compare two different teaching strategies. The study sample was drawn from experienced registered nurse new hires onboarded through an organization that has as a centralized onboarding center for several area hospital facilities.

Participants, Human Subjects Protection, and Setting

Using G-power version 3.1 with a medium effect size of .50 with an alpha of .05, power .80, the estimated sample size was determined to be a total of 128 participants, 64 per group. The study had a sample size of 130 participants, all of whom are registered nurses. All participants voluntarily chose to partake in this study, with the assurance that their decision would not affect their employment status. Eligible participants were those who had accrued more than one year of experience in an Intensive Care Unit (ICU), Emergency Department (ED), or inpatient obstetrical area.

Participants were informed about the study via a flyer at a hospital's centralized orientation offering detailing inclusion and exclusion criteria. Nurses interested in the study scanned the QR code on the flyer, which asked for an e-mail address to receive study surveys. Consent forms were collected and managed using REDCap electronic data capture tools hosted at Northwell Health. After consent was obtained, participants proceeded to complete the remaining surveys. Participants were screened using a demographics survey to confirm eligibility.

Study participants were informed that they were under no obligation to complete the study and could withdraw at any time without penalty. The contact information for both the principal investigator and the Institutional Review Board (IRB) was readily available on the consent form so that any questions or concerns participants had about the study could be addressed.

This study was granted approval from the (IRBs of Teachers College, Columbia University, and Northwell Health. The rigorous review processes at both respective institutions ensured the study's adherence to ethical guidelines and standards, as well as the protection of participant rights and welfare.

Intervention and Control Group Description

After they gave informed consent, eligible participants were randomly assigned to either the intervention group or the control group utilizing a randomization instrument.

The intervention group participated in the VER, a gamified multimedia learning experience designed to enhance knowledge and skills related to managing cardiac arrest in pregnancy. This group had the opportunity to interactively apply key concepts and problem-solving skills within a virtual simulation environment. The control group received a traditional

PowerPoint presentation with voiceover. This group accessed the same learning objectives as the intervention group, but the information was delivered in a traditional lecture-style format. Upon completion of all study surveys, participants received a \$30 Amazon gift card.

Intervention Development

The two education interventions, PowerPoint with voiceover and the VER were developed as independent learning activities by the principal investigator. Study participants were randomly assigned to engage individually with one or the other of these activities. Additional design details and learner experience are highlighted below:

1. PowerPoint with voiceover:

- Design: The design of PowerPoint included embedding images and having voiceover highlight content to the corresponding slide. Transition effects were utilized to enhance images appearing on slides. The lesson plan is outlined in Table 3.1.
- Learner Experience: Upon clicking the play button, the participant viewed the presentation length of recording over 15 minutes. No interactive teaching strategies were utilized.

Table 3.1*PowerPoint with Voiceover Lesson Plan*

Objectives	Content	Time Frame	Teaching Strategies	Learning validation Method
Describe the appropriate management and care of cardiac arrest in pregnancy by the end of the presentation.	Overview of AHA expectations for effective management for cardiac arrest in pregnancy	2.5 minutes	PowerPoint presentation with pictures and voiceover	None
Illustrate anatomical differences in administering cardiopulmonary resuscitation between pregnant and non-pregnant individuals.	Illustration of key anatomical variations in pregnancy and suggested differences in management of cardio-pulmonary resuscitation	2.5 minutes	PowerPoint presentation with pictures and voiceover	None
Recognize the indications for a perimortem cesarean delivery	AHA expectations and necessary preparations for perimortem cesarean delivery	5 minutes	PowerPoint presentation with pictures and voiceover	None
Discuss the management of the neonate immediately after delivery necessitating resuscitation	Neonatal Resuscitation Program recommendations for initial interventions and assessment for a neonate at delivery	5 minutes	PowerPoint presentation with pictures and voiceover	None

2. Virtual Escape Room:

- Design: The design of the VER included using Google Slides and Google Forms.

Upon entering the VER a YouTube timer video embedded into Google Slides automatically started a count-down. The principal investigator additionally used Videoscribe, a video animation software, to create videos embedded into the Google Slide that only played as clues or puzzles were solved. A total of seven videos were created, three on maternal resuscitation and four on neonatal

resuscitation. The lesson plan is outlined in Table 3.2. VER design map is outlined in Figure 3.2, and clues 2-5 are outlined in Figure 3.3.

- **Learner Experience:** Prior to clicking on the VER link the participant was aware that they were about to enter a VER activity. Upon clicking the link, the participant was given a scenario with instructions on how to engage in the VER (Figure 3.1). The allocated length of time to complete the VER activity was 15 minutes. A post-scenario four-minute video ending the unfolding case study concluded the experience. The total time for the VER intervention was 19 min.

Table 3.2*Virtual Escape Room Lesson Plan*

Objectives	Content	Time Frame	Teaching Strategies	Learning validation Method
Describe the appropriate management and care of cardiac arrest in pregnancy by the end of the presentation.	Overview of AHA expectations for effective management for cardiac arrest in pregnancy	- Unfolding Case Study, timing is user dependent - Cardiac Arrest in Pregnancy Video 1 (26 seconds)	- Unfolding Case Study - 1 Video Animation - Informational page with distinct information (clue for VER)	Knowledge-check (Cannot advance with VER without correct responses)
Illustrate anatomical differences in administering cardiopulmonary resuscitation between pregnant and non-pregnant individuals.	Illustration of key anatomical variations in pregnancy and suggested differences in management of cardio-pulmonary resuscitation	- Unfolding Case Study Timing is user dependent - Cardiac Arrest in Pregnancy Video 2 (26 seconds)	- Unfolding Case Study - 1 Video Animation - Informational page with distinct information (clue for VER)	Knowledge-check (Cannot advance with VER without correct responses)
Recognize the indications for a perimortem cesarean delivery	AHA expectations and necessary preparations for perimortem cesarean delivery	- Unfolding Case Study Timing is user dependent - Cardiac Arrest in Pregnancy Video 3 (48 seconds) - Cardiac Arrest in Pregnancy Video 4 (4 minutes)	- Unfolding Case Study - 2 Video Animations	Knowledge-check (Cannot advance with VER without correct responses)
Discuss the management of the neonate immediately after delivery necessitating resuscitation	Neonatal Resuscitation Program recommendations for initial interventions and assessment for a neonate at delivery	- Unfolding Case Study Timing is user dependent NRP Video 1(29 seconds) NRP Video 2 (39 seconds) NRP Video 3 (1 minute, 8 seconds) NRP Video 4 (26 seconds)	- Unfolding Case Study - 4 Video Animations - 2 pages with distinct information (clue for VER)	Knowledge-check (Cannot advance with VER without correct responses)

Figure 3.1

Virtual Escape Room Opening Screen

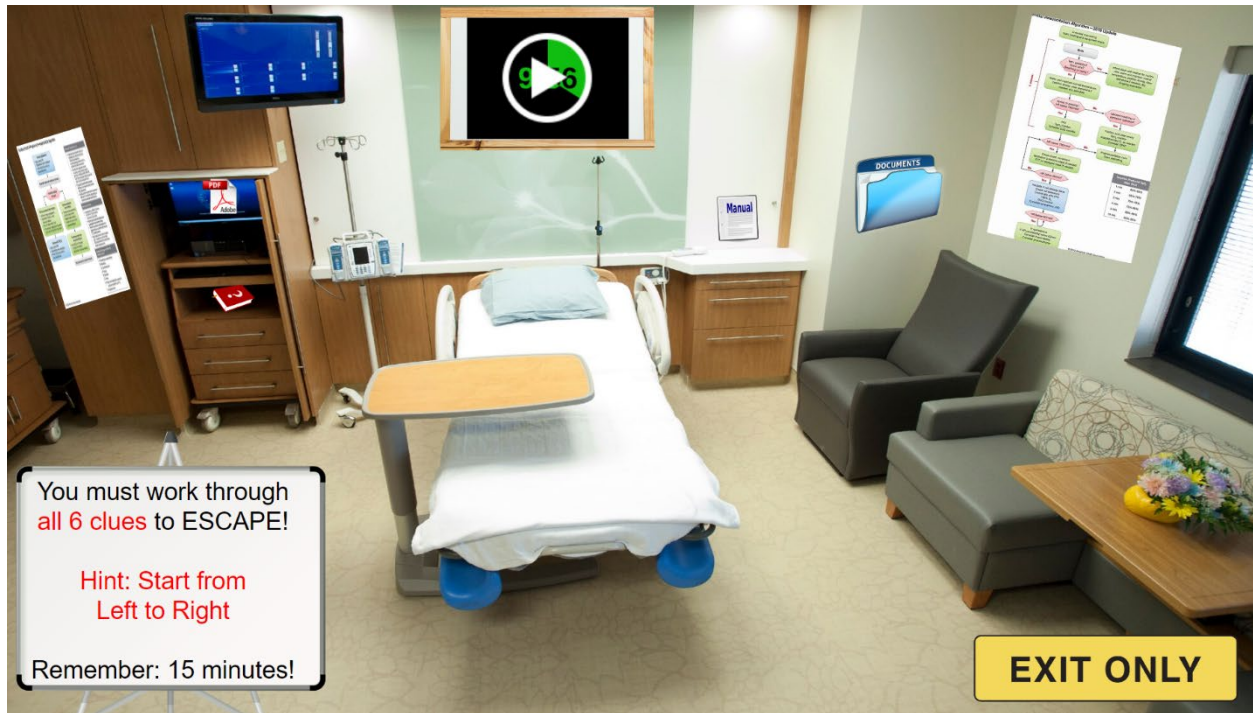


Figure 3.2

Escape Room Design Map

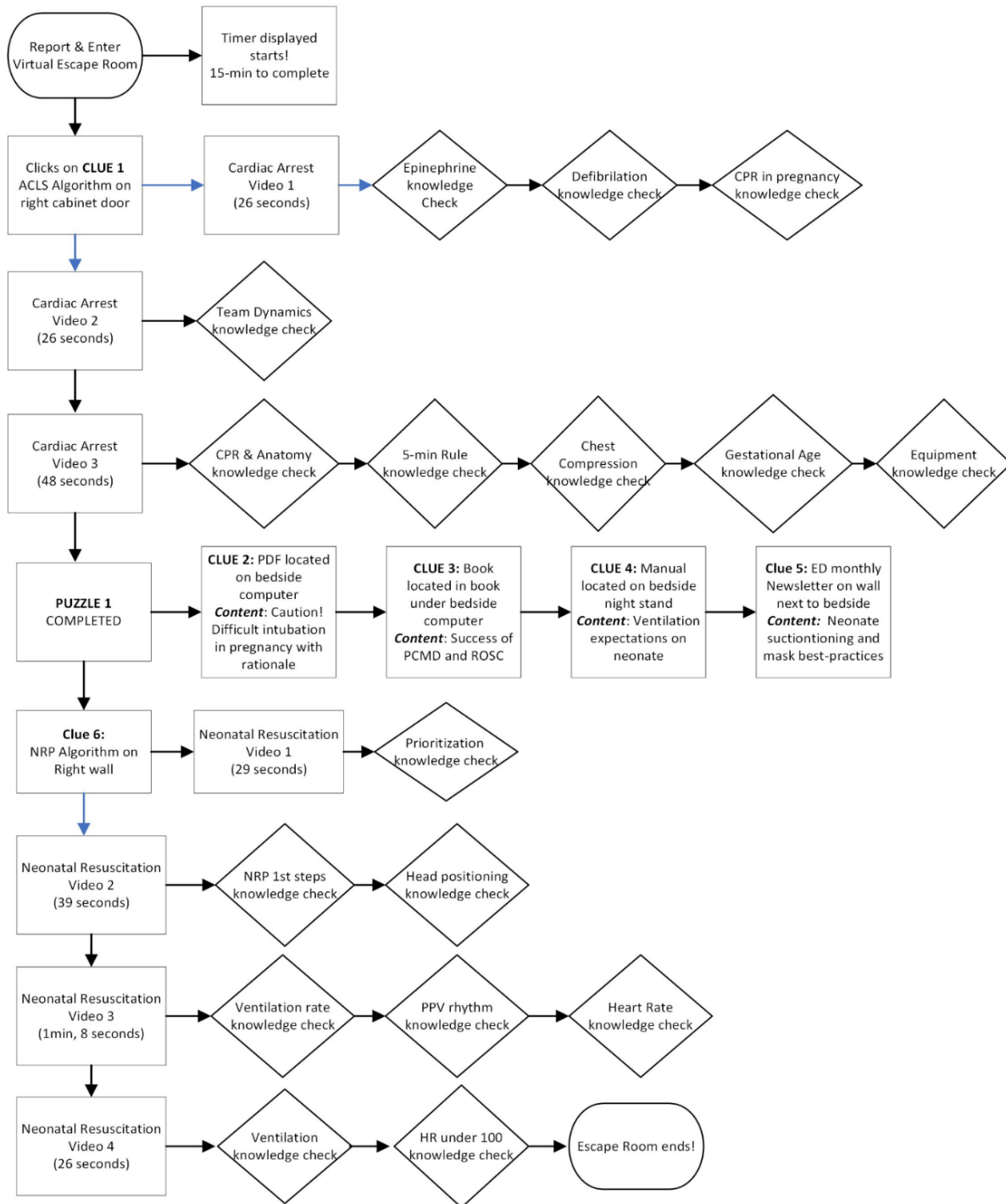


Figure 3.2


Escape Room Design Map Continued

Note. ACLS= Advanced Cardiac Life Support, CPR= Cardiopulmonary Resuscitation, PCMD= Perimortem Cesarean Delivery, ROSC= Return of Spontaneous Circulation, ED= Emergency Department, NRP= Neonatal Resuscitation Program, PPV= Positive Pressure Ventilation, HR= Heart Rate

Figure 3.3

Clues 2-5 of Virtual Escape Room

CLUE 2 OF 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!



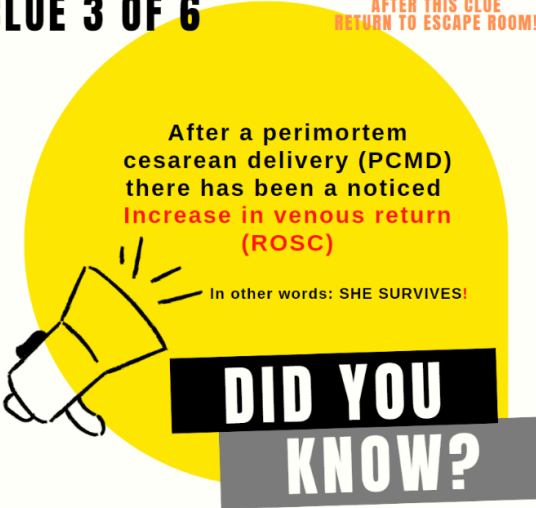
CAUTION

INCREASED airway edema and altered airway anatomy may predispose to **difficult intubation** in **PREGNANCY**

CLUE 3 OF 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!

After a perimortem cesarean delivery (PCMD) there has been a noticed **Increase in venous return (ROSC)**

In other words: SHE SURVIVES!



DID YOU KNOW?

CLUE 4 OF 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!

Deliver me here!



FILM NEGATIVE

P.S. If I don't look this cute when you first see me, VENTILATE me!



FILM NEGATIVE


CLUE 5 of 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!

EMERGENCY DEPARTMENT STAFF UPDATES

Monthly Newsletter : OB Focus Edition

BULB SUCTION

A bulb suction can cause a **BRADYCARDIA** due to eliciting a **vagal response!**
Use **ONLY** if needed
This is no longer routine practice.



CORRECT INCORRECT INCORRECT



CORRECT MASK

Last month's delay in effective ventilation was due to incorrect mask placement. Just like adults ensure a good seal and the mask is used correctly!

Instruments

Demographic Survey

A demographic survey was created for the study that included questions on age, gender, race, nursing specialty, years of experience, and previous education in cardiac arrest in pregnancy.

Knowledge (Pre-test/Post-test Questionnaire)

A knowledge quiz was developed to evaluate participants' baseline and post-intervention knowledge score in relation to key concepts of cardiac arrest in pregnancy and neonatal resuscitation. This pre-test/post-test was a 30-question knowledge quiz offered before and after the teaching strategy intervention. The first 15 initial questions address ACLS components in the management and care of cardiac arrest in pregnancy. The final 15 questions focus on critical concepts of neonatal resuscitation. The total of 30 questions was designed to assess participant knowledge on concurrent maternal and neonatal resuscitation (see appendix). A score of 100% indicates all questions were answered correctly, with each question being scored dichotomously, earning 3.33 points for a correct response.

This instrument comprised questions selected from the "Cardiac Arrest in Pregnancy" survey (Cohen et al., 2008). Additionally new items that tested the participants' knowledge in neonatal resuscitation were included aligning with the Neonatal Resuscitation Program (*Textbook of Neonatal Resuscitation, 8th Ed, 2021*). The selection of questions was tailored to the learning objectives of the educational intervention. In this study, Cronbach's alpha for the knowledge pre-test was .76 and for the knowledge post-test was .88.

This knowledge instrument underwent pilot testing with a group of 10 nurses who met the study's inclusion criteria. This preliminary stage served multiple purposes. Firstly, it helped

to estimate the length of time needed to complete the VER and the knowledge quiz, providing valuable data for planning, and scheduling the actual study. Secondly, it tested the difficulty level of the knowledge quiz, ensuring that the questions were challenging but not excessively difficult. Changes included correcting typos or having the automated grading feature in RedCap identify a correct answer as incorrect. The pilot study also identified process-related issues, such as incorrect timing of certain automated surveys in RedCap. By identifying these issues early, necessary modifications were made to enhance accuracy in data collection, thereby maximizing the study's success.

The National League for Nursing (NLN) Student Satisfaction and Self-Confidence

The NLN Student Satisfaction and Self-Confidence in Learning Scale measured learner satisfaction and self-confidence after participating in the educational intervention. This 13-item questionnaire is a series of statements about personal attitudes about the instruction received during a simulation activity. This NLN instrument was not modified, and learners experiencing either intervention were asked to consider their experienced teaching strategy when the term “simulation” was utilized. The scoring range on this scale is 1-5 rated on a 5-point Likert scale, with responses ranging from *Strongly Agree* to *Strongly Disagree* with a maximum score of 65. Each item represents a statement about attitudes toward satisfaction with learning and self-confidence in instruction offered. Nine clinical experts in nursing established content validity and reliability, tested using Cronbach's alpha, which was found to be 0.94 for Satisfaction with Learning and 0.87 for Self-Confidence in Learning (National League for Nursing, 2005). The Satisfaction with Learning scale is five items with a maximum score of 25, and the Self-Confidence in Learning scale is made up of eight items with a maximum score of 40. In this

study, Cronbach's alpha for the Satisfaction with Learning was .93 and for the Self-Confidence in Learning was .86.

Procedure

Once all permissions from Teachers College, Columbia University and Northwell Health. IRBs approvals were obtained, a pilot study was conducted. This identified any necessary process modifications (enrolling in the learning module, technical difficulties, etc.) to ensure the study's success. A flyer outlining the study and its eligibility criteria was disseminated to prospective participants. Participants were nurses onboarding via a centralized orientation program. The flyer was designed with a QR code that when scanned, prompted potential participants to provide their email addresses to receive additional study information, consent and offered compensation. Participants had the flexibility to complete the study either on-site during breaks in the orientation program or from home. The entire process was overseen and directed by the principal investigator, who held a leadership role in nursing education. Participation in the study was entirely voluntary and had no bearing on participants' assessments or their positions within their respective workplaces.

Following the consent process, participants completed the Demographic survey and knowledge quiz (pre-test) and an additional survey reported in another manuscript. Participants were randomly assigned to one of the two learning interventions: a PowerPoint presentation with voiceover or a VER. Randomization was completed via an instrument provided by the Feinstein Institute for Medical Research at Northwell Health. The subsequent procedures included the post-intervention NLN Student Satisfaction and Self-Confidence in Learning Scale and other instruments not discussed here. The post-test knowledge scale was released on Day 3 after the completion of the learning intervention (Table 3.3). Day 3 was selected to promote study

completion as this was the culmination of the centralized orientation program before new-hires transition to their respective hired institution’s orientation.

Table 3.3

Study Procedure

Demographics	Pre-Test Knowledge Quiz	Intervention	Student Satisfaction and Self-Confidence in Learning Scale	Post-Test Knowledge Quiz
Day 1	Day 1	PowerPoint with Voiceover	Day 1	Day 3
Day 1	Day 1	VER	Day 1	Day 3

Data Analysis

Descriptive statistics were generated to describe the sample.

Aim 1: To evaluate different teaching strategy interventions (PowerPoint with voiceover and VER) in increasing knowledge in cardiac arrest in pregnancy. A mixed ANOVA tested the interaction between group (VER and Traditional PowerPoint with voiceover) and time of test (knowledge pre/post-tests). If the interaction were significant, simple main effects tests using independent and paired-samples *t* tests were completed.

Aim 2: To evaluate the effect of two different teaching strategies (PowerPoint with voiceover only or VER) on increasing learner satisfaction with the educational strategy on cardiac arrest in pregnancy. An independent-samples *t* test identified differences in satisfaction scores between the teaching strategies.

Aim 3: To evaluate the effect of two different teaching strategies (PowerPoint with voiceover only or VER) on increasing self-confidence in managing cardiac arrest in pregnancy. An independent-samples *t* test assessed the relationship of self-confidence scores to the teaching strategy.

Aim 4: To determine if a post-test response is influenced by demographic variables (nursing specialty years of experience and nursing specialty) by nurses receiving the education on cardiac arrest in pregnancy. The following research questions were addressed:

- Are knowledge scores by nurses receiving education on cardiac arrest in pregnancy impacted by their years of experience? Pearson's *r* investigated the relationship between years of experience and knowledge scores.
- Are knowledge scores by nurses receiving education on cardiac arrest in pregnancy impacted by their nursing specialty? An ANOVA investigated the relationship between nursing specialty and knowledge scores.

Results

Demographics

The current study included a sample of 297 nurses, of which 167 individuals were excluded either because they did not meet the inclusion criteria ($n = 10$) or did not complete the study ($n = 157$). Thus, a total of 130 individuals completed the study. The results are summarized in Table 3.4. Non-significant differences were observed between the intervention and control groups on the demographic variables. Additionally, no significant demographic differences were found between participants who completed the study and those who did not.

Table 3.4*Demographic Characteristics*

Characteristic	<i>n</i>	%
Age in years		
20–29	43	33
30–39	56	43
40-49	22	16.9
≥50	9	6.9
Gender		
Female	103	79.2
Male	27	20.8
Race & Ethnicity		
African American/Black	19	14.6
Asian	15	11.5
Native Hawaiian or Pacific Islander	4	3.1
White	48	36.9
More than 1 Race	22	16.9
Other	5	3.8
Prefer not to say	7	5.4
Spanish, Hispanic or Latino	10	7.7

Note. *N* = 130

Specialty & Education Characteristics

Additional demographic questions included participant nursing specialty and education received in cardiac arrest in pregnancy. Results are summarized in Table 3.5.

Table 3.5*Specialty & Education Characteristics*

Characteristic	<i>n</i>	%
Nursing Specialty		
Critical Care	56	43.1
Emergency Department	31	23.8
Obstetrics	32	24.6
More than 1 specialty	11	8.5
Education in Cardiac Arrest in Pregnancy		
No previous education	70	53.8
Yes, received	60	46.2
Yes, with Concurrent Maternal and Neonatal Resuscitation	27	20.8
Yes, During ACLS/BLS course	25	19.23

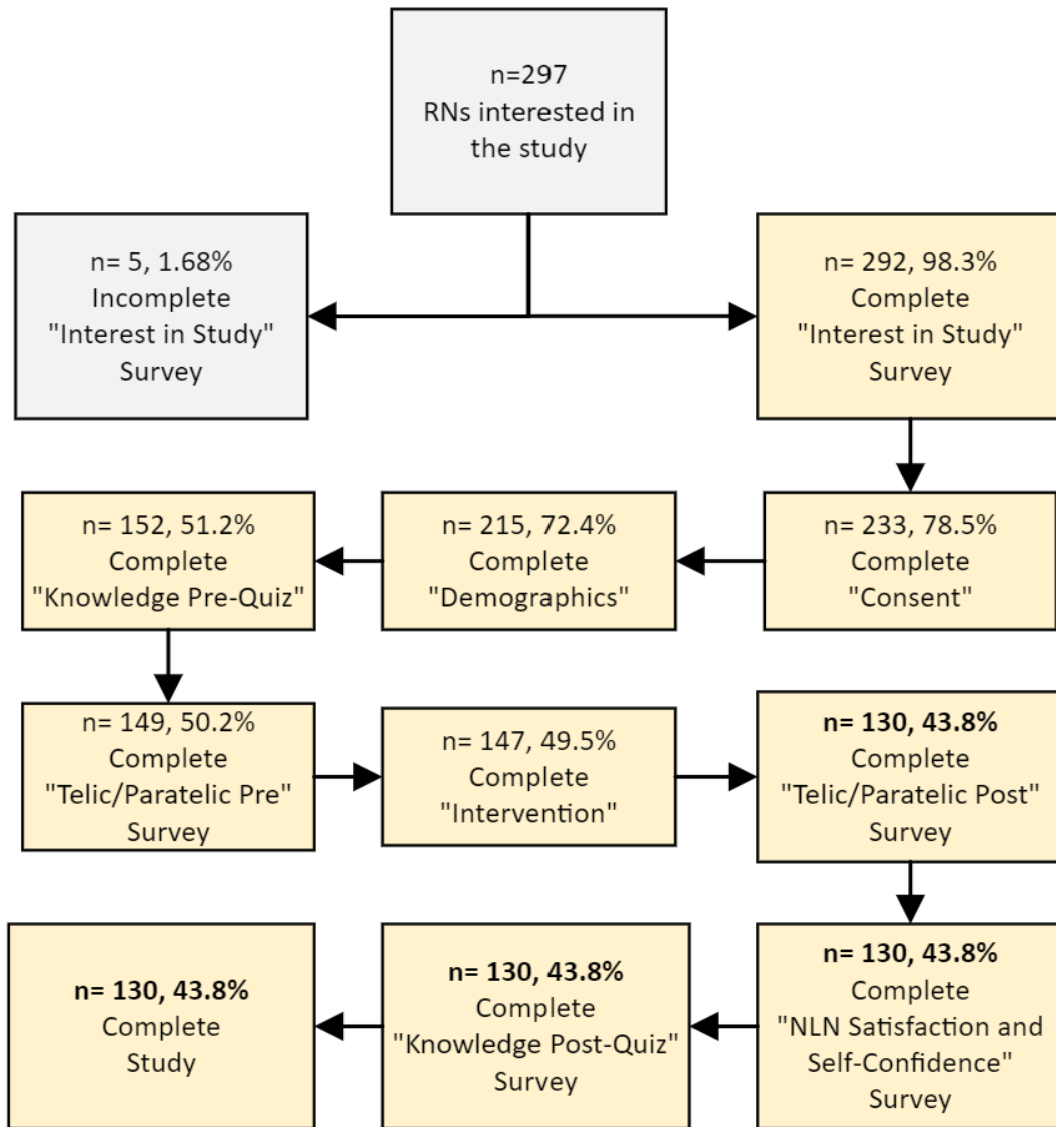
Note. *N* = 130

Attrition

Although 297 participants had an interest in the study, only 130 participants completed the study (43.8%). See Figure 3.4 that demonstrates attrition trend rates throughout the study. Participants who completed the study were primarily those who arrived early at the centralized orientation program, managing to finish most of the study on-site. It is believed attrition was higher when participants were unable to complete the study on-site. Although REDCap automatically sent reminders to participants to complete each survey, a significant portion of subject attrition occurred between the completion of the demographic survey and the knowledge pre-quiz.

Figure 3.4

Attrition



Findings

Descriptive statistics were generated to describe the sample. Findings are displayed in Table 3.6.

Table 3.6*Descriptives of Study Sample*

Variable	Control (n=130)		VER (n=65)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Knowledge Pre	59.58	16.30	58.51	17.35
Knowledge Post	68.24	17.42	77.67	20.95
Satisfaction	17.68	3.19	22.15	3.37
Self-confidence	30.69	3.99	33.63	5.00

N= 130

Hypothesis Tests

Aim 1 Hypothesis: Nurses receiving the VER teaching strategy intervention will have increased knowledge of cardiac arrest in pregnancy than nurses receiving the PowerPoint with voiceover only.

A mixed ANOVA revealed a significant interaction effect between the teaching method and time of test (pre vs post) on participants' knowledge scores, suggesting the impact of time on knowledge scores differed based on the teaching strategy used (Table 3.7). Figure 3.5 displays the marginal means. Furthermore, the within-subject test demonstrated a significant overall effect of time of test on knowledge scores from pre to post-test. The between subjects' effect was not statistically significant indicating that there was no significant difference in the average of the pre and posttest scores between the Traditional PowerPoint and the VER.

Simple main effects test were conducted to assess the impact of different teaching strategies on knowledge. Two independent samples *t* tests were completed to compare pre-test and post-test knowledge scores between the Traditional PowerPoint and VER groups. As illustrated in Table 3.8 comparison of pre-test knowledge scores between the Traditional PowerPoint and VER groups revealed no significant difference in mean scores. An independent

samples *t* test was conducted to compare post-test knowledge scores between the Traditional PowerPoint and VER groups. Results revealed a statistically significant difference in mean scores.

A paired-samples *t* test in the control group showed statistically significant mean difference between pretest and posttest scores resulting in increased knowledge in cardiac arrest in pregnancy (Table 3.9). Another paired-samples *t* test also showed that participants who received the VER teaching strategy had significantly higher knowledge post-test scores compared to their pretest scores.

The overall analysis revealed a significant interaction effect, indicating that the impact of time (pre-test vs. post-test) on knowledge scores varied depending on the teaching strategy employed. Both groups showed a significant improvement in knowledge scores from pre-test to post-test. Notably there was no significant difference in the average knowledge pre-test scores between the Traditional PowerPoint and VER groups before the intervention. However, after the intervention, we observed a significant difference in mean scores, with the VER being significantly more effective with higher knowledge scores than the PowerPoint with voiceover.

Table 3.7

Results of Mixed ANOVA on Knowledge Score

Variable	VER		Control		ANOVA				
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	Effect	F ratio	<i>df</i>	<i>p</i>	η^2
Knowledge									
Pre	58.51	17.35	59.58	16.30	Group	2.19	1,128	.14	.02
Post	77.67	20.95	68.24	17.42	Time	92.29	1,128	<.001	.42
<i>N</i>	65		65		G x T	13.15	1,128	<.001	.93

Note. ANOVA = Analysis of variance; VER= Virtual Escape Room; Control = Traditional PowerPoint group; η^2 = partial eta squared; G = group; T = time.

Figure 3.5

Estimated Marginal Means of Group

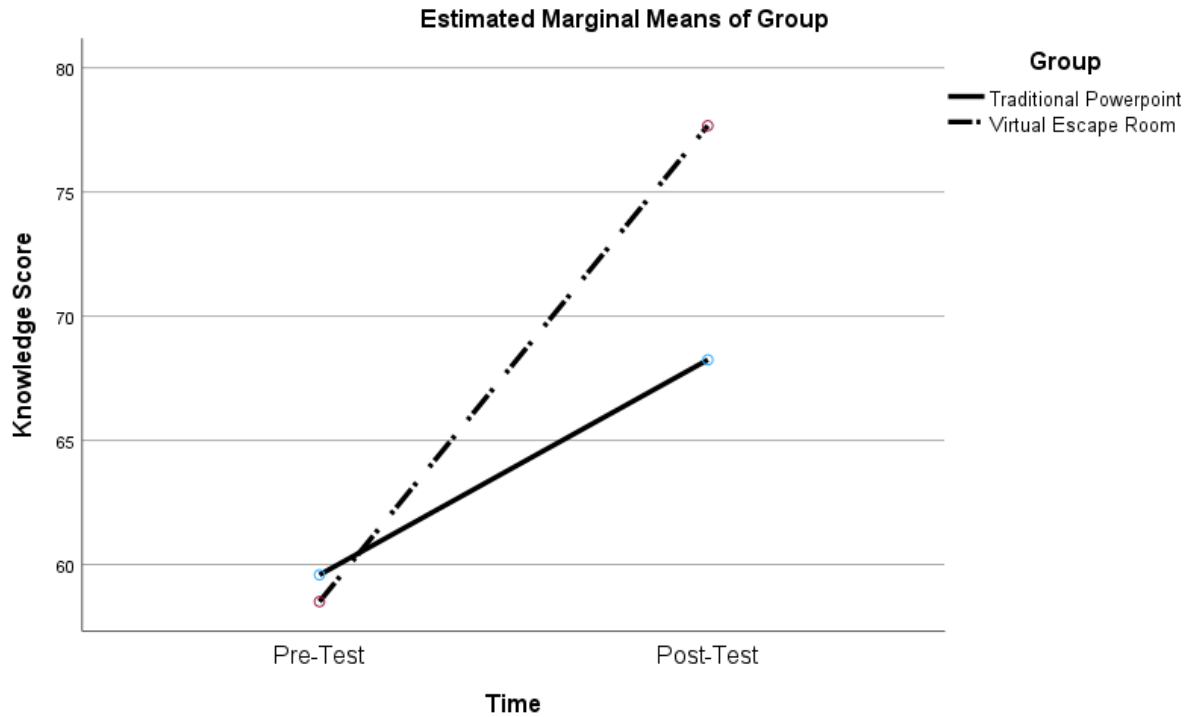


Figure 3.5. The graph illustrates the knowledge scores of participants in the Traditional PowerPoint (control group) and the VER (intervention group) before (Pre-Test) and after (Post-Test) the intervention.

Table 3.8

Independent Samples t tests Comparing VER and Control Group on Knowledge

	Mean Difference	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Pretest	1.08	0.36	128	.72	.06
Posttest	-9.43	-2.79	128	.01	-.49

Note. Equal variances assumed for both tests.

Table 3.9

Paired Samples t Tests Comparing Pre and Post Knowledge Scores for Intervention Group and Control Group

	Mean difference	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Intervention	-19.46	5.64	128	<.001	-0.97
Control	-8.66	-7.81	128	<.001	-0.70

Aim 2 Hypothesis: Nurses receiving the VER teaching strategy will have increased learner satisfaction with the educational strategy in cardiac arrest in pregnancy than nurses receiving the PowerPoint with voiceover only.

To test this hypothesis, an independent samples *t* test was conducted, comparing the mean satisfaction scores of the Traditional PowerPoint group ($M = 17.68, SD = 3.19$) and the VER group ($M = 22.15, SD = 3.37$). The findings revealed a significant difference between the groups, $t(128) = -7.77, p < .001$. The VER group reported significantly higher satisfaction scores compared to the Traditional PowerPoint group. This demonstrates the effectiveness of the VER strategy in enhancing learner satisfaction in this educational context.

Furthermore, the effect size, as indicated by Cohen's *d*, was substantial ($d = -1.36$), providing evidence of a large difference in satisfaction scores between the two groups in favor of the VER approach (95% CI [-1.74, -0.98]). These findings support the hypothesis, underscoring the potential of the VER teaching strategy in improving learner satisfaction in nursing education related to cardiac arrest in pregnancy.

Aim 3 Hypothesis: Nurses receiving the VER teaching strategy will have increased self-confidence in managing cardiac arrest in pregnancy than nurses receiving the PowerPoint with voiceover only.

This hypothesis was tested by comparing self-confidence scores between the groups receiving the two teaching strategies. The findings indicated a significant difference between the Traditional PowerPoint group ($M = 30.69$, $SD = 3.99$) and the VER group ($M = 33.63$, $SD = 5.00$), as indicated by a t test, $t(128) = -3.70$, $p < .001$. Nurses in the VER group exhibited significantly higher self-confidence scores than those in the Traditional PowerPoint group, with a mean difference of -2.94 (95% CI $[-4.51, -1.37]$).

Effect size measures further indicated a substantial effect of the VER teaching strategy on self-confidence scores, with Cohen's $d = -0.65$. These results support the hypothesis, highlighting the efficacy of the VER teaching strategy in enhancing self-confidence among nurses managing cardiac arrest in pregnancy compared to the traditional PowerPoint with voiceover method.

Aim 4 Hypothesis:

- a. Years of experience impacts post quiz knowledge scores by nurses receiving education on cardiac arrest in pregnancy.
- b. Nursing specialty impacts post quiz knowledge scores by nurses receiving education on cardiac arrest in pregnancy.

Regarding the influence of years of experience on knowledge scores, the results showed no significant correlation, $r(130) = 0.03$, $p = 0.78$. Thus, the first hypothesis suggesting an impact of years of experience on knowledge scores was not supported.

An analysis of variance (ANOVA) was conducted to investigate the relationship between nursing specialty and knowledge scores for nurses receiving education on cardiac arrest in

pregnancy. The ANOVA revealed a significant main effect of nursing specialty on knowledge scores ($F(3, 126) = 8.764, p < .001$). The effect size measures indicated a moderate effect of nursing specialty on knowledge scores, with an eta-squared of .173, suggesting that approximately 17.3% of the variance in knowledge scores can be attributed to nursing specialty. Multiple comparisons were performed to further understand the differences between nursing specialties. The Tukey Honestly Significant Difference (HSD) test revealed significant differences in knowledge scores between the Obstetrics specialty and both Critical Care (Mean Difference = -20.44, $p < .001$) and Emergency Department (Mean Difference = -15.90, $p = .004$). However, no significant differences were found among other pairs of specialties. Nurses in the obstetrics specialty exhibited significantly higher knowledge scores than those in Critical Care and Emergency Department specialties. A subsequent chi-square analysis investigated whether the intervention group had a higher proportion of obstetrics nurses than the control group, a finding that would also explain the superiority of the intervention knowledge scores. However, analysis showed no relation between specialty and group assignment, $\chi^2(3, N = 130) = 2.93, p = .402$. Twenty-three percent of the VER group were obstetrics nurses, while 28% of the Traditional group were obstetrics nurses.

Discussion

This study primarily focuses on comparing the efficacy of two teaching strategies, the VER, and the traditional PowerPoint with voiceover, in enhancing knowledge, learner satisfaction, and self-confidence among nurses managing cardiac arrest in pregnancy. These findings underscore the multifaceted impact of innovative teaching methods in nursing education. Furthermore, nursing years of experience and nursing specialty were considered to further understand how these demographic variables impact knowledge outcomes.

The VER teaching strategy, which incorporates elements of gamification, outperformed the traditional PowerPoint approach in knowledge acquisition, learner satisfaction, and self-confidence. Additionally, it is important to note that both groups showed a statistically significant increase in knowledge, but by the end of the study, the VER group demonstrated greater improvement despite starting with similar knowledge levels to that of the traditional group. This aligns with existing evidence supporting virtual escape rooms as effective tools for improving nursing students' knowledge and confidence in patient care and safety concerns (Vestal et al., 2021). Educational methodologies aimed at fortifying participant confidence can play a pivotal role in promoting the execution of appropriate resuscitative interventions and facilitating the acquisition of expertise (Monod et al., 2014). Gamification, exemplified by the VER, has gained validation from numerous studies, promoting engagement, knowledge retention, and the acquisition of critical competencies (Anguas-Gracia et al., 2021). Escape rooms, whether physical or virtual, have been recognized for fostering enjoyment, motivation, teamwork, communication, and critical thinking (Reinkemeyer et al., 2022). These studies and this study's findings advocate for the integration of VER teaching strategies, highlighting their superior capability to enhance learner satisfaction, confidence, and knowledge retention compared to traditional methods.

Additionally, this study identified the significant impact of nursing specialty on knowledge acquisition, particularly among nurses who specialize in obstetrics. It is worth noting that the study's pre and post-knowledge test questions were divided equally between maternal resuscitation and neonatal resuscitation, which may account for higher knowledge scores observed in obstetric nurses. Given their expertise in caring for both mothers and newborns, obstetric nurses may have had an advantage. Acknowledging that some specialties inherently

encompass a different range of knowledge and skills, it becomes imperative to design personalized approaches. These findings stress the importance of adopting nuanced and individualized educational strategies that can effectively address the diverse requirements of nurses in the clinical professional development setting as compared to the academic setting. Regrettably, the existing literature lacks robust studies in nursing professional development focusing on knowledge outcomes in escape rooms. In a recent integrative review of escape rooms in nursing education by Reinkemeyer, Chrisman, and Patel (2018), only one of the 18 studies reviewed was noted to be in a clinical professional development setting. Consequently, this study makes an important contribution to filling this gap.

Furthermore, the study explored the impact of demographic variables such as nursing specialty and years of experience. While most nursing specialties did not differ on knowledge scores, nurses in the obstetrics specialty exhibited significantly higher knowledge scores than those in critical care and emergency department specialties. This highlights the complex nature of knowledge acquisition, where individual experience and the effectiveness of educational interventions play pivotal roles. These insights are crucial for the development of future educational interventions tailored to the unique needs and preferences of diverse learners. The VER teaching strategy not only yielded statistically significant findings in terms of knowledge, satisfaction, and self-confidence but also holds immense promise for nursing educators in preparing nurses to meet the multifaceted and dynamic challenges such as in cardiac arrest in pregnancy.

Limitations

The focus of the study is solely on a specific sample of nurses in clinical professional development, potentially limiting the findings' generalizability to other healthcare professionals

or educational contexts. The analysis did not account for potential confounding variables that might influence knowledge scores, such as educational background (i.e., BSN, MSN, etc.). Furthermore, the use of a cross-sectional design captures only a snapshot of knowledge scores at a specific point in time, limiting our understanding of knowledge score retention. Future research should aim to address these issues to enhance the generalizability and validity of the findings. Attrition throughout the study, as visualized in Figure 3.4, underscores the challenge in retaining participants from initial interest to study completion, with varying completion rates across different surveys. Although attrition may have been related to participants' ability to complete surveys on-site, future studies should consider these limitations and design methodologies to mitigate such challenges.

Despite these limitations, this study provides valuable contributions with identified strengths. This study is notably robust due to the use of random assignment to eliminate potential biases and enhance the reliability of its conclusions. The employment of validated instruments reinforces the accuracy and dependability of the data obtained. Lastly, this study achieved adequate power, increasing the sensitivity to effect sizes and allowing for more definitive interpretations. These strengths together elevate the study's reliability of its findings.

Conclusion

The VER's inherent interactivity encourages problem-solving in a risk-free environment. Its adaptability to diverse learning styles may lead to enhanced knowledge retention. As technology becomes more integrated into healthcare, adopting digital platforms in education can better prepare nurses to manage complex clinical environments in cardiac arrest in pregnancy. Despite study limitations, the insights gained support the integration of innovative, technology-driven methods like VER, ensuring healthcare education remains current, dynamic, and

effective. This study sets the groundwork for future research to further validate these findings and promises a significant positive impact on the evolution of healthcare education strategies.

The VER teaching strategy outperformed the Traditional PowerPoint approach in enhancing knowledge scores, improving learner satisfaction, and fostering self-confidence among nurses handling cardiac arrest in pregnancy with concurrent maternal and neonatal resuscitation. The VER teaching strategy not only yielded statistically significant findings, but also holds immense promise for nursing educators in preparing nurses to meet the multifaceted and dynamic challenges inherent to the healthcare profession.

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Chapter 4

Puzzling Out the Correlates of Learner Engagement and Exploring Motivational States

Within a Virtual Escape Room

Background

Cardiac arrest in pregnancy is a critical event requiring a response within healthcare that necessitates comprehensive understanding, specifically in the context of concurrent maternal and neonatal resuscitation. An effective pedagogical approach is essential for advancing nursing knowledge and practice. This is particularly true when addressing the nurse's pivotal role in patient safety, which encompasses identifying safety risks and implementing timely interventions (Vestal et al., 2021). This manuscript explores the correlates of learner engagement, and motivational states (telic/paratelic state) within an innovative Virtual Escape Room (VER). While traditional strategies have been effective, VERs have emerged as a gamified teaching strategy, capturing the potential of enriching learning experiences. However, the full scope of VER's impact, especially in nursing professional development, remains under exploration.

Within the innovative educational landscape, gamification, or the integration of game-like elements into learning, has emerged as a mechanism for engaging students. The validity of gamification, especially escape rooms, in fostering professional competencies in higher education is increasingly recognized (Anguas-Gracia et al., 2021). Within the field of nursing, VERs align with the broader trend towards digitization in healthcare, offering immersive and interactive experiences that promote problem-solving and critical thinking. Gamification mirrors the paratelic (playful-oriented) motivational state, providing enjoyment and a different approach to engaging with educational content. The direct impact of learner engagement on success and satisfaction has been noted to improve performance in nursing students (Ferrer-Sargues et al.,

2021). Understanding the role of the telic/paratelic pair of states within clinical professional development in nursing education is useful for recognizing the correlates of learner engagement and gamified teaching strategies.

Understanding teaching strategies and paratelic motivational states is essential in the context of education. While telic motivation emphasizes goal-oriented behavior and task completion, paratelic motivation focuses on the immediate experience and enjoyment of the process (Apter, 1982). Recognizing the balance between these states allows for the creation of an educational environment that harmonizes achievement with pleasure in learning. This alignment is significant in preparing nurses for their role in healthcare.

This manuscript provides a comprehensive analysis of the correlates of learner engagement in an innovative VER. By investigating the impact of VERs on knowledge acquisition and juxtaposing this with metrics like engagement and the telic/paratelic state we acquire invaluable insights into the relationships among these variables. This exploration not only contributes empirical data to nursing education but also underscores the importance of integrating both traditional and modern pedagogical tools. Weaving together elements such as learner engagement, motivational states, gamification, and outcome measurements, this manuscript positions itself as a contribution to paving the way for further research into gamified education strategies.

Literature Review

Virtual Escape Room (VER)

Escape rooms are immersive games where participants navigate high-stakes scenarios by completing various puzzles and riddles. The surge in incorporating escape rooms within educational settings is supported by studies indicating their potential. For instance, García-Viola

et al. (2019) highlighted that gamification, notably through escape rooms, plays a pivotal role in fostering decision-making capabilities in nursing education. Similarly, Anguas-Gracia et al. (2021) affirmed the effectiveness of gamification, especially escape rooms, in bolstering professional skill acquisition. Emphasizing the value of such innovative pedagogies, Ferrer-Sargues et al. (2021) observed that escape room interventions often elevate knowledge levels and enhance learner satisfaction. Through game-centric learning, both educators and students interact with educational content in unique ways, leading to heightened engagement and learning outcomes. Adams et al. (2018) further substantiated these findings, noting that escape rooms can notably boost confidence, critical thinking, and communication abilities in learners. These findings collectively advocate for the integration of cutting-edge tools like escape rooms within the nursing educational framework.

Gamification

Gamification, a pedagogical strategy characterized by game-like elements, has emerged as a compelling technique in nursing education. A systematic literature review by Tavares (2022) discussed that escape rooms promote learner engagement and motivation amongst nursing undergraduate students. These findings suggest that integrating game-like elements as a teaching strategy can augment and enhance the learner's experience. However, in another systematic review, Min (2022) discussed mixed results due to limited sample sizes in determining effectiveness of serious games in nursing education for increasing knowledge and improving performance.

In elevating standards of research in gamification, Orsoni (2023) discussed the significance of establishing methodological protocols in gamification applications. Robust research methodologies and protocols are essential components for comprehensively assessing

the effects of gamified teaching strategies on learner engagement and educational outcomes to ensure that the nuances of gamification's impact are adequately explored (Orsoni et al., 2023). To advance our understanding of the multifaceted relationship between gamified teaching strategies and nursing students' learning experiences, it is imperative to consider mechanisms underlying why gamification works. Such practices can contribute valuable empirical data that not only inform but also refine the ongoing development and implementation of gamification in nursing education (Orsoni et al., 2023).

Knowledge, Satisfaction and Self-Confidence

The rise in the popularity of VERs in education, paired with their promising outcomes, certainly calls for more in-depth research. Lyman (2022) highlighted that nurses who participated in these virtual sessions not only found considerable satisfaction but also gained enhanced self-confidence. Interestingly, Lyman's research from 2002 showed that these virtual setups can be just as effective in delivering education as traditional face-to-face sessions. In a separate study by Adams et al. (2018), it was found that both novice and seasoned nurses succeeded in the challenge, with each one effectively navigating their way out of the room. This success wasn't merely a game achievement; it indicated a boost in knowledge and heightened confidence, reinforcing the educational significance of the VER (Adams et al., 2018).

Additionally, other domains like behavioral health are tapping into the potential of VERs. They serve as a potent teaching method, especially in altering views on severe mental illness (SMI) among learners. Research has shown that employing escape rooms has led to a marked reduction in negative perceptions of SMI, especially when compared to groups that didn't partake in the escape room activities (Rodriguez-Ferrer et al., 2022). Drawing from this evidence, it is clear that VERs play a pivotal role in enhancing knowledge, satisfaction, and self-confidence

among participants. As such, VERs stand out as a valuable innovation in modern educational methodologies.

Theoretical Frameworks

Three theoretical frameworks guided this study.

Reversal Theory's Telic/Paratelic States

Reversal theory, a lens into personality and motivation, delves into the intricacies of human experiences and the dynamic interplay between an individual and a specific context (Martin et al., 1987). This theory introduces various meta-motivational states, among which the telic-paratelic duality stands out as foundational (Apter, 1982). At any given moment, an individual is influenced by either the telic state, characterized by a goal-driven, serious demeanor, or the paratelic state, marked by spontaneity and playfulness (Apter, 1982). The relevance of reversal theory in this research stems from its alignment with the study's objectives. While the content predisposes learners to adopt a telic (serious-minded) orientation, the VER could potentially stimulate a paratelic mindset (playful orientation), subsequently influencing educational outcomes. By weaving in the insights from reversal theory, this research aims to illuminate the nuanced effects of melding telic and paratelic educational environments. Recognizing the potential psychological shifts elicited by a learning tool is paramount, especially as game-based approaches gain momentum in nursing education. Typically, managing acute emergencies demands a telic stance. But this investigation seeks to discern whether the VER is more likely to induce the paratelic state over the telic state, and whether one state is aligned with more learner engagement than the other.

Behaviorism

Behaviorism positions the educator at the center of the learning process, orchestrating the environment, formulating specific cues or stimuli, and crafting reward structures to bolster desired behaviors while diminishing undesirable ones (Kay & Kibble, 2016). From a behaviorist perspective, learners are perceived as reactive entities, greatly influenced by environmental variables, with their primary role being to react fittingly to these external prompts, thereby earning the respective rewards for desired behaviors.

In this context, this study employed behaviorism as its foundational theoretical framework, focused on the premise that individuals' actions are molded through environmental stimuli, leading to reinforcement of established routines, procedures, and guidelines (Merriam & Bierema, 2014). The instructional interventions within this study concern cardiac arrest during pregnancy, integrated with maternal and neonatal resuscitation guidelines. The behavioral expectation is for participants to align their responses with the established guidelines set forth by the American Heart Association, bypassing their innate instincts. Established protocols like Advanced Cardiac Life Support (ACLS), Basic Life Support (BLS), and the Neonatal Resuscitation Program (NRP) equip medical practitioners with standardized reactions to emergencies. Central to behaviorist thought is the conviction that satisfying outcomes fortify and reinforce behaviors, a principle termed operant conditioning (Ansar et al., 2021). Within the context of this research, the design of the VER aligns with this principle of operant conditioning; Participants are required to give accurate answers to advance in the VER experience.

The VER offered participants an immersive, simulation-like setting. Positive behavioral reinforcements were experienced when they were aptly engaged with the presented challenges, facilitating their progression. Missteps went unrewarded. As behaviorists posit, supported or

disregarded behaviors are respectively intensified or attenuated (Merriam & Bierema, 2014). This study's VER aimed to emphasize behaviors conducive to improving maternal and neonatal outcomes during a maternal cardiac arrest. Through the lens of behaviorism, the VER evaluated participants' actions (responses) in reaction to environmental prompts (stimuli). Such evaluations provided invaluable insights into knowledge acquisition, satisfaction, self-assuredness, and learner involvement (Kay & Kibble, 2016). In essence, the VER encouraged learner participation, via resolving puzzles and clues essential for a successful exit.

Mayer's Cognitive Learning Theory

Another foundational theory guiding the creation of the VER intervention, specifically its video animation elements, was Mayer's cognitive theory of multimedia learning. The VER teaching strategy integrated video animations, puzzles, and questions, and stimulated both auditory and visual senses having offered an immersive and simulation-like experience. Central to Mayer's theory was the "multimedia principle," suggesting that a combination of words and pictures fosters more effective learning than using words alone (Mayer, 2009). Moreover, Mayer (2009) posited that learning is an active engagement process, emphasizing three core assumptions: (1) two distinct channels process information - auditory and visual, (2) each channel has a limited capacity, and (3) active participation is paramount in learning. Understanding Mayer's theory was crucial in shaping an optimal learning environment for participants to evaluate the efficacy of VERs in nursing education.

In recent times, the integration of multimedia in nursing education has expanded, warranting an examination of outcomes derived from such digital platforms. Multimedia, as defined by Clark & Mayer (2016), is an amalgamation of sounds, graphics, text, and animations leveraging computer technology to curate compelling instructional materials. A pivotal aspect of

this multimedia principle and its three tenets is the concept of cognitive load. Straining either the visual or auditory channel can hinder the learning process (McAlpin et al., 2019). Hence, delivering content in a balanced manner is vital for ensuring deep and effective learning. As per a literature review by Chin-Soon (2020), multimedia learning tools that utilized animations accompanied by narration are more effective than merely presenting on-screen text. In line with Chin-Soon's findings, it is recommended that minimize on-screen text be minimized to avert overloading the visual channel and working memory (Chin-Soon, 2020). This guidance was adhered to during the design phase of the VER incorporating short video animations (spanning 30-60 seconds). While recognizing the immense potential of multimedia in elevating education is crucial, it is imperative to pursue additional research, to ascertain its efficacy and inform its future trajectory (McAlpin et al., 2019).

Conceptual Framework

In the context of this study investigating learner engagement within the VER, a series of assumptions have been developed, offering insight into the anticipated relationships between various key variables. The variables encompassed within this framework include knowledge, satisfaction, self-confidence, and the paratelic state (associated with playfulness), as well as overall engagement, which is further explored with distinct subscales.

In this manuscript, we focus specifically on the subscales of overall engagement, which are originally defined by Epmann et al. as GAMEX dimensions encompassing enjoyment, absorption, creative thinking, activation, absence of negative affect, and dominance. Each of these subscale items encapsulates specific facets of the learner's experience during a gaming activity, aligning with Epmann et al.'s delineations:

- **Enjoyment:** Reflects the pleasure derived from engaging in the activity.

- **Absorption:** Represents the immersion and presence within the activity.
- **Creative Thinking:** Involves imagination and the sense of adventure experienced in the activity.
- **Activation:** Represents feelings of excitement and anticipation during the activity.
- **Absence of Negative Affect:** Pertains to the mitigation of frustration and negative emotions during the activity.
- **Dominance:** Relates to the learner's sense of influence and autonomy within the activity.

The following provides a summary of assumptions, offering a structured framework for understanding the relationships and expectations surrounding these variables within the context of the study. Refer to Figure 4.1 for an illustration.

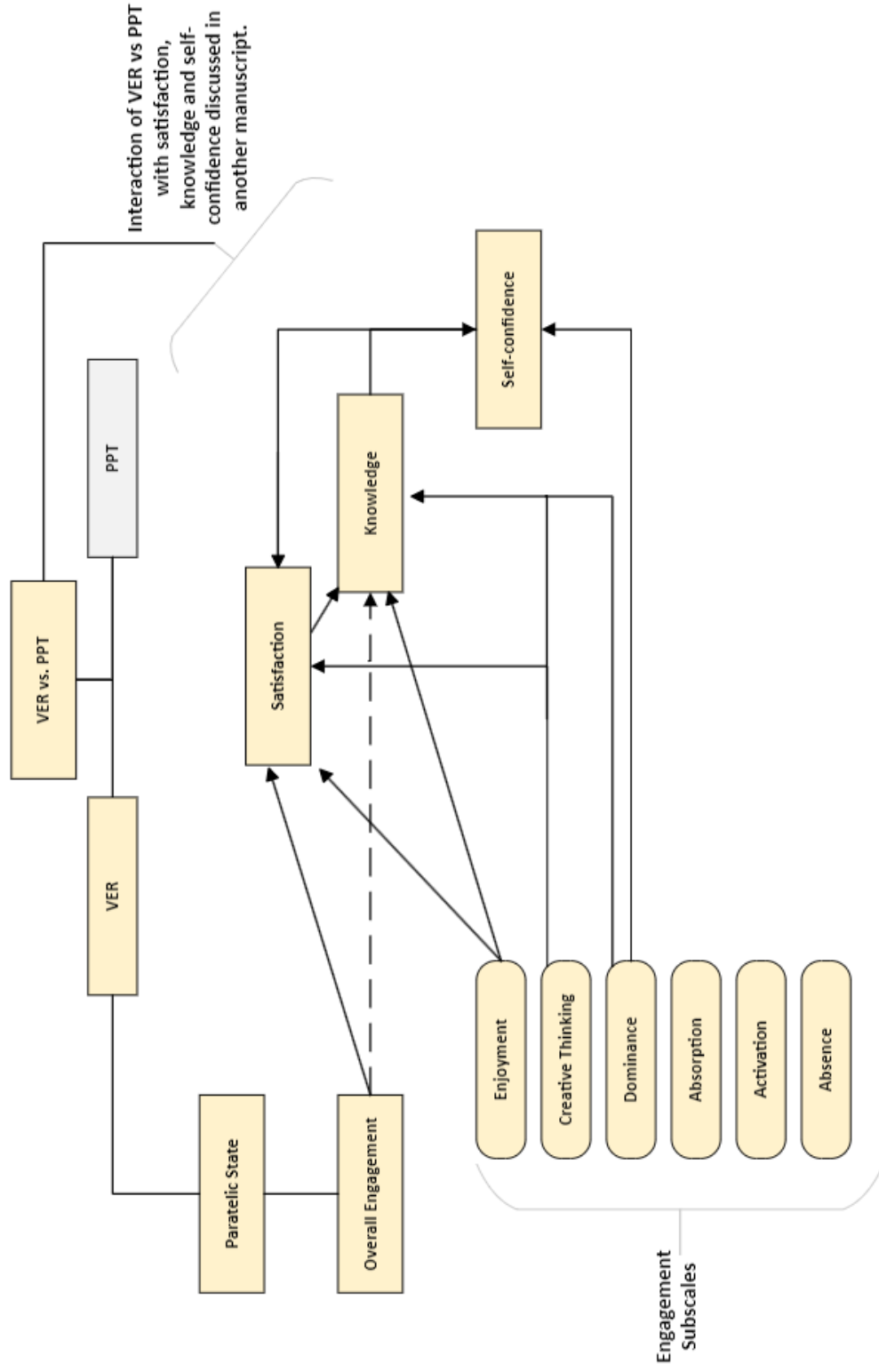
1. ***Paratelic State and Overall Engagement:*** It was assumed that the presence of a paratelic state, characterized by playful behavior, would have a positive influence on overall engagement. This suggested that learners in the VER who are in a paratelic state would likely exhibit higher levels of engagement.
2. ***Overall Engagement and Outcomes:*** Overall engagement was expected to play a pivotal role, positively impacting both satisfaction and knowledge. This implied that a heightened level of engagement within the VER would be positively correlated with increased learner satisfaction and enhanced knowledge acquisition.
3. ***Enjoyment:*** Enjoyment was anticipated to contribute positively to both satisfaction and knowledge stemming from the belief that learners who derived enjoyment from the VER would report elevated levels of satisfaction and demonstrate a greater propensity for knowledge acquisition.

4. ***Creative Thinking:*** Creative thinking was presumed to have a positive correlation with both satisfaction and knowledge. The underlying assumption suggested that learners engaged in creative thinking during the VER experience would be more likely to report heightened satisfaction levels and display improved knowledge retention.
5. ***Dominance:*** Representing a sense of control or autonomy, Dominance was expected to positively impact knowledge and self-confidence. The belief was that learners exhibiting dominance within the VER would be likely to acquire more knowledge and experience heightened self-confidence.
6. ***Satisfaction:*** It was hypothesized that learners reporting higher levels of satisfaction within the VER would also exhibit increased knowledge acquisition and an enhanced sense of self-confidence.
7. ***Knowledge:*** This assumption implies that learners who gain a deeper understanding from their VER experience would be more likely to report higher levels of satisfaction and an increased sense of self-confidence.

Absorption, Activation, and Absence of Negative Affect, as components of overall engagement, were not expected to have direct positive or negative correlations with the other major study variables (satisfaction, knowledge, self-confidence). These assumptions collectively form a structured conceptual framework, providing direction for understanding the interplay between the identified variables in the context of this study. They served as foundational pillars upon which hypotheses were formulated to guide the analytical approach for interpreting the correlates of learner engagement.

Figure 4.1

Illustration of Conceptual Framework



Note. The dashed line indicates a hypothesized relationship that was not supported.

Purpose

The purpose of this study was to investigate the correlates of learner engagement on satisfaction, knowledge, self-confidence and the telic/paratelic state. This study aimed to offer valuable insights into the VER as a teaching strategy in nursing education and focused primarily on two main aims:

Aim 1- To investigate variables associated with learner engagement in the VER. The following hypotheses and research question were addressed: To what extent are knowledge scores related to learner engagement?

Hypotheses:

1. There is a significant positive relationship between the paratelic state and engagement.
2. Engagement is positively correlated with satisfaction.
3. Engagement positively affects self-confidence.
4. Engagement is positively associated with knowledge acquisition.

Research Question: Are the demographic variables of age, race/Hispanic ethnicity, nursing specialty, years of experience, and previous education on cardiac arrest during pregnancy, related to learner engagement in the VER?

1. Is there a significant relationship between learner age and engagement levels in the VER?
2. Are there statistically significant differences in engagement levels among different racial groups in the VER?
3. Is nursing specialty related to learner engagement in the VER?

4. Does previous education on cardiac arrest during pregnancy have a statistically significant effect on learner engagement?

Aim 2: To examine the influence of the VER vs. traditional PowerPoint on learners'

Telic/Paratelic motivational scores (Higher scores signify a paratelic state, whereas lower scores indicate a telic state).

Research Question: How does educational intervention influence the motivational state score from pre-intervention to post-intervention?

Method

Study Design

Utilizing a quantitative methodology, this research employed a randomized-controlled-trial (RCT) design to evaluate and contrast two distinct teaching strategies. The participants in the study were experienced registered nurses who had been newly hired and onboarded through a centralized organization serving several hospital facilities in the area.

Participants, Human Subjects Protection, and Setting

This study had a sample size of 130 participants, all of whom are registered nurses with greater than 1 year of nursing experience. Using G-power version 3.1 with a medium effect size of .50, an alpha of .05, and power .80 the optimal sample size was determined to be 128 total participants, split into two groups of 64 each. Participation in the research was voluntary, and involvement (or lack thereof) had no effect on their job status or performance. Eligible participants included nurses with over a year's experience in Intensive Care Units (ICU), Emergency Departments (ED), or inpatient obstetrical areas.

Information for research participation was disseminated through a flyer during a hospital's centralized orientation offering, detailing inclusion and exclusion criteria. Prospective

participants could express their interest by scanning a QR code on the flyer, which would then prompt them to provide an email address to receive pertinent study-related surveys. The RedCap platform facilitated the completion of the electronic consent form. After obtaining consent, participants progressed to fill out subsequent surveys. An initial demographics survey was employed to verify their eligibility.

Study participants were informed that they were under no obligation to complete the study and could withdraw at any time without penalty. The contact information for both the principal investigator and the Institutional Review Board (IRB) was readily available on the consent form so that any questions or concerns participants had about the study could be addressed. The Institutional Review Boards at both Teachers College, Columbia University, and Northwell Health granted approval. The rigorous review processes at both respective institutions ensured the study's adherence to ethical guidelines and standards, as well as the protection of participant rights and welfare.

Intervention and Control Group Description

Upon obtaining informed consent, eligible participants were randomized into either the intervention or control group using a specialized randomization instrument. Those in the intervention group received the VER, a learning experience designed to enhance knowledge and skills related to managing cardiac arrest in pregnancy. This group had the opportunity to interactively apply key concepts and problem-solving skills within a virtual simulation-like environment. In contrast, the control group was presented with the traditional PowerPoint presentation complemented by voiceover narration. At study completion, after completing all respective surveys, each participant was rewarded with a \$30 Amazon gift card.

Intervention Development

The principal investigator designed and created two different learning activities. Nurses were randomly assigned to engage individually with one or the other of the activities: Traditional PowerPoint with voiceover and the VER. Additional design details and learner experience are highlighted below:

1. Control Group (Traditional PowerPoint):

- **Design Details:** The Traditional Power Point format was enriched with visual aids, and the voiceover was synchronized with respective slides. Transitions were also employed to boost the visual appeal of images on slides. The lesson's structure is demonstrated in Table 4.1.
- **User Experience:** After pressing the 'play' option, participants watched the voiceover presentation, which spanned over a duration of 15 minutes. This method did not incorporate any interactive pedagogical techniques. The learner's experience was characterized by slides populated with text accounting for roughly 50% of the content space, complemented by a few illustrations. The entirety of the traditional PowerPoint was overlaid with a voiceover.

Table 4.1*Traditional PowerPoint with Voiceover Lesson Plan*

Objectives	Content	Time Frame	Teaching Strategies	Validation Method
Describe the appropriate management and care of cardiac arrest in pregnancy by the end of the presentation.	Overview of American Heart Association expectations for effective management for cardiac arrest in pregnancy	2.5 minutes	PowerPoint presentation with pictures and voiceover	None
Illustrate anatomical differences in administering cardiopulmonary resuscitation between pregnant and non-pregnant individuals.	Illustration of key anatomical variations in pregnancy and suggested differences in management of cardio-pulmonary resuscitation	2.5 minutes	PowerPoint presentation with pictures and voiceover	None
Recognize the indications for a perimortem cesarean delivery	American Heart Association expectations and necessary preparations for perimortem cesarean delivery	5 minutes	PowerPoint presentation with pictures and voiceover	None
Discuss the management of the neonate immediately after delivery necessitating resuscitation	Neonatal Resuscitation Program recommendations for initial interventions and assessment for a neonate at delivery	5 minutes	PowerPoint presentation with pictures and voiceover	None

2.VER:

1. Design Details: The VER was crafted using Google Slides and Google Forms platforms. A YouTube timer video was integrated into Google Slides and initiated a countdown upon entry (Figure 4.1). To further enrich the experience, Videoscribe, a video animation tool, was employed by the principal investigator to develop videos that were embedded within Google Slides, and activated as particular puzzles were deciphered. These comprised three videos focusing on maternal resuscitation and four on neonatal resuscitation. The lesson plan is depicted in Table 4.2, while the design

trajectory of the VER can be seen in Figure 4.2. Clues 2 through 5 are visualized in Figure 4.3.

2. User Experience: Before accessing the VER, participants were informed that they were entering a VER. Upon initiating the link, they were introduced to an unfolding case study presented over three slides featuring a blend of images and text. Upon entering the VER, a timer was automatically activated. Clues 2-5 were conveyed through text, video animations, and images (Figure 4.3). Video animations had voiceovers that had hints and clues for questions to continue progression in the VER activity. Conversely, Clues 1 and 6 were enriched with animated videos accompanied by voiceovers and subtle background music. The puzzles posed brief knowledge-checks utilizing embedded Google Forms that impeded progression unless questions were solved accurately. Knowledge validation had an essential role in the VER by ensuring that learners had effectively met the learning objectives of the activity when they successfully completed the escape room. After successfully navigating through the 15-minute VER activity, the unfolding case was wrapped up via a concluding 4-minute video illustrating the patient's outcome, bringing the entire VER intervention duration to 19 minutes.

Table 4.2*Virtual Escape Room Lesson Plan*

Objectives	Content	Time Frame	Teaching Strategies	Validation Method
Describe the appropriate management and care of cardiac arrest in pregnancy by the end of the presentation.	Overview of AHA expectations for effective management for cardiac arrest in pregnancy	- Unfolding Case Study timing is user dependent - Cardiac Arrest in Pregnancy Video 1 (26 seconds)	- Unfolding Case Study - 1 Video Animation - Informational page with distinct information (clue for VER)	Knowledge-check (Cannot advance with VER without correct responses)
Illustrate anatomical differences in administering cardiopulmonary resuscitation between pregnant and non-pregnant individuals.	Illustration of key anatomical variations in pregnancy and suggested differences in management of cardio-pulmonary resuscitation	- Unfolding Case Study Timing is user dependent - Cardiac Arrest in Pregnancy Video 2 (26 seconds)	- Unfolding Case Study - 1 Video Animation - Informational page with distinct information (clue for VER)	Knowledge-check (Cannot advance with VER without correct responses)
Recognize the indications for a perimortem cesarean delivery	AHA expectations and necessary preparations for perimortem cesarean delivery	- Unfolding Case Study Timing is user dependent - Cardiac Arrest in Pregnancy Video 3 (48 seconds) - Cardiac Arrest in Pregnancy Video 4 (4 minutes)	- Unfolding Case Study - 2 Video Animations	Knowledge-check (Cannot advance with VER without correct responses)
Discuss the management of the neonate immediately after delivery necessitating resuscitation	Neonatal Resuscitation Program recommendations for initial interventions and assessment for a neonate at delivery	- Unfolding Case Study Timing is user dependent NRP Video 1(29 seconds) NRP Video 2 (39 seconds) NRP Video 3 (1 minute, 8 seconds) NRP Video 4 (26 seconds)	- Unfolding Case Study - 4 Video Animations - 2 pages with distinct information (clue for VER)	Knowledge-check (Cannot advance with VER without correct responses)

Figure 4.2

Virtual Escape Room Opening Screen

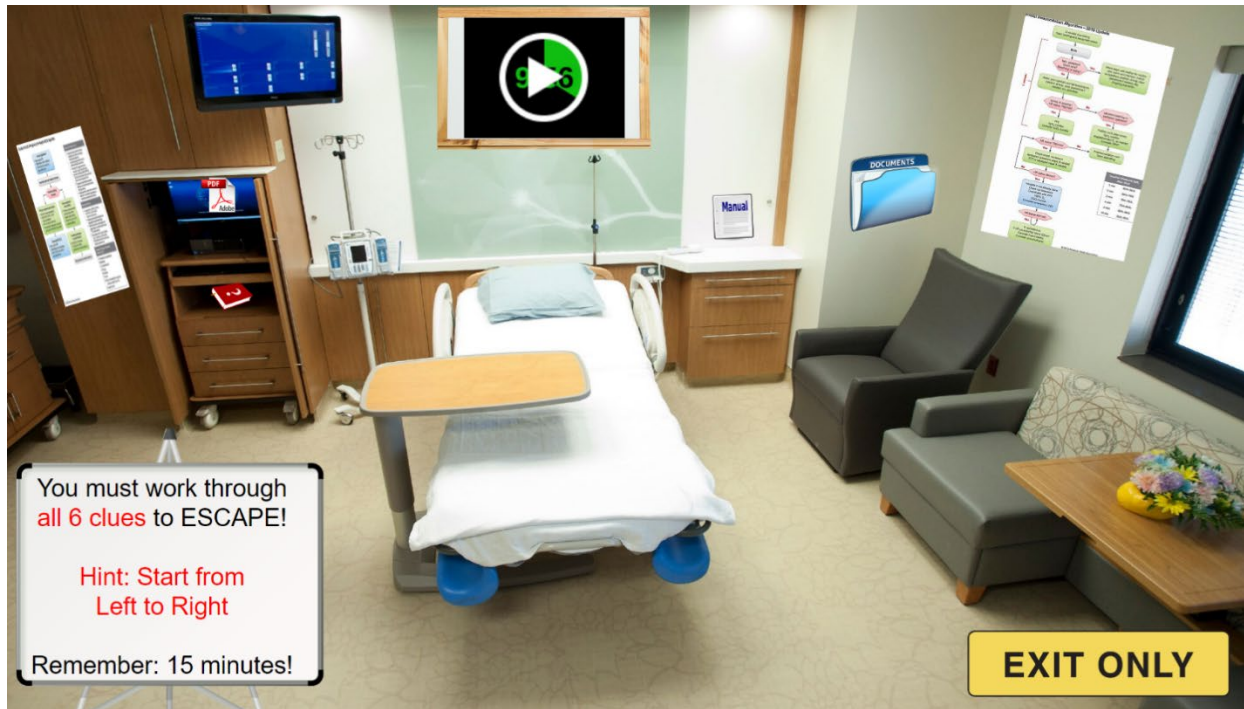


Figure 4.3

Virtual Escape Room Design Map

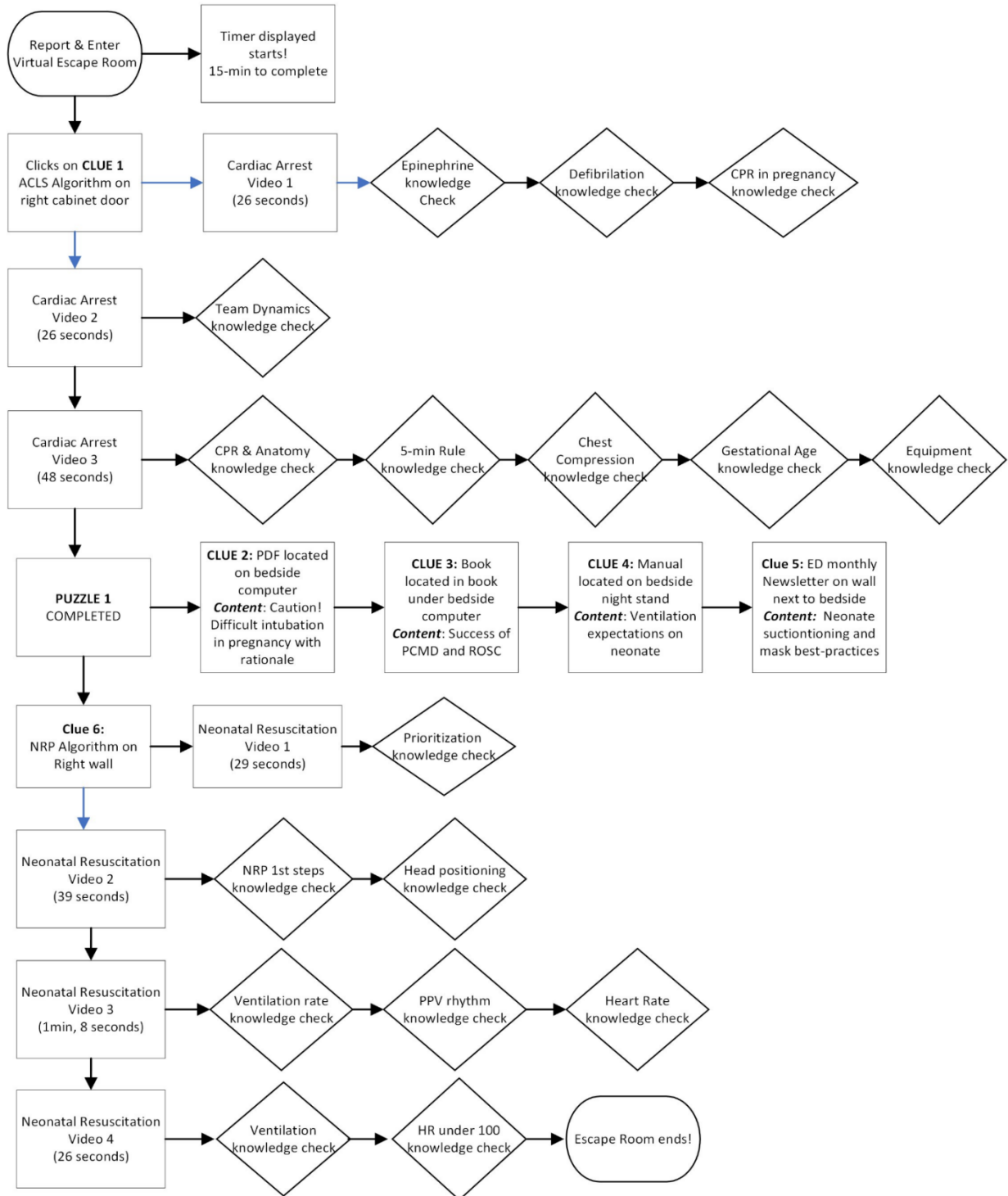


Figure 4.2

Virtual Escape Room Design Map Continued

Note. ACLS= Advanced Cardiac Life Support, CPR= Cardiopulmonary Resuscitation, PCMD= Perimortem Cesarean Delivery, ROSC= Return of Spontaneous Circulation, ED= Emergency Department, NRP= Neonatal Resuscitation Program, PPV= Positive Pressure Ventilation, HR= Heart Rate

Figure 4.4

Clues 2-5 of Virtual Escape Room

CLUE 2 OF 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!



INCREASED airway edema and altered airway anatomy may predispose to **difficult intubation** in **PREGNANCY**

CLUE 3 OF 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!



After a perimortem cesarean delivery (PCMD) there has been a noticed **Increase in venous return (ROSC)**

In other words: SHE SURVIVES!

DID YOU KNOW?

CLUE 4 OF 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!

Deliver me here!



P.S. If I don't look this cute when you first see me, VENTILATE me!

CLUE 5 OF 6 AFTER THIS CLUE RETURN TO ESCAPE ROOM!

EMERGENCY DEPARTMENT STAFF UPDATES

Monthly Newsletter : OB Focus Edition

BULB SUCTION

A bulb suction can cause a **BRADYCARDIA** due to eliciting a **vagal response!** Use **ONLY** if needed. This is no longer routine practice.



CORRECT INCORRECT INCORRECT



CORRECT MASK

Last month's delay in effective ventilation was due to incorrect mask placement. Just like adults ensure a good seal and the mask is used correctly!

Instruments

Demographic Survey

A demographic survey was created for the study that included questions on age, gender, race, nursing specialty, years of experience, and previous education in cardiac arrest in pregnancy.

Knowledge Quiz (Pre/Post)

The development of a knowledge quiz was aimed to evaluate participants on key aspects of cardiac arrest during pregnancy and neonatal resuscitation. Presented as a pre-test and post-test, this knowledge quiz, comprising 30 questions, was administered before and three days after the educational intervention. The initial set of 15 questions focused on ACLS components specific to cardiac arrest in the context of pregnancy, while the latter focused on principles of neonatal resuscitation. Collectively, these questions assessed the understanding of simultaneous maternal and neonatal resuscitative procedures. A score of 100% indicates that all questions were answered correctly, with each question being allotted 3.33 points. The quiz was scored dichotomously, meaning that each question was either marked as fully correct or not, without partial credit. In this study, Cronbach's Alpha for the knowledge pre-test was .76 and for the knowledge post-test was .88.

This instrument integrated questions derived from the "Cardiac Arrest in Pregnancy" survey (Cohen et al., 2008). It also incorporated questions evaluating participants' comprehension of neonatal resuscitation aligned with the Neonatal Resuscitation Program (*Textbook of Neonatal Resuscitation, 8th Ed*, 2021). The selection of questions was tailored to the learning objectives of the educational intervention.

Learning Objectives:

1. Describe the appropriate management and care of cardiac arrest in pregnancy.
2. Illustrate anatomical differences in administering cardiopulmonary resuscitation between pregnant and non-pregnant individuals.
3. Recognize the indications for a perimortem cesarean delivery.
4. Identify management of the neonate necessitating resuscitation after delivery.

The knowledge quiz was subjected to a pilot evaluation with a cohort of 10 nurses, each fulfilling the study's prerequisites. This initial phase served multiple purposes: it determined the time needed to navigate the VER and complete the knowledge quiz and provided essential insights for the study's planning. It also evaluated the difficulty of the quiz, ensuring it was challenging but not overly complicated. Adjustments were made, such as correcting typographical mistakes and fixing issues where RedCap's automatic system incorrectly marked answers. Additionally, the pilot highlighted certain procedural issues, especially concerning the timing of some automated RedCap surveys. These early discoveries allowed for timely modifications, ensuring more accurate data collection, and enhancing the overall success of the study.

GAMEX

A significant limitation within the existing literature is the restricted generalizability of many nursing studies involving escape rooms, primarily due to insufficient sample sizes. A primary objective of this study is to discern whether escape rooms enhance learner engagement. To measure learner engagement, an instrument called the Gameful Experience Scale (GAMEX) was utilized as outlined in a study by Eppman et al. in 2018. Prior research using the GAMEX in the context of nursing education has shown its potential in evaluating escape room experiences,

particularly with sizable samples that attest to both competency development and heightened student engagement (Anguas-Gracia et al., 2021). Instruments like the GAMEX pave the way for measuring game experience from innovative content delivery approaches in nursing education, however while its capability to measure nursing education effectiveness accurately and reliably is recognized, its incorporation into studies remains relatively sparse (Márquez-Hernández et al., 2019).

The Gameful Experience Scale (GAMEX) was used to assess the game experience and to measure overall engagement in the learning activity. Comprising 27 items, the scale is categorized into six dimensions: enjoyment, absorption, creative thinking, activation, absence of negative effects, and dominance. The composite reliability of the factors fluctuated between .84 and .94. Regarding convergent factor validity, every factor loading was notable, and the average variance extracted (AVEs) varied between .56 and .90. Discriminant factor validity showed that all AVEs surpassed the corresponding maximum squared factor correlation. The scale operates on a scoring range of 1-5, providing an overall range of 27-135. Cronbach's α values for each dimension are displayed in Table 4.3 including values from the original study (Eppman et al., 2018). Because GAMEX was administered only to those participants assigned to the VER, sample sizes for analyses vary.

Table 4.3*Cronbach's α Values for Each Dimension*

Dimension	α values in this study	α values in the original study
Enjoyment	0.92	0.96
Absorption	0.87	0.91
Creative thinking	0.94	0.88
Activation	0.85	0.87
Absence of negative effects	0.95	0.85
Dominance	0.91	0.84
Total	.93	0.89

TPSI

The Telic/Paratelic State Measure (TPSI) is a 12-item instrument. It features a 7-item Serious-Minded/Playful subscale and a 5-item Arousal-Seeking/Arousal Avoidance subscale. Respondents are instructed to select numbers on 6-point rating scales, which juxtapose opposing meta-motivational states. The derived scores from each subscale are aggregated to yield a total score on the telic/paratelic continuum. Lower scores are consistent with telic (serious-minded) states; higher scores are consistent with paratelic (playful) states. Construct validity and reliability for this scale have been affirmed with a sample size of 571 adults (O'Connell & Calhoun, 2001). Score ranges for the subscales include serious-minded/playful (SM/P): 7-42, arousal-avoidant/arousal-seeking (AA/AS): 5-30, while the comprehensive T/PSI range spans from 12-72. This measure has an internal consistency reliability with a Cronbach's alpha of 0.89. Although established cut-off points also guide in dichotomizing telic or paratelic states, the cutoffs were based on a different sample. Therefore, the continuous scores were used in this analysis. For this study a Cronbach's alpha of .68 was established for T/PSI pre-test and

Cronbach's alpha of .75 for post-test. Cronbach's alpha exclusively for the VER group of .73 for T/PSI pre-test and Cronbach's alpha of .76 for post-test.

Procedure

After securing permissions from Teachers College at Columbia University and Northwell Health, along with the necessary IRB approvals, an informational flyer, detailing the study's requirements and containing a QR code, was shared with potential participants. Scanning the QR code allowed these individuals to share their email addresses, through which they would receive further details about the study, consent forms, and details about compensation. The principal investigator, who also served as a leader in nursing education, oversaw and supervised the entire process. Participation in the study was entirely voluntary, with no influence on participants' assessments or impact on their position at their place of hire.

Once participants gave their consent, they undertook the demographic survey, the knowledge quiz pre-test, and the Telic/paratelic state survey. Participants were then randomly assigned to undergo one of two educational interventions: either the traditional PowerPoint or the VER. The Feinstein Institute for Medical Research at Northwell Health supplied the instrument used for random assignment. Subsequent steps entailed the post-intervention Telic/paratelic state survey and the Student Satisfaction and Self-Confidence in Learning Scale (discussed in a different manuscript). Participants who received the VER intervention received an additional survey, the Gameful Experience Scale. Lastly, all participants received the knowledge quiz post-test on the third day after the educational intervention (refer to Table 4.4). The choice of Day 3 was made to support participants to study completion, as it marked the conclusion of the centralized orientation program before new hires transitioned to the orientation programs specific to their respective institutions of employment.

Table 4.4

Procedures

Demographics	Pre-Test Knowledge Quiz	Telic/Paratelic State Instrument Pre	Intervention	Gameful Experience Scale (GAMEX)	Telic/Paratelic State Instrument Post	Student Satisfaction and Self-Confidence in Learning Scale	Post-Test Knowledge Quiz
Day 1	Day 1	Day 1	Control Group	N/A	Day 1	Day 1	Day 3
Day 1	Day 1	Day 1	Virtual Escape Room	Day 1	Day 1	Day 1	Day 3

Data Analysis

Methods for analyzing data to address hypotheses and research questions are listed below.

Aim 1 Hypotheses:

1. There is a significant positive relationship between T/PSI scores and engagement. Statistical test: Pearson's Correlation Coefficient
2. Engagement is positively correlated with satisfaction. Statistical test: Pearson's Correlation Coefficient
3. Engagement positively affects self-confidence. Statistical test: Pearson's Correlation Coefficient.
4. Engagement is positively associated with knowledge acquisition. Statistical test: Pearson's Correlation Coefficient

Aim 1 Research Questions:

1. Is there a significant relationship between learner age and engagement levels in the VER? Statistical test: Pearsons Correlation Coefficient
2. Are there statistically significant differences in engagement levels among different racial groups in the VER? Statistical test: ANOVA
3. Is nursing specialty related to learner engagement in the VER? Statistical test: ANOVA
4. Is there a significant correlation between years of experience and engagement levels? Statistical test: Pearsons Correlation Coefficient
5. Does previous education on cardiac arrest during pregnancy have a statistically significant effect on learner engagement? Statistical test: Independent-samples *t* test

Aim 2 To examine the influence of the VER on learners' Telic/Paratelic motivational state.

Research Question: How does educational intervention influence the motivational state from pre-intervention to post-intervention? Statistical test: Mixed-ANOVA

Results

Demographics

The current study included a sample of 297 nurses, of which 167 individuals were excluded either because they did not meet the inclusion criteria ($n = 10$, 4%) or did not complete the study ($n = 157$, 53%). Thus, a total of 130 individuals completed the study. The demographic characteristics, nursing specialty, and prior education related to cardiac arrest for both the entire sample and the intervention group are outlined in Table 4.5. Additionally, Table 4.5 provides descriptive statistics for the key variables central to this study. This report will focus mainly on

the intervention group. There were no significant differences in demographic characteristics between the intervention and control groups, and similarly, there were no significant demographic differences between participants who completed the study and those who did not.

Table 4.5

Demographic Characteristics and Key Variables Central to Study

Characteristic	VER & Control Group Combined		VER Group Only	
	<i>N</i>	%	<i>n</i>	%
Age in years				
20–29	43	33	22	33.8
30–39	56	43	28	43
40–49	22	16.9	10	15.4
≥50	9	6.9	5	7.7
Gender				
Female	103	79.2	54	83.1
Male	27	20.8	11	16.9
Race & Ethnicity				
African American/Black	19	14.6	8	12.3
Asian	15	11.5	7	10.8
Native Hawaiian or Pacific Islander	4	3.1	2	3.1
White	48	36.9	25	38.4
More than 1 Race	22	16.9	12	18.4
Other	5	3.8	2	3.1
Prefer not to say	7	5.4	5	7.7
Spanish, Hispanic or Latino	10	7.7	4	6.2

Table 4.5*Demographic Characteristics and Key Variables Central to Study Continued*

Characteristic	VER & Control Group Combined		VER Group Only	
	<i>N</i>	%	<i>n</i>	%
Nursing Specialty				
Critical Care	56	43.1	24	36.9
Emergency Department	31	23.8	18	27.7
Obstetrics	32	24.6	15	23
More than 1 specialty	11	8.5	8	12.3
Education in Cardiac Arrest in Pregnancy				
No previous education	70	53.8	36	55.4
Yes, education received	60	46.2	29	44.6
Yes, Concurrent Maternal and Neonatal Resuscitation	27	20.8	13	20
Yes, During ACLS/BLS course	25	19.23	8	12.3

Note: *N* = 130 for VER and Control Group Combined; *N*=65 for VER only

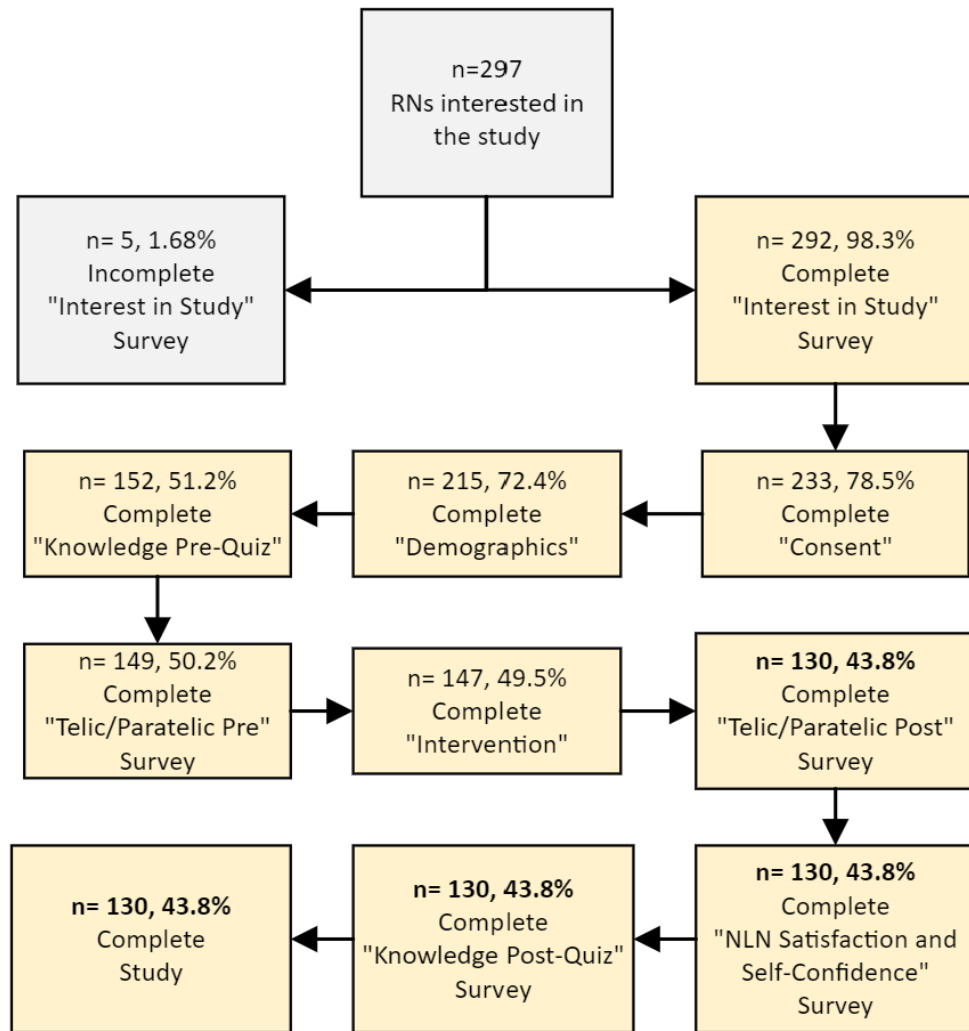
Attrition

Of the initial 297 interested participants, only 130 (43.8%) successfully completed the study. Refer to Figure 4.4 for a visual representation of the attrition rates over the course of the study. The majority of those who finished were early attendees of the centralized orientation program, completing a significant portion of the study while on-site. It is posited that the attrition rate rose for participants that anticipated to complete the study remotely. Although REDCap automatically sent reminders to participants to complete each survey, a significant portion of

subject attrition occurred between the completion of the demographic survey and the knowledge pre-quiz.

Figure 4.5

Attrition



The aim of this report involved investigating the correlates of both overall learner engagement, as indexed by the total score on the GAMEX survey, and of the subscales of the GAMEX survey. Two types of correlates were investigated: major substantive variables in the study, such as knowledge, motivational states, and demographic characteristics, such as racial

group or nursing specialty (Table 4.7). In addition, the effect of the intervention on motivational state scores was assessed.

Table 4.6

Means and Standard Deviations by Group for the Major Analysis Variables Including GAMEX Subscales

Variable	Control (n=65)		VER (n=65)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
GAMEX Overall	-	-	88.06	16.97
Enjoyment Score	-	-	25.52	3.93
Absorption Score	-	-	19.07	5.19
Creative Thinking Score	-	-	14.94	3.56
Activation Score	-	-	10.11	4.51
Absence Score	-	-	4.75	3.04
Dominance Score	-	-	13.66	3.67
T/PSI Pretest	35.89	7.02	35.83	8.67
T/PSI Posttest	35.57	7.94	38.86	9.91
Knowledge Pre	59.58	16.30	58.51	17.35
Knowledge Post	68.24	17.42	77.67	20.95
Satisfaction	17.68	3.19	22.15	3.37
Self-confidence	30.69	3.99	33.63	5.00

N= 130; GAMEX= Gameful Experience Scale, T/PSI= Telic/Paratelic State Measure

Results of the investigation of the correlates are as follows:

Aim 1 findings:

1. ***Engagement and Knowledge:*** A correlation analysis revealed a positive correlation between GAMEX overall engagement scores and knowledge acquisition, but this correlation did not reach statistical significance, $r(65) = .21, p = .09$.
2. ***Engagement and Satisfaction:*** There was a significant positive correlation between overall engagement scores and satisfaction scores, $r(65) = .40, p < .001$. in VER.

3. **Engagement and Confidence:** A correlation analysis indicated a positive correlation between GAMEX overall engagement scores and self-confidence scores, although this correlation did not reach statistical significance, $r(65) = .24, p = .06$.
4. **Engagement and T/PSI scores:** There was a non-significant negative correlation between T/PSI scores and GAMEX (overall engagement) scores. Correlation analyses of the two T/PSI subscales with the six GAMEX subscales also revealed non-significant relationships (Table 4.7).
5. **Knowledge and Satisfaction:** There was a significant positive correlation between knowledge scores and satisfaction scores, $r(65) = .35, p < .001$. in VER.
6. **Knowledge and Confidence:** There was a significant positive correlation between knowledge scores and confidence, $r(65) = .28, p < .001$. in VER.
7. **Satisfaction and Confidence:** There was a significant positive correlation between satisfaction and confidence, $r(65) = .74, p < .001$. in VER.
8. **Engagement and Learner Age:** There was no statistically significant relationship between learner age and overall engagement levels in the VER ($r(65) = .01, p = .92$).
9. **Engagement and Race:** There were no statistically significant differences in overall engagement levels among different racial groups in the VER ($F(7, 57) = 0.94, p = 0.48, \eta^2 = 0.10$).
10. **Engagement and Nursing Specialty:** There was no statistically significant relationship between nursing specialty and overall engagement in the VER ($F(3, 61) = 1.25, p = 0.30, \eta^2 = 0.06$).
11. **Engagement and Years of Experience:** A statistically significant negative correlation was found between years of experience and engagement levels ($r(65) = -.30, p =$

.015), indicating that as years of experience increase, engagement levels tend to decrease.

12. **Engagement and Previous Education:** There was no statistically significant difference in engagement scores between learners with previous education in cardiac arrest in pregnancy ($M = 86.76, SD = 17.49$) and those without such education ($M = 89.11, SD = 16.71$), $t(63) = 0.55, p = 0.29$.

Correlational analyses on GAMEX sub-scales demonstrated statistical significance with knowledge acquisition and three GAMEX subscales (Table 4.7). The below positive correlations were identified:

1. **Engagement (Creative Thinking) and Knowledge:** There is a statistically significant positive correlation between creative thinking score and knowledge post-test ($r = 0.305, p = 0.013$).
2. **Engagement (Enjoyment) and Knowledge:** There is a statistically significant positive correlation between enjoyment score and knowledge post-test ($r = 0.346, p = 0.005$).
3. **Engagement (Dominance) and Knowledge:** There is a statistically significant positive correlation between dominance score and knowledge post-test ($r = 0.255, p = 0.04$).

Aim 1 Summation:

The investigation yielded several significant and nonsignificant findings. The significant results included a positive correlation between overall engagement and satisfaction scores in the VER group. Additionally, correlational analyses within the GAMEX sub-scales showed positive correlations with knowledge acquisition, enjoyment, creative thinking, and dominance scores. Non-significant findings included a negative correlation between T/PSI scores and GAMEX

overall engagement, as well as non-significant correlations between T/PSI subscales and GAMEX subscales. Furthermore, although there was a positive correlation between GAMEX overall engagement and self-confidence scores, it did not reach statistical significance. Similarly, a positive correlation between GAMEX overall engagement and knowledge acquisition did not reach statistical significance.

Table 4.7

Correlation Matrix of Major Substantive Variables

		Knowledge (post)	T/PSI (post)	GAMEX Overall	Satisfaction	Confidence
Knowledge (post)	<i>r</i>	--	-.11	.21	.35	.28
	<i>p</i>	--	.23	.09	.001	.001
T/PSI (post)	<i>r</i>	-.11	--	-.10	.01	-.15
	<i>p</i>	.23	--	.413	.97	.09
GAMEX Overall	<i>r</i>	.21	-.10	--	.40	.24
	<i>p</i>	.09	.41	--	<.001	.06
Satisfaction	<i>r</i>	.35	.01	.40	--	.74
	<i>p</i>	.001	.97	<.001	--	.001
Confidence	<i>r</i>	.28	-.15	.24	.74	--
	<i>p</i>	.001	.09	.06	.001	--

Note: GAMEX= Engagement Score

Table 4.8*Correlation Matrix of Posttest Knowledge Scores with GAMEX Sub-scales*

		Knowledge (post)	GAMEX Overall
Enjoyment	<i>r</i>	.35	.66
	<i>p</i>	.005	<.001
Absorption	<i>r</i>	.13	.78
	<i>p</i>	.31	<.001
Creative Thinking	<i>r</i>	.305	.79
	<i>p</i>	.01	<.001
Activation	<i>r</i>	-.01	.72
	<i>p</i>	.93	<.001
Absence	<i>r</i>	-.12	.44
	<i>p</i>	.33	<.001
Dominance	<i>r</i>	.255	.81
	<i>p</i>	.04	<.001

Note. GAMEX= Engagement Score

Results of the investigation of the relationships of learner engagement to demographic characteristics were as follows:

Aim 2 findings:***T/PSI***

A mixed analysis of variance (mixed-ANOVA) was employed to examine motivational states (T/PSI) in the VER group as compared to the control group (Table 4.9). Figure 4.5 displays the marginal means. There was no statistically significant within subjects main effect of

time (pre vs. post) on motivational state. There was no statistically significant between-subjects main effect of the education intervention (VER vs. control group). An interaction effect between T/PSI score (pre vs. post) and education intervention (VER vs. control group) was statistically significant. This signifies that the effect on the T/PSI differed depending on the educational intervention (VER vs. control group) and the time of testing (pre vs post).

A simple main effects test was conducted to assess the impact of different teaching strategies on T/PSI pre and post-test scores. Two independent sample *t* tests were completed to compare pre-test and post-test T/PSI scores between the VER and control groups. As Table 4.10 shows, the comparison of pre-test T/PSI score between traditional PowerPoint and VER groups revealed no significant difference in mean scores. The effect size measure indicates negligible differences between groups. An independent samples *t* test was conducted to compare post-test T/PSI scores between VER and control groups. Results revealed a statistically significant difference in mean scores. The effect size measures indicate a moderate effect size. The following discusses T/PSI score findings:

- For the pre-test T/PSI scores, there was no significant difference between the traditional PowerPoint and VER groups, meaning their mean scores were similar.
- For the post-test T/PSI scores, the VER group had a significantly higher mean score than the control group.

Two paired-samples *t* tests (shown in Table 4.11) demonstrate a significant difference in T/PSI scores before and after the VER intervention for the VER group. Furthermore, there was no significant difference in T/PSI scores before and after the traditional PowerPoint intervention for the control group. These findings indicate that the VER condition was associated with higher playfulness than the control condition.

Table 4.9 Results of Mixed ANOVA on Telic/Paratelic Score.

Variable	VER		Control		ANOVA				
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	Effect	F ratio	<i>df</i>	<i>p</i>	η^2
T/PSI									
Pre	35.83	8.67	35.89	7.02	Group	1.56	1,128	.21	.01
Post	38.86	9.91	35.57	7.94	Time	3.27	1,128	.073	.03
N	65		65		G x T	5.02	1,128	.027	.04

Note. ANOVA = Analysis of variance; T/PSI = Telic/Paratelic Score; Control = traditional group; η^2 = partial eta squared; G = group; T = time.

Figure 4.5

Estimated Marginal Means of Telic/Paratelic Scores

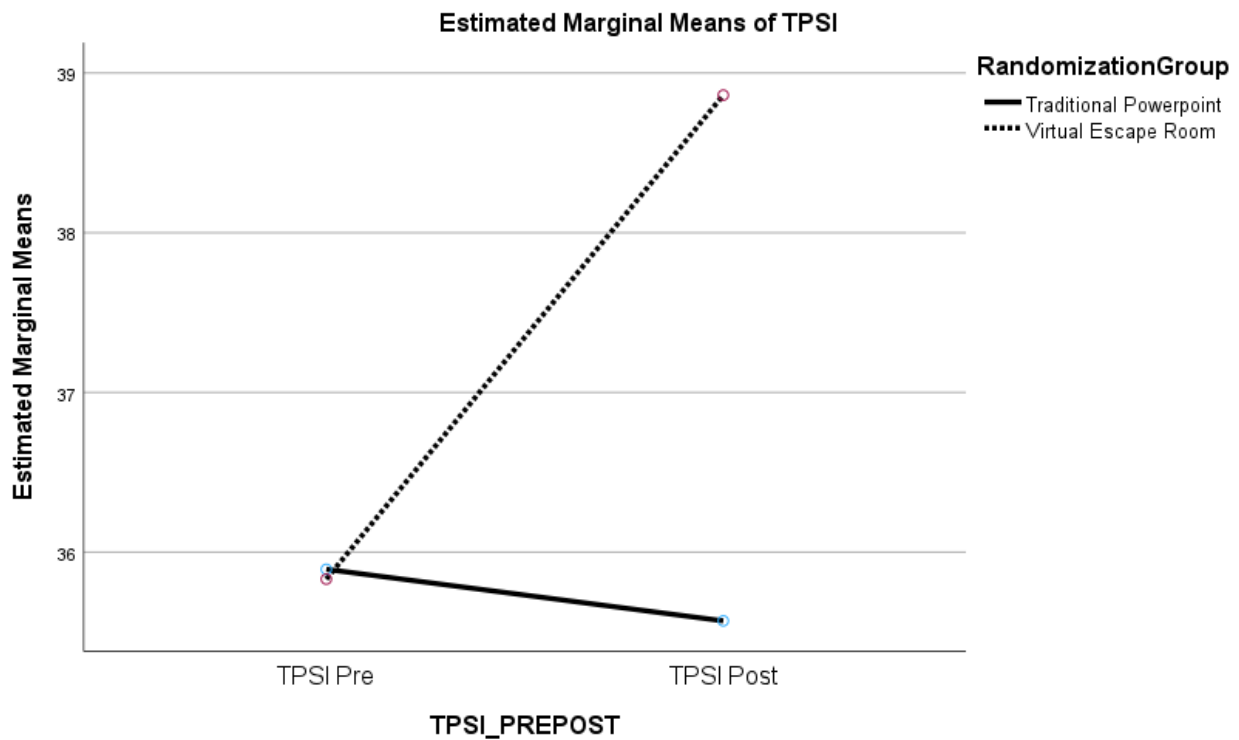


Table 4.10*Independent Samples t tests Comparing VER and Control Groups on T/PSI Score*

	Mean Difference	<i>t</i>	<i>df</i>	<i>p</i>	Cohen's <i>d</i>
Pretest	0.062	0.044	128	.97	.01
Posttest	-3.29	-2.09	128	.039	-.37

Note. Equal variances assumed for both tests.**Table 4.11***Paired Samples t Tests Comparing Pre and Post-tests for VER and Control Group*

	Mean difference	<i>t</i>	<i>df</i>	<i>p</i>	Cohen's <i>d</i>
Intervention	-3.03	-2.55	64	.013	-.32
Control	0.32	0.35	64	.72	.04

Discussion

This study examined the correlates of engagement in an innovative VER and explored the motivational states of learners receiving education in cardiac arrest during pregnancy. A salient observation consistent with Ryan and Deci's findings, is the positive correlation between learner engagement and satisfaction, reinforcing the fundamental link in education where engagement, manifested through attention, curiosity, and interest is closely tied to a learner's satisfaction (2000). The sources of this satisfaction within the VER could be manifold, ranging from the novelty of the learning environment to the engaging multimedia videos, or the interactive problem-solving elements. The relationship of engagement and satisfaction resonates with theories of intrinsic motivation, suggesting that when learners find an activity enjoyable and stimulating, their satisfaction levels naturally increase (Ryan & Deci, 2000).

In contrast to the relationship between overall engagement and satisfaction which was statistically significant, this study revealed a lack of statistically significant correlations between overall engagement and other variables like self-confidence and knowledge acquisition. While the literature often demonstrates engagement as a precursor to improved learning outcomes. Fredricks et al.(2004) suggest that engagement, in isolation, may not be a sufficient predictor of knowledge gains. Knowledge might be influenced by the complex nature of the learning environment, where engagement could be more reflective of a learner's behavioral, emotional and cognitive immersion rather than their capacity to assimilate new information (Fredricks et al., 2004). This perspective aligns with recent findings from a nursing study by Fritz (2023), in clinical professional development, where no statistically significant association was found between increased knowledge and learner engagement. The layered complexity of knowledge and engagement warrants more comprehensive exploration in future research.

Contrasted with the lack of an association between overall engagement and knowledge acquisition, relationships between specific aspects of engagement and knowledge acquisition were significant. Enjoyment, creative thinking, and dominance, subscales of GAMEX, all positively correlated with knowledge post-tests. These correlations highlight the integral role of enjoyment, creative thinking, and a sense of control or dominance in enhancing knowledge acquisition within a gamified learning environment like the VER. The positive relationship between enjoyment and knowledge underscores the idea that when learners find the material or the method of delivery enjoyable, they may be more inclined to absorb and retain information (Blakely et al., 2009). Similarly, the link between creative thinking and knowledge acquisition suggests that fostering an environment that encourages innovative thought processes can lead to deeper learning. The correlation between the dominance score and knowledge acquisition might

reflect the importance of empowering learners, giving them a sense of control and influence over their learning experience, which in turn enhances their ability to grasp and retain new information. Further research is needed to best understand the correlations of these subscales for knowledge attainment.

Upon investigating the effects of the VER on motivational states (telic/paratelic), learners significantly increased their likelihood of endorsing paratelic or playful responses as opposed to telic responses. This shift towards a paratelic state, characterized by curiosity and exploration, is especially compelling considering the serious nature of the subject matter: cardiac arrest during pregnancy. This finding echoes Brukman's (2023) research on utilizing an escape room for child maltreatment education yielding positive learning experiences with gamified approaches with sensitive content. However, it is important to note that there was no significant correlation between T/PSI scores and overall engagement or knowledge acquisition. While the learners gravitated towards a more playful state, this did not directly translate to increased engagement or knowledge, as measured by the instruments used in this study. This absence of a direct relationship between the T/PSI subscales and GAMEX subscales demonstrates the multifaceted nature of engagement and motivational states within gamified environments like the VER.

Lastly, a statistically significant negative correlation was observed between years of experience (YOE) and engagement. This could indicate a potential saturation point where experienced professionals find traditional or even innovative educational methods less engaging, possibly due to familiarity with the subject matter or a different set of learning needs and preferences. Although there's a difference between work engagement and gamified or educational engagement, such findings might hint at a potential relationship between years of experience and engagement, necessitating further exploration. It is pertinent to highlight that the

participants of this study were also from critical care areas and were onboarded during the peak of the Omicron variant of COVID-19.

Overall, this study offers valuable insights into the complexities of engagement and motivational states, particularly in the context of innovative gamified approaches like the VER. These findings not only challenge existing assumptions but also pave the way for a more nuanced perspective to incorporating and researching innovative teaching strategies.

Conceptual Framework in Relation to Study Variables

The absence of statistically significant correlations between overall engagement and other variables like self-confidence and knowledge acquisition challenges that engagement alone can reliably predict knowledge acquisition. The study's noteworthy findings reveal significant positive relationships between specific dimensions of engagement, such as enjoyment, creative thinking, dominance, and knowledge acquisition. The outcomes from this study, contribute to the idea that certain aspects of engagement play a more prominent role in facilitating learning, reinforcing the notion that enjoyable experiences, and fostering innovative thinking can substantially bolster knowledge acquisition. The conceptual framework discussed earlier in the manuscript, demonstrates the multifaceted nature of the relationships between engagement, satisfaction, and knowledge acquisition within the context of innovative gamified educational approaches like the VER. These ideas and concepts reveal the need for ongoing investigation to uncover the intricacies of engagement, satisfaction, and knowledge in education to inform the development of effective and engaging teaching strategies.

Limitations

The design and execution of this study come with certain limitations. Attrition among prospective subjects was considerable. Over 50% of the prospective study participants dropped

out of the study. A primary limitation lies in the correlation analysis, which prevents the establishment of causal relationships. The potential for unmeasured variables to influence the study's findings should also be considered, as these could impact the reported relationships among the variables studied. Additionally, it is essential to acknowledge that participants' varying levels of familiarity with technology, game literacy, or exposure to escape rooms might have influenced their engagement or satisfaction. Furthermore, this study lacked a comparable measure of engagement for the control group, as an engagement instrument did not apply to both conditions.

Conclusion

Cardiac arrest in pregnancy is a critical subject within healthcare that necessitates comprehensive understanding, particularly in the context of education of concurrent maternal and neonatal resuscitation. This study explored the variables that may influence learner engagement and motivational states in a VER. The intricate relationships between knowledge, self-confidence, satisfaction, and demographic variables compels educators to continually refine and enhance their teaching methodologies to achieve optimal results.

The findings of this study illuminate the significance of engagement in enhancing learner satisfaction within a VER setting. However, it also uncovers that engagement alone does not automatically translate into improved knowledge or self-confidence. This insight serves as a prompt for a more comprehensive approach in educational design, one that seamlessly integrates engagement with other pedagogical methods to foster a well-rounded and impactful learning experience. The multifaceted nature and complexities of learning engagement, particularly in innovative settings like VERs, call for more extensive research to fully understand and leverage its innovative capabilities in nursing education.

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Chapter 5

Conclusion

This dissertation addressed the critical knowledge gap surrounding maternal cardiac arrest during pregnancy, a rare yet life-threatening emergency that requires swift and coordinated intervention from healthcare teams. The urgency of this dual-patient scenario is heightened by recognized knowledge deficits in the resuscitation of pregnant individuals and the alarming increase in maternal mortality rates in the United States (Alimena et al., 2023; Hoyert, 2019). This empirical comparative study compared the effectiveness of two teaching strategies: the Virtual Escape Room (VER) and the Traditional PowerPoint with voiceover aimed to enhance knowledge, learner satisfaction, self-confidence, engagement levels, and motivational states among nurses managing cardiac arrest during pregnancy.

Findings

In a comprehensive literature review, studies within obstetrical and critical care domains often focused only on maternal resuscitation, neglecting the integration of neonatal teams. Despite the American Heart Association's endorsing the importance of conducting interdisciplinary drills, many studies predominantly conducted simulations or drills within obstetrical units. This observation underscores the critical need to broaden educational and preparedness exercises to ensure comprehensive readiness and collaboration across the entire healthcare team.

This study yielded several significant findings that identified the superiority of VER as an innovative teaching strategy to improve knowledge in managing this complex emergency as compared to PowerPoint with voiceover. Firstly, the VER teaching strategy outperformed the Traditional PowerPoint approach in terms of knowledge acquisition, learner satisfaction, and

self-confidence. Both groups demonstrated a statistically significant increase in knowledge, but the VER group exhibited greater improvement, highlighting the effectiveness of gamification and immersive learning experiences in healthcare education. Secondly, findings revealed significant positive correlations in engagement subscale components including enjoyment, creative thinking, and dominance with knowledge acquisition. These correlations underscore the pivotal role that enjoyment, creative thinking, and a sense of control or dominance play in enriching knowledge acquisition within the context of a gamified learning environment such as the VER. Lastly, the study identified the significant impact of nursing specialty on knowledge acquisition, with obstetric nurses achieving higher knowledge scores. This emphasizes the importance of tailored educational approaches to meet the diverse needs of nursing specialties.

Overall Implications

The findings of this study hold significant implications for healthcare education and practice, offering valuable insights that can shape the way healthcare professionals are educated and prepared to respond to maternal cardiac arrest during pregnancy. The incorporation of gamification and immersive learning experiences, as demonstrated by the VER, hold promise to better equip nurses to respond effectively to this life-threatening scenario.

Additionally, the study's exploration of engagement and motivational states within the gamified learning environment offers valuable insights into the complexities of learner engagement. While engagement was found to be positively correlated with learner satisfaction and specific elements such as enjoyment, creative thinking, and dominance, it did not directly translate into enhanced knowledge acquisition. This suggests that engagement is a multifaceted construct influenced by various factors and warrants further investigation in future research

endeavors. Understanding the intricate interplay between engagement and learning outcomes can inform the development of more effective educational strategies in healthcare settings.

Conclusion

Emphasizing the importance of effective education in managing cardiac arrest during pregnancy is paramount, especially as persistent knowledge gaps among resuscitation teams are frequently reported. The introduction of the VER as an innovative and effective educational strategy marks an advancement in addressing knowledge deficits in concurrent maternal and neonatal resuscitation. Educational approaches like the VER can empower resilient healthcare teams and potentially support a future reduction in maternal mortality rates and improve neonatal outcomes.

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Appendices

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Appendix A

Demographic Survey

About: This questionnaire is strictly confidential, and when reported, responses will not identify any individual.

1. What is your age?

2. Which race(s) do you identify as?

- African American or Black
- American Indian or Alaska Native
- Asian
- Native Hawaiian or Pacific Islander
- White
- Other: _____
- Prefer Not to Answer

3. Are you Spanish, Hispanic, Latino, or none of these?

- None of these
- Yes

4. Which gender do you identify as?

- Female
- Male
- Non-binary
- Prefer to self-describe: _____

5. What nursing specialty(s) do you have experience in?

- Critical Care
- Emergency Department
- Obstetrics
- Other: _____

6. How many years of experience do you have in the below specialties?

- Critical Care: _____
- Emergency Department: _____
- Obstetrics: _____
- Other: _____

7. Have you previously received education in Cardiac Arrest in Pregnancy?

- Yes
- No

If yes, what year (approximate) was the last time this was received? _____

Who delivered the education? (Select all that apply)

- During ACLS course
- During orientation
- Ongoing unit education
- Self-Taught

8. Have you previously received education in Cardiac Arrest in Pregnancy discussing

CONCURRENT maternal and neonatal resuscitation?

- Yes
- No

9. What email address would you like your learning module delivered to? _____

(This e-mail address will be used solely for the purpose of ensuring delivery of the learning strategy (module) to the correct address)

Appendix B

The Telic/Paratelic State Instrument (T/PSI)

The Telic/Paratelic State Measure is a 12-item scale with a 7-item Serious-Minded/Playful subscale and a 5-item Arousal-Seeking/Arousal Avoidance Subscale. The items ask participants to circle numbers on 6-point rating scales with items identifying oppositional states. Scores are summed to achieve subscale scores and the subscale scores are added together to produce a total score. The internal consistency reliability of this scale is a Cronbach's alpha of 0.89.

Feeling	1	2	3	4	5	6	Opposing Feeling

Copyright 1996, Judith Elaine Calhoun

Below are 12 pairs of words that are opposites. Please circle the number that is located BETWEEN each pair of words that best indicates how you were feeling in the LAST FEW MINUTES, just before you started filling out this questionnaire. For example, if the pair were

Happy 1 2 3 4 5 6 Sad

and you were definitely feeling happy, you would circle the "1."

If you were definitely feeling sad, you would circle the "6." If

You were feeling just a little bit sad, you would circle the "4."

- | | | | |
|---|---------------------------------------|-------------|--|
| 1 | Feeling playful | 1 2 3 4 5 6 | Feeling serious-minded |
| 2 | Wanting peace and quiet | 1 2 3 4 5 6 | Wanting adventure |
| 3 | Trying to accomplish | 1 2 3 4 5 6 | Just having fun something |
| 4 | Doing activity just for the fun of it | 1 2 3 4 5 6 | Doing activity because it may affect my future |
| 5 | Wanting to feel excitement | 1 2 3 4 5 6 | Wanting to feel calm |

6	Wanting to be serious	1 2 3 4 5 6	Wanting to be playful
7	Concerned about the future effects of my current activity	1 2 3 4 5 6	Not concerned about the future effects of my current activity
8	Wanting to just have fun	1 2 3 4 5 6	Wanting to accomplish something
9	Wanting to feel less aroused	1 2 3 4 5 6	Wanting to feel more aroused
10	Living for the moment	1 2 3 4 5 6	Focusing on the future
11	Feeling serious	1 2 3 4 5 6	Feeling playful
12	Feeling Adventurous	1 2 3 4 5 6	Not feeling adventurous

INSTRUCTIONS FOR SCORING THE TELIC/PARATELIC STATE INSTRUMENT (T/PSI)

1. The following items comprise the serious-minded/playful (SM/P) subscale:
1, 3, 4, 6, 8, 10, 11
2. The following items comprise the arousal-avoidant/arousal-seeking (AA/AS) subscale:
2, 5, 7, 9, 12
3. Recode items, 1, 4, 5, 8, 10, 12, so that a response of 1 equals a 6, a response of 2 equals a 5, a response of 3 equals a 4, a response of 4 equals a 3, a response of 5 equals a 2, and a response of 6 equals a 1.
4. Low values (1, 2, or 3) reflect the telic state. Higher values (4, 5, or 6) reflect the paratelic state.

5. Summed scores that are higher reflect the paratelic state; summed scores that are lower reflect the telic state.

Sum over the items for each subscale:

SM/P: 1, 3, 4, 6, 8, 10, 11

AA/AS: 2, 5, 7, 9, 12

Sum over the two subscales for get a total T/PSI score.

6. Range of possible scores

SM/P: 7-42

AA/AS: 5-30

T/PSI: 12-72

7. Suggested cut scores:

SM/P: telic = <23

paratelic = >22

AA/AS: telic = <18

paratelic = >17

T/PSI: telic = <41

Paratelic = >40

Author Permissions



Ivy Torres
To: OConnell, Kathleen
Cc: Kaur, Tresa



Sat 1/29/2022 6:56 PM

Thank you so much! And Thank you for the clarification.
Much appreciated,
Ivy

From: [OConnell, Kathleen](#)
Sent: Saturday, January 29, 2022 4:49 PM
To: [Ivy Torres](#)
Cc: [Kaur, Tresa](#)
Subject: Re: Reversal Theory

Here you go.
I'm not sure what you mean by reduced item set. We used fewer items in an ecological assessment study, but it's better to use this one.
KOC

Kathleen A. O'Connell, PhD, RN, FAAN
Isabel Maitland Stewart Professor of Nursing Education
Teachers College Columbia University
212 678-3120
occonnell@tc.columbia.edu

On Sat, Jan 29, 2022 at 3:04 PM Ivy Torres <it2242@tc.columbia.edu> wrote:

Hi KOC,
Hope all is well and that you're keeping warm amidst all the snow (if your in NY area).

I am considering incorporating The telic/paratelic state instrument (T/PSI) based on our discussion a few weeks ago. Would you be able to share the instrument as the participant would receive it? I see there is also a reduced item set as well, would you be able to share that one too?

Thank you very much,
Ivy

Appendix C

National League of Nursing (NLN) Student Satisfaction and Self-Confidence in Learning Scale

Instructions: This questionnaire is a series of statements about your personal attitudes about the instruction you receive during your simulation activity. Each item represents a statement about your attitude toward your satisfaction with learning and self-confidence in obtaining the instruction you need. There are no right or wrong answers. You will probably agree with some of the statements and disagree with others. Please indicate your own personal feelings about each statement below by marking the numbers that best describe your attitude or beliefs. Please be truthful and describe your attitude as it really is, not what you would like for it to be. This is anonymous with the results being compiled as a group, not individually.

Mark:

- 1 = STRONGLY DISAGREE with the statement
- 2 = DISAGREE with the statement
- 3 = UNDECIDED - you neither agree or disagree with the statement
- 4 = AGREE with the statement
- 5 = STRONGLY AGREE with the statement

Satisfaction with Current Learning	SD	D	UN	A	SA
1. The teaching methods used in this simulation were helpful and effective.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
2. The simulation provided me with a variety of learning materials and activities to promote my learning the medical surgical curriculum.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
3. I enjoyed how my instructor taught the simulation.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
4. The teaching materials used in this simulation were motivating and helped me to learn.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
5. The way my instructor(s) taught the simulation was suitable to the way I learn.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Self-confidence in Learning	SD	D	UN	A	SA
6. I am confident that I am mastering the content of the simulation activity that my instructors presented to me.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
7. I am confident that this simulation covered critical content necessary for the mastery of medical surgical curriculum.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
8. I am confident that I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a clinical setting	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
9. My instructors used helpful resources to teach the simulation.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
10. It is my responsibility as the student to learn what I need to know from this simulation activity.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
11. I know how to get help when I do not understand the concepts covered in the simulation.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
12. I know how to use simulation activities to learn critical aspects of these skills.	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
13. It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time..	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5

Author Permissions

Dear Ivy,

Thank you for your inquiry. We are pleased that you have decided to use one of NLN's simulation instruments for your dissertation research. NLN's instruments are available for researchers and students to download from the NLN website here: <http://www.nln.org/professional-development-programs/research/tools-and-instruments/descriptions-of-available-instruments>.

Before using the instrument, we ask that you please review the caveats that accompany permission for use of NLN's research instruments here, especially around modifying the instruments: <http://www.nln.org/newsroom/copyright-permissions>. We do allow modifications to our instruments, but as noted in the caveats for using the instruments, please understand that:

- Modifications to a survey/instrument may affect the reliability and/or validity of results. Any modifications made to a survey/instrument are the sole responsibility of the researcher.
- When published or printed, any research findings produced using an NLN survey/instrument must be properly cited. **If the content of the NLN survey/instrument was modified in any way, this must also be clearly indicated in the text, footnotes and endnotes of all materials where findings are published or printed.** The NLN does not provide permission for

If needed, the reliability and validity of the instruments are discussed in this summary report here: <http://www.nln.org/docs/default-source/professional-development-programs/read-the-nln-laerdal-project-summary-report-pdf.pdf?sfvrsn=0> (see page 6 for section on Instruments).

The NLN will allow you to publish findings based on the survey data, but we will not give you permission to publish the surveys verbatim in a manuscript. When you are ready to publish your findings, please send a separate request to this Copyright Permission inbox and we will send you a permission letter for the publisher of the specific journal, if required.

Regards, NLN Copyright Permissions

From: Torres, Ivy <lotiniano@northwell.edu>
Sent: Sunday, November 7, 2021 7:46 AM
To: Copyright Permission <cpermission@nln.org>
Subject: Permission: NLN Student Satisfaction and Self-Confidence in Learning

[EXTERNAL EMAIL] This email did not come from the NLN mail server. DO NOT CLICK links or attachments unless you recognize the sender and know the content is safe.

Good Morning,

I am asking for commercial use of the NLN "Student Satisfaction and Self-Confidence in Learning" instrument. I anticipate using this as part of my dissertation study with Columbia University Teachers College, EdD in Nursing Education, where chapters are expected to be published. In addition, the study is expected to be completed at Northwell Health.

Furthermore, I anticipate modifying the survey by replacing the word "simulation" with "learning module."

Would you please advise if these permissions are granted?

I thank you in advance for your time and consideration,
Ivy

Ivy Torres, MS, NPD-BC, RNC-OB, RNC-MNN, C-EFM, IBCLC

Appendix D

Gameful Experience Scale (GAMEX)

	Never	Rarely	Sometimes	Often	Always
All Questions	1	2	3	4	5

Items

Enjoyment

Playing the game was fun.

I liked playing the game.

I enjoyed playing the game very much.

My game experience was pleasurable.

I think playing the game is very entertaining.

I would play this game for its own sake, not only when being asked to.

Absorption

Playing the game made me forget where I am.

I forgot about my immediate surroundings while I played the game.

After playing the game, I felt like coming back to the “real world” after a journey.

Playing the game “got me away from it all”

While playing the game I was completely oblivious to everything around me.

While playing the game I lost track of time.

Creative thinking

Playing the game sparked my imagination.

While playing the game I felt creative.

While playing the game I felt that I could explore things.

While playing the game I felt adventurous.

Activation

While playing the game I felt activated.

While playing the game I felt jittery.

While playing the game I felt frenzied.

While playing the game I felt excited.

Absence of negative affect

While playing the game I felt upset.

While playing the game I felt hostile.

While playing the game I felt frustrated.

Dominance

While playing the game I felt dominant/I had the feeling of being in charge.

While playing the game I felt influential.

While playing the game I felt autonomous.

While playing the game I felt confident.

Author Permissions

Von: Kristina Klein <kklein@uni-bremen.de>
Gesendet: Dienstag, 9. November 2021 11:59
An: 'Torres, Ivy' <lotiniano@northwell.edu>
Cc: Bekk, Magdalena <bekk@wiso.uni-koeln.de>
Betreff: AW: Permission use of Gameful Experience Scale [GAMEX]

Dear Ivy,

I grant you permission to use the GAMEX scale as published in our paper; you will find the scale in our publication: Eppmann, René, Magdalena Bekk und Kristina Klein (2018). Gameful Experience in Gamification (GAMEX): Construction and Validation of a New Scale, Journal of Interactive Marketing, 43(August), 98-115;
<https://www.sciencedirect.com/science/article/abs/pii/S1094996818300124?via%3Dihub>

Best regards
Kristina Klein

From: Torres, Ivy
Sent: Sunday, November 7, 2021 7:55 AM
To: eppmann@wiso.uni-koeln.de; bekk@wiso.uni-koeln.de; k.klein@wiso.uni-koeln.de
Subject: Permission use of Gameful Experience Scale [GAMEX]

Good Morning,

I am asking for permission to use your Gameful Experience Scale [GAMEX]. I anticipate using this as part of my dissertation study with Columbia University Teachers College, EdD in Nursing Education, where chapters are expected to be published. In addition, the study is expected to be completed at Northwell Health.

No modifications will be made to the instrument.

Would you please advise if these permissions are granted? Also, may I receive a copy of the scale to include in my dissertation appendixes?

I thank you in advance for your time and consideration,
Ivy

Ivy Torres, MS, NPD-BC, RNC-OB, RNC-MNN, C-EFM, IBCLC

Appendix E

Knowledge Pre/Post Quiz

Knowledge Quiz Part I

Instructions: This is a multiple-choice 20-item Knowledge Quiz. Please circle the answer that best fits the question and only submit one answer per question.

1. A code blue is called on a 26-year-old G1P0 at 34 weeks gestation found unresponsive, apneic, and pulseless. The most appropriate position for performing chest compressions is:

- a. Supine
- b. Reverse Trendelenburg
- c. Supine with displacement of the uterus
- d. Lithotomy

Answer: C. This option promotes for circulation, improving outcomes with cardiac arrest in pregnancy (AHA, 2015).

2. Regarding the use of epinephrine in a pregnant person experiencing cardiac arrest:

- a. Epinephrine is avoided, as it will cause decreased uterine blood flow.
- b. Epinephrine is avoided, as it will cause fetal tachycardia.
- c. Epinephrine is indicated in full ACLS doses.
- d. Epinephrine is indicated decreased doses to avoid deleterious effects on the fetus.

Answer: C. Recommendation from the American Heart Association indicates full Epinephrine dosages (2015).

3. Regarding the use of defibrillation in a pregnant person experiencing cardiac arrest:

- a. DO NOT defibrillate.
- b. Do defibrillate but at decreased energy levels.
- c. Only defibrillate after 5 minutes have elapsed and epinephrine is given.
- d. Defibrillation recommendations does not change in the pregnant population.

Answer: E. Recommendation from the American Heart Association indicates no changes in defibrillation recommendation in pregnancy (2015).

4. A pregnant woman has been in cardiac arrest in the emergency room and has been receiving ACLS resuscitation for five minutes. The most appropriate treatment is:

- a. Begin high dose epinephrine, at doses of 1 mg/kg IV every 5 minutes.
- b. Begin magnesium sulfate, 1 gram IV over 5 minutes.
- c. Call surgeons to open her chest to begin open cardiac massage.
- d. Deliver the baby by emergent cesarean section.

Answer: D. Recommendation from the American Heart Association indicates delivery within 5 minutes (2015).

5. A 35-year-old G2P1 at 36 weeks gestation experiences a cardiac arrest and chest compressions appear to be ineffective after 4 minutes. What should be done next?

- a. Call for cesarean section equipment, an obstetrician, and a neonatologist STAT to perform a cesarean section in the labor and delivery room.
- b. Transport STAT to the nearest OR for a cesarean delivery
- c. Place the patient on her right side with a wedge under her left flank.
- d. Defibrillate at 100 joules, repeat at 200 joules, then 360 joules thereafter

Answer: A. Recommendation from the American Heart Association indicates performing cesarean delivery in location of arrest (2015).

6. An 18-year-old G3P2 at 25 weeks gestation is rushed into the emergency department in pulseless ventricular tachycardia. The appropriate first step is to:

- a. Give epinephrine 1-gram IV push.
- b. Intubate
- c. Transfer to the OR for immediate cesarean delivery
- d. Manually displace the uterus leftward and begin chest compressions.

Answer: D. Recommendation from the American Heart Association indicates manual displacement of uterus and chest compressions (2015).

7. During pregnancy, major physiologic changes occur that affect resuscitation measures in a parturient in cardiac arrest. These include:

- a. decreased circulating blood volume, as up to a third of the maternal blood volume may be in the placenta.
- b. decreased cardiac output that predisposes to extreme bradycardia and hypotension.
- c. the gravid uterus, after 20 weeks gestation, compresses the iliac vessels and inferior vena cava causing increased SVR and hypertension.
- d. increased airway edema and altered airway anatomy that may predispose to difficult intubation.

Answer: D. Increased airway edema has been attributed to difficult intubations in pregnancy (AHA, 2015).

8. At what gestational age is a perimortem cesarean delivery recommended:

- a. 20 weeks
- b. 21 weeks
- c. 22 weeks
- d. 23 weeks

Answer: A. Recommendation from the American Heart Association indicates perimortem cesarean delivery after 20 weeks gestation (2015).

9. The gestational age for recommended interventions such as a perimortem cesarean delivery is best assessed if the pregnant persons fundus is at the level of:

- a. Their elbow
- b. Their umbilicus
- c. Their xiphoid process
- d. Their symphysis pubis

Answer: B. The umbilicus is generally the best landmark to identify gestational age (AHA, 2015).

10. A 26-year-old G2P1 at 36 weeks gestation is admitted after a motor vehicle accident. She is combative and becomes unresponsive. The first intervention should be:

- a. Intubation
- b. Shock with 200J
- c. Epinephrine 500 mg IV

d. Position her with a wedge under her right flank to relieve compression of the uterus on the great vessels, then start ACLS.

Answer: D. Recommendation from the American Heart Association indicates supporting displacement of uterus for improved circulation (2015).

11. Recommendations for a perimortem cesarean delivery include delivery within how many minutes from time of cardiac arrest:

- a. 3 minutes
- b. 4 minutes
- c. 5 minutes
- d. 10 minutes

Answer: C. Recommendation from the American Heart Association indicates 5 minutes (2015).

12. On a pregnant person CPR is completed:

- a. At a higher level than anatomically recommended by the American Heart Association
- b. At a lower level than anatomically recommended by the American Heart Association
- c. At the same level as recommended for adults by the American Heart Association
- d. Chest compressions are not recommended in pregnant individuals.

Answer: C. Recommendation from the American Heart Association indicates chest compressions at the same level (2015).

13. One of these most essential instruments to have when a pregnant person is experiencing cardiac arrest is:

- a. Electronic Fetal Monitor
- b. Scalpel
- c. Betadine
- d. Lucas (Chest Compression System)

Answer: B. Recommendation from the American Heart Association recommends prompt delivery where a scalpel is necessary (2015).

14. The recommended location for a perimortem cesarean delivery (PCMD) is:

- a. Operating Room in Labor in Delivery
- b. As close as possible to the Neonatal Intensive Care Unit (NICU)
- c. Do not relocate, complete perimortem cesarean delivery (PCMD) in location of occurrence.
- d. Perimortem cesarean delivery is only to be performed in tertiary care hospitals.

Answer: C. Recommendation from the American Heart Association indicates PCMD in location of cardiac arrest (2015).

15. After a perimortem cesarean delivery, there has been a noticed:

- a. Decrease in venous return (ROSC)
- b. Increase in venous return (ROSC)
- c. No change in venous return (ROSC)
- d. Increase in peripheral return

Answer: B. Recommendation from the American Heart Association indicates PCMD results in increase in venous return (2015).

Knowledge Quiz Part II

16. You anticipate delivery of a newborn. Which do you prioritize obtaining before delivery:

- a. Bulb Suction
- b. ET Tube
- c. Neonatal Warmer
- d. Blankets

Answer: C. According to the Neonatal Resuscitation Program warming the infant is prioritized before delivery (2015).

17. The newborn delivered is not crying, is limp and needs neonatal resuscitation. The first step to take is:

- a. Pat
- b. Dry
- c. Stimulate
- d. Warm

Answer: D. According to the Neonatal Resuscitation Program the initial step in resuscitation is to warm (2015).

18. When using suction to clear secretions, first suction the newborn's (mouth)/(nose).

Answer: Mouth. According to the Neonatal Resuscitation Program mouth precedes the nose in suctioning (2015).

19. You suction the newborn too deeply and you anticipate you may illicit what type of response:

- a. No response
- b. Bradycardia
- c. Tachycardia
- d. Palpitations

Answer: B. According to the Neonatal Resuscitation Program deep suctioning can elicit a vagal response contributing to bradycardia (2015).

20. You have provided warmth, positioned the head and neck, cleared the airway, dried, and stimulated a newborn. It is now 60 seconds after birth, and she is still apneic and limp. Your next action is to:

- a. Continue stimulation by vigorously rubbing her back and extremities.
- b. Give free-flow supplemental oxygen.
- c. Consider making the infant warmer.
- d. Start positive-pressure ventilation.

Answer: D. According to the Neonatal Resuscitation Program positive-pressure ventilation is indicated next after initial steps are unsuccessful (2015).

21. Which image shows the correct way to position a newborn's head to open the airway (A, B, or C)? _____



A

B

C

Answer: C. According to the Neonatal Resuscitation Program the correct position is indicated as the “sniffing” position as seen in image “C” (2015).

22. Had you previously noticed the newborn was gasping, your next intervention would have been to:

- a. Suction
- b. Stimulate
- c. Provide PPV
- d. Change the warm blanket.

Answer: C. According to the Neonatal Resuscitation Program in the absence of effective initial interventions the next appropriate step is to provide PPV (2015).

23. Upon your colleague’s assessment, they announce a HR of 90 on the newborn, your next intervention is:

- a. Continue providing PPV.
- b. Start Chest Compressions
- c. Suction the newborn.
- d. Start drawing up Epinephrine.

Answer: A. According to the Neonatal Resuscitation Program in the presence of a HR less than 100 but greater than 60 continue to provide PPV (2015).

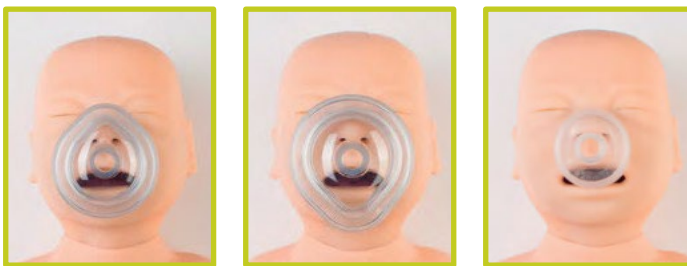
24. The single most important and most effective step in neonatal resuscitation is (aggressive stimulation)/(ventilation of the lungs).

Answer: ventilation of the lungs. According to the Neonatal Resuscitation Program the most effective step in neonatal resuscitation is ventilation (2015).

25. If a baby is born limp and apneic. You place her under a radiant warmer, position her airway, remove secretions, and dry and stimulate her. She does not improve. The next step is to (stimulate her more)/ (begin positive-pressure ventilation).

Answer: begin positive-pressure ventilation. According to the Neonatal Resuscitation Program if initial steps are not successful the next indicated step is to provide PPV (2015).

26. Which mask is the correct size and correctly placed on the newborn's face? _____



A

B

C

Correct Answer: A. According to the Neonatal Resuscitation Program the appropriate mask placement corresponds to image A with appropriate alignment of nose and mouth and corresponding mask placement (2015).

27. Administer positive-pressure ventilation at a rate of (20 to 25 breaths per minute)/(40 to 60 breaths per minute).

Answer: B. According to the Neonatal Resuscitation Program the positive-pressure ventilation rate is 40-60 breaths per minute (2015).

28. You count a newborn's heartbeat for 6 seconds and count 6 beats. You report the heart rate as (36 beats per minute)/(60 beats per minute).

Answer: 60 beats per minute. According to the Neonatal Resuscitation Program counting a heartbeat for 6 seconds with 6 beats indicates a heart rate of 60 beats per minute (2015).

29. If positive-pressure ventilation is given, at least (1)/(2) qualified providers will be needed at the radiant warmer to perform the necessary steps efficiently.

Answer: 2. According to the Neonatal Resuscitation Program two qualified providers need to be available to perform necessary steps efficiently (2015).

30. The rhythm for positive-pressure ventilations (PPV) alone is:

a. Breathe 2 3, Breathe 2 3, Breathe 2 3

b. 1 and 2 and 3 and Breathe, 1 and 2 and 3 and Breathe

c. Breathe 1 2 3, Breathe 1 2 3, Breathe 1 2 3

d. Breathe 1 2, Breathe 1 2, Breathe 1 2

Answer: A. According to the Neonatal Resuscitation Program the recommended rhythm for PPV alone is Breathe 2 3, Breathe 2 3, Breathe 2 3 (2015).

Author Permissions

From: Brendan Carvalho <carvalb@stanford.edu>
Sent: Sunday, November 7, 2021 11:48 PM
To: Torres, Ivy <lotiniano@northwell.edu>
Subject: [EXTERNAL] RE: Permission: Use of Cardiac Arrest in Pregnancy Survey

External Email. Do not click links or open attachments unless you trust the sender and content. Report suspicious emails using Report Phishing button or forward email to phish@northwell.edu

Sure you have my permission. I no longer have a copy of the survey, but you can get it from the original study appendix.
Brendan

Brendan Carvalho MBBCh, FRCA, MDCH, FASA
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Stanford University School of Medicine
453 Quarry Road, Palo Alto, CA 94304
Phone: 650-861-8607
Fax: 650-725-8544
E-mail: bcarvalho@stanford.edu

From: Torres, Ivy <lotiniano@northwell.edu>
Sent: Sunday, November 7, 2021 5:11 AM
To: Brendan Carvalho <carvalb@stanford.edu>
Subject: Permission: Use of Cardiac Arrest in Pregnancy Survey

Good Morning,

I am asking for permission to use your questions 1-10 from your 12 question Cardiac Arrest in Pregnancy Survey. I anticipate using this as part of my dissertation study with Columbia University Teachers College, EdD in Nursing Education, where chapters are expected to be published. In addition, the study is expected to be completed at Northwell Health.

Would you please advise if these permissions are granted? Also, may I receive a copy of the survey to include in my dissertation appendixes?

I thank you in advance for your time and consideration,
Ivy

Ivy Torres, MS, NPD-BC, RNC-OB, RNC-MNN, C-EFM, IBCLC

Appendix F

Teachers College IRB Approval

Attachments:

- Expedited Review Approved by Chair - IRB ID: 22-280.pdf



Teachers College IRB

Expedited Approval Notification

To: Ivy Torres
From: Amanda O'Hara
Subject: IRB Approval: 22-280 Protocol
Date: 05/25/2022

Please be informed that as of the date of this letter, the Institutional Review Board for the Protection of Human Subjects at Teachers College, Columbia University has given full approval to your study, entitled "*Cardiac Arrest in Pregnancy Escape Room: An Experimental Education Approach in a Concurrent Maternal and Neonatal Emergency Response*," under **Expedited Review** on 05/25/2022: Category (7) Research on individual or group characteristics or behavior

The IRB Committee must be contacted if there are any changes to the protocol during this period. Under the new IRB regulations, continuing review for this study is not required. If you encounter any problems or issues, please contact the IRB office to discuss. When you have completed the study, please terminate using the "Terminate Protocol" button at the top of the view protocol page in Mentor IRB. The IRB number assigned to your protocol is **22-280**. Feel free to contact the IRB Office (212-678-4105 or irb@tc.edu) if you have any questions.

Please note that your Consent form bears an official IRB authorization stamp and is attached to this email. Copies of this form with the IRB stamp must be used for your research work. Further, all research recruitment materials must include the study's IRB-approved protocol number.

As the PI of record for this protocol, you are required to:

- Use current, up-to-date IRB approved documents
- Ensure all study staff and their CITI certifications are on record with the IRB
- Notify the IRB of any changes or modifications to your study procedures
- Alert the IRB of any adverse events

You are also required to respond if the IRB communicates with you directly about any aspect of your protocol. Failure to adhere to your responsibilities as a study PI can result in action by the IRB up to and including suspension of your approval and cessation of your research.

You can retrieve a PDF copy of this approval letter from Mentor IRB.

When your study ends, please visit the IRB Mentor site. Go to the view protocol page and click on the "Terminate Protocol" button at the top.

Best wishes for your research work.

Sincerely,
Amanda O'Hara

amanda.oharaa@gmail.com

Northwell IRB Approval Letter



Institutional Review Board
FWA #00002505
Office of the Human Research Protection Program
125 Community Drive
Great Neck, NY 11021
Phone: 516-465-1910

The study cannot begin enrollment until you receive Northwell Institutional Approval (IA). Institutional Approval is separate from IRB approval, and will be issued in a separate letter. For IA guidance click [here](#), or visit the HRPP website.

To: Ivy Torres

From: Human Research Protection Program

Date: September 19, 2022

RE: **IRB #:** 22-0683
 Protocol Title: Cardiac Arrest in Pregnancy Escape Room: An Experimental Education Approach in a Maternal and Neonatal Emergency Response

Dear Ivy Torres:

The above referenced project meets the criteria outlined in 45 CFR 46.101 for EXEMPTION. The following category applies to the project:

45CFR46.104(d)(1) - Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction.

The following people are approved to participate in this study: Ivy Torres.

It is your responsibility to notify the IRB in writing of any changes or modifications made in the research study design, procedures, etc. which do not fall within one of the exempt categories. Such changes necessitate a new, complete IRB submission. If the IRB receives no correspondence on this study for three years, the file will be closed.

The Institutional Review Board will be notified of this action at a meeting.

Investigators are reminded that research must be conducted in accordance with all applicable Department of Health and Human Services regulations 45 CFR 46, Food and Drug Administration regulations 21CFR 50, 21CFR 56, 21 CFR 312, 21 CFR 812, and the Health Insurance Portability and Accountability Act (HIPAA).

All studies are subject to audits by the Office of Research Compliance and/or Institutional Review Board to confirm adherence to institutional, state, and federal regulations governing research.

NOTE: This approval is subject to recall if at any time the conditions and requirements as specified in the IRB Policies and Procedures are not followed (see next page and web site: <https://feinstein.northwell.edu/sites/northwell.edu/files/2020-12/HRPP-Policies-and-Procedures.pdf>)

NOTE: All IRB Policies and Procedures must be followed, including the following:

1. Using only IRB-approved consent forms, questionnaires, letters, advertisements, etc. in your research.
2. Submitting any modifications made to the study for IRB review prior to the initiation of changes except when necessary, to eliminate apparent, immediate hazards to the subject.
3. Reporting unanticipated problems involving risk to subjects or others.
4. Prior to implementation, any changes made to studies utilizing TAP must have COPP, as well as IRB approval.

Northwell Institutional Approval



FWA #00002505
Human Research Protection Program
125 Community Drive
Great Neck, NY 11021
Phone: 516-465-1910

****THE BELOW REFERENCED STUDY MAY NOW BEGIN ENROLLMENT****

To: Ivy Torres

From: Kevin J. Tracey, MD
Executive Vice President, Research

A handwritten signature in black ink, appearing to read "Kevin J. Tracey".

Date: September 28, 2022

Re: **IRB #:** 22-0683

Protocol Title: Cardiac Arrest in Pregnancy Escape Room: An Experimental Education Approach in a Maternal and Neonatal Emergency Response

Dear Ivy Torres:

The Feinstein Institute for Medical Research has confirmed that the above referenced study has obtained all appropriate approvals.

The above referenced study now has institutional approval for commencement at the Northwell Health Facilities listed in the initial submission application.

Please note: It is the study team's responsibility to contact with Research IT for all future modifications regarding the electronic data storage.