EXPLORING THE LIVED EXPERIENCES OF DENTAL HYGIENE FACULTY USING SIMULATION WITH DENTAL MANIKIN HEAD DEVICES TO TEACH LOCAL ANESTHESIA

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ABSTRACT

This study employed a qualitative phenomenological methodology to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. This study aimed to address the gap in the literature given the lack of discussion regarding dental manikin head simulation use in teaching local anesthesia within dental hygiene education. The purpose extended to explore if educators could guide students and ease anxieties by incorporating simulation in the development of treatment skills on a manikin before applying these skills to real-life interactions. John Dewey's (1938) concept of interconnectedness between education and experience and David Kolb's (1984) theory of experiential learning were the frameworks that directed this study. Eight semi-structured interviews were conducted to answer this study's research questions. Four themes emerged from this study's findings, including empowerment, beneficial preparation, concerns as a challenge, and support. This study's participants reported their experiences related to the use of simulation with dental manikin head devices in teaching local anesthesia education and described the benefits and challenges in preparing students to administer local anesthesia. This research added additional perspective to the limited body of literature regarding the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. Findings implied that simulation training fosters faculty teaching methods and student development by easing student uncertainties, increasing confidence levels, and enhancing hands-on skills and critical thinking skills within a safer and less intimidating learning environment.

Keywords: dental hygiene education, local anesthesia education, dental manikin head devices, simulation-based learning, simulation education

DEDICATION

My work is dedicated to those who have never left my side, guiding my inner strength and resilience to keep smiling and shining.

To my parents, Sal and Carol Castro. I cannot express my gratitude enough for your never-ending love and support throughout every step of my life. You have been instrumental in molding my perspective on education, hard work, and determination. There are no words to truly capture how appreciative I am of you both. You are my foundation. You have held my pieces together and encouraged me to persevere. I love you both more than anything.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1: INTRODUCTION

The concept of using simulation in dental education dates to the 19th century (Buchanan, 2001; Mustilwar et al., 2022; Perry et al., 2015). Traditionally used as simulation in the initial stages of dental curricula, the first phantom dental manikin head simulator was created in 1894 by Oswald Fergus to improve realism in teaching oral anatomy and physiology to dental students (Perry et al., 2015; Serrano et al., 2020). As technology evolved, more advanced computer-aided dental simulation technology appeared in the 1990s (Serrano et al., 2020) due to further research into methods of dental preclinical education, concern for patient safety, improvements in computer technology, and the inappropriateness of a clinical environment for the novice (Li et al., 2021). Simulation technology encompasses the umbrella term extended reality (XR), which includes virtual reality (VR), augmented reality (AR), and mixed reality (MR) (Buchanan, 2001; Lee et al., 2022). Dental education is one of the few disciplines where invasive procedures must be performed on live human subjects under minimal supervision to achieve the clinical competence necessary to provide independent patient care (Serrano et al., 2020).

The practice of dental hygiene and local anesthesia delivery requires attention to detail, meticulous manual dexterity, and demands acquisition and maintenance of specific fine motor skills (Dixon et al., 2020; Haji et al., 2021). Additionally, the application of anesthesia requires cognitive abilities, procedural knowledge, and immense knowledge of the facial nerves and structures to determine the proper placement and delivery of anesthetics (Correa et al., 2017; Hanson, 2011). Supplemental to the didactic delivery of education, dentistry incorporates clinical laboratory portions that require students to practice on one another (Brand et al., 2010; Correa et al., 2017). While effective and necessary, practicing on one another becomes a challenge with anesthesia delivery due to potential risks, complication concerns, and student practical

apprehensions (Correa et al., 2017; Haji et al., 2021). Provided as a means for pain management, the practical application of local anesthesia creates ethical trepidations as the administration of a potentially toxic anesthetic medication is being delivered for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021).

Local anesthesia administration is a safe and effective method used to manage pain and accomplish optimal patient comfort in dental treatment (Reed et al., 2012). In 1971, Washington became the first state to allow dental hygienists to provide pain management with local anesthesia (Smith et al., 2019). Over the years, local anesthesia supervision laws for dental hygienists have varied from state to state, where some have granted indirect supervision permission where the supervising dentist must be on the premises and available during administration, some have granted permission that is partial and specific to the type of anesthesia technique, and others have granted direct supervision permission where the supervising dentist must be present while the operator performs the procedure (Smith et al., 2019). The decision to allow dental hygienists to administer local anesthesia has since been supported by dentists and incorporated into the National Board Dental Hygiene Examination, which is offered under the auspices of the Joint Commission on National Dental Examinations, an agency of the American Dental Association (American Dental Hygienists' Association, 2023a; Manski & Cartee, 2015; Pocket Dentistry, 2016). At the time of this writing, only Texas and Delaware did not permit dental hygienists to administer local anesthesia, while the law allowing dental hygienists to administer local anesthesia in Georgia and Mississippi had passed and was in the stage of rules and regulation (Texas Dental Hygienists' Association, 2023). However, of the states that permitted dental hygienists to administer local anesthesia, New York, South Carolina, and

Alabama were three states that at the time of this writing still limited dental hygienists to administer nerve block anesthesia, only permitting local infiltration anesthesia (American Dental Hygienists' Association, 2023b; Manski & Cartee, 2015; Pocket Dentistry, 2016). A type of local anesthesia, nerve block anesthesia involves the more common technique known as inferior alveolar nerve block anesthesia (Reed et al., 2012). This nerve block anesthesia technique is included in the National Board Dental Hygiene Examination, holding dental hygiene students accountable for knowing how to administer this type of anesthesia nationwide, yet some institutions are not able to provide hands-on experience for students (Pocket Dentistry, 2016). Permission to administer inferior alveolar nerve block anesthesia is a highly anticipated request dental hygienists persistently advocate for (Smith et al., 2019), as safe administration of local anesthesia by dental hygienists has been consistently documented since the 1970's (Boynes & Bassett, 2016; Manski & Cartee, 2015; Reed et al., 2012; Smith et al., 2019), local infiltration anesthesia can be limiting, and nerve block anesthesia could provide a quicker and more efficient numbing route (Becker & Reed, 2012; Manski & Cartee, 2015).

The concept of simulation through simulation-based learning has generated interest as an alternative educational approach in health care training to allow for smoother transition into the clinical environment through skill development by replicating real-life scenarios, reinforcement of ergonomics and skillset, increased procedural practice, and ensured patient safety (Davitadze et al., 2022; Loutet et al., 2020). Concerns began emerging in the practice of local anesthesia education in that students practice on their peers prior to performing their skills on an actual patient to prove competency (Mladenovic et al., 2019; Sjöström & Brundin, 2021; Zafar et al., 2022; Zafar et al., 2021). Not only does the skill of administering local anesthesia include cognitive abilities, procedural knowledge, and motor skills, but ethical considerations are

questioned as students are indeed introducing potentially toxic anesthetic medication into the bloodstream of peers for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021). An effective measure to reduce human subject danger risk with such an application involving potential for adverse events is by incorporating simulation into the curriculum, providing students with the opportunity to first perform aspects of necessary procedural and specific skills within a realistic, safe, and controlled environment (Ramlogan et al., 2021). Researchers first started investigating the use of simulation technology as a possible alternative to the use of human subjects for the instruction and evaluation of clinical skills (Hanson, 2011). By incorporating this simulation concept, students can learn treatment skills on a manikin before applying such skills to real world interactions (Imran et al., 2021). In dental education, simulation technology has been more recently used as an adjunctive to traditional clinical skill training prior to treatment on actual patients (Moussa et al., 2022; Perry et al., 2015; Serrano et al., 2020). The COVID-19 pandemic encouraged more education to start being performed on dental manikin head devices within dentistry (Clemente et al., 2021). For training purposes, specifically for administering local nerve block anesthesia, dental manikin head devices are available but not as often utilized.

Numerous studies have examined dental manikin head device simulator use in dentistry (Dixon et al., 2020; Haji et al., 2021; Li et al., 2021; Moron, 2020; Nassar & Tekian, 2020; Serrano et al., 2020). However, there is minimal literature on the use of simulation in dental hygiene education. This study will address the gap in the literature as there is a lack of discussion regarding dental manikin head simulation use in teaching local anesthesia within dental hygiene education. While simulation is not a new approach in dental and medical education (Lateef, 2010; Perry et al., 2015), the hands-on allied health profession of dental hygiene has rarely

incorporated simulation technique in dental hygiene curricula to teach local anesthesia education. Simulation technology has been utilized in health education programs over recent decades to strengthen skill, enhance procedure, and reduce harm (Lateef, 2010; Perry et al., 2015; Ramlogan et al., 2021). This study focused on the lived experiences of dental hygiene faculty in the exploration of incorporating simulation with dental manikin head devices in teaching local anesthesia as a precursor to working on live human subjects. This was accomplished by reviewing the literature regarding simulation using dental manikin head devices, simulation technology in dental education, uncertainties related to simulation including faculty concerns implementing simulation and faculty apprehensions in losing the traditional teaching approach, limitations and advantages of simulation, personal connection with simulation and learning, faculty development as a result of incorporating simulation, and student development using simulation.

Definition of Key Terms

Augmented reality (AR): Augmented reality is defined as a superimposition of computer-generated graphics over a real-life scene without the demonstration of natural circumstances (Moussa et al., 2022). Augmented reality differs from VR in that AR is a form of technology that integrates both real and virtual elements in a combined experience, allowing learners to visualize complex spatial relationships, abstract concepts, and experience phenomena that may have otherwise been unachievable in the real world (Moussa et al., 2022).

Dental hygiene: The science and practice of the recognition, treatment, and prevention of oral diseases accomplished as an occupation consisting of dental hygienists who clean and examine teeth and supporting oral and maxillofacial structures (Bowen, 2013).

Dental manikin head devices: A phantom model head used in dental training to gain experience and skill from technique application by replicating hard and soft tissues of the oral cavity (Li et al., 2021).

Ergonomics: The science and study of people's efficiency in their working environment by designing and arranging usable objects to help reduce fatigue and increase productivity (Gupta et al., 2014).

Extended reality (XR): Refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. It includes augmented reality, mixed reality, virtual reality, and the areas interpolated among them (Lee et al., 2022).

Haptic reality (HR): A more recent simulation technology that involves the user experiencing tactile sensations while interacting with computer-generated objects (Moussa et al., 2022). Haptics refers to the sense of touch and consists of incorporating interaction with the external environment through contact (Moussa et al., 2022).

Infiltration anesthesia: Local anesthetic delivery directly into an area of terminal nerve endings (Bassett et al., 2011).

Local anesthesia: A type of pain control that refers to using a drug called an anesthetic to temporarily numb a small area of the body (Reed et al., 2012). Local anesthesia in the context of this study refers to anesthesia given intraorally in anticipation of dental procedures.

Nerve block anesthesia: The injection of numbing medication (local anesthetic) delivered closer to the nerve trunk, blocking sensation to the teeth, jaw, or lips (Reed et al., 2012).

Simulation: A situation in which a set of conditions is created artificially for the purpose of study or experience in something that might exist in actual reality (Buchanan, 2001).

Virtual reality (VR): A computer-generated medical simulation of a three-dimensional image or environment that uses software to create a computer-generated environment (Bhandari et al., 2021; Moussa et al., 2022). In VR, users can utilize a head-mounted display that places them inside an experience where they can feel as though they are realistically engaging with the setting and virtual characters (Moussa et al., 2022).

Statement of the Problem

Concerns have emerged in the educational setting of the practical administration of local anesthesia, as students learn to deliver local anesthesia on their peers prior to performing their skills on a live patient to demonstrate competency (Mladenovic et al., 2019; Sjöström & Brundin, 2021; Zafar et al., 2022; Zafar et al., 2021). The problem is the lack of discussion regarding simulation including the use of dental manikin head devices being used among faculty within dental hygiene institutions when teaching local anesthesia in dental hygiene education (Hanson, 2011; Zafar et al., 2021). The standard procedure of local anesthesia education on live human subjects introduces increased student apprehension, prospective ethical dilemmas, and hazard in the practical application and administration of a potentially toxic anesthetic medication for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021). Numerous studies have examined dental manikin head simulator use in dentistry (Dixon et al., 2020; Haji et al., 2021; Li et al., 2021; Moron, 2020; Nassar & Tekian, 2020; Serrano et al., 2020), however, few studies focus on the use in dental hygiene education. Not only does the skill of administering local anesthesia include cognitive abilities, procedural knowledge, and motor skills, but ethical considerations are

questioned as students are indeed introducing potentially toxic anesthetic medication into the bloodstream of peers for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021).

Purpose of the Study

The purpose of this qualitative phenomenological study was to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. Simulation with dental manikin head devices was referred to as simulation, and more advanced computer-aided simulators were referred to as simulation technology. Simulation technology, including extended reality (XR), which involves virtual reality (VR), augmented reality (AR), and mixed reality (MR) in dentistry provides the opportunity for students to develop psychomotor skills for procedures by practicing pre-clinical, standardized learning competencies with the opportunity to receive objective and reproducible feedback before they engage in patient-management (Haji et al., 2021; Perry et al., 2015). The purpose extends to explore if educators can guide students by incorporating simulation in the development of treatment skills on a manikin before applying these skills to real-life interactions, thereby offering a safer and less intimidating approach to learning (Imran et al., 2021).

Research Questions and Design

The research questions explored are as follows:

- Research Question 1: How do dental hygiene faculty describe the use of simulation with dental manikin head devices when teaching local anesthesia education?
- Research Question 2: How do dental hygiene faculty describe the benefits and challenges in preparing students for administering local anesthesia?

A phenomenological qualitative design guided this study. Interviews were conducted using the English language through a video-conferenced Zoom meeting. Dental hygiene is a profession that is considered one of allied health, directly involving the concerns of individual's everyday lives in a continual quest to meet best practices for optimal oral and overall health (Asadoorian et al., 2019). Thus, qualitative research is an appropriate fit as qualitative research has been described as a research design comprised of ongoing knowledge sought out by people to make meaning of the activities or experiences that they engage in as they occur (Merriam & Tisdell, 2016).

Conceptual and Theoretical Framework

According to Ravitch and Riggan (2017), the conceptual framework is a representation of the building blocks through which a study is conducted, including its importance and why it matters. The framework is the foundation that gives a study its shape (Ravitch & Riggan, 2017). Through the research methodology, design, and interpretation of the data, the conceptual framework articulates the researcher's choices so that both the researcher and the reader can evaluate the findings that feed back into the conceptual framework (Ravitch & Riggan, 2017). The conceptual framework serves as a guiding tool for those involved in the research process. John Dewey's (1938) concept of interconnectedness between education and experience directed this research conceptually in that learning occurs when students are permitted to take their learning into their own hands by expressing their curiosity and impulse. This simulation approach allows students to practice until mastery, embrace mistakes, and look to correct errors in a judgement-free zone without restriction or reprimand by the educator. When the educator views teaching and learning as a continuous process of reconstructing experience, it is possible

to look to the future with the notion of taking each experience as a building block towards a foundation that influences future experiences (Dewey, 1938).

Dewey (1938) posited that the key to successful learning is having a foundation in education grounded in a theory of real-world experiences that offer growth, imagination, and skill strengthening. The focus of this study was to provide insight on how dental hygiene faculty perceive simulation using dental manikin head devices to teach local anesthesia in dental hygiene education. Numerous studies have examined dental manikin simulator use in dentistry (Dixon et al., 2020; Haji et al., 2021; Li et al., 2021; Moron, 2020; Nassar & Tekian, 2020; Serrano et al., 2020). However, few studies focus on the use in dental hygiene education. In its evaluation of the lived experiences of dental hygiene faculty in using simulation with dental manikin head devices in teaching local anesthesia as a precursor to working on live human subjects, the theoretical framework directing this research is modeled after David Kolb's (1984) theory of experiential learning. In this model, teaching by modeling the experiential learning process begins with experience, followed by learner reflection. The learner processes the learning experience and applies the knowledge or skills following the creation of learning from reflection.

Assumptions, Limitations, and Scope

The assumptions within this study were that dental hygiene faculty participants would answer all interview questions based on their comprehension level. Participants' level of comprehension of the information being asked of them was considered by the researcher. Limitations involved with this study included the specific population chosen for this study being four states within the Northeastern United States as this may have limited institutions who have incorporated simulation into their programs. The scope of this study was limited to faculty in schools within four states of the Northeastern United States who have this experience. Financial

burden within programs to incorporate dental manikin head simulators exists as they are expensive, limiting potential faculty with experience. It was beneficial to investigate how many programs use or do not use simulation and associated technology.

Rationale and Significance

Dental education is complex in delivery, as attaining theoretical knowledge requires spatial imagination and traditional manikin simulation does not resemble realistic clinical situations in patient-centered training (Moussa et al., 2022; Serrano et al., 2020). The advancement of the field of dental hygiene encourages the enhancement of safe and effective educational methodologies. The lack of discussion in the literature regarding the use of dental manikin head devices within local anesthesia education is a concern as there are more conducive methods to use initially in avoidance of potential risks, adverse reactions, and hesitancies in the administration of anesthetic medication for nontreatment purposes (Haji et al., 2021; Hanson, 2011). Dental manikin head simulator training can also allow for intentional error and reflection for real student learning in dental anesthesia delivery.

Summary

The dental hygiene profession is facing an evolving landscape. Dental hygiene faculty are being challenged to adapt and develop new teaching methods to reach different levels of student learning in changing times. The practice of dental hygiene and dental anesthesia delivery requires attention to detail, meticulous manual dexterity, and demands acquisition and maintenance of specific fine motor skills (Dixon et al., 2020; Haji et al., 2021), yet clinical laboratory portions require students to practice on one another (Brand et al., 2010; Decloux & Ouanounou, 2020), leaving practical application open to ethical concerns and student practical apprehensions (Correa et al., 2017; Haji et al., 2021). An effective measure to reduce human

subject danger risk, potential for adverse events, and student apprehensions with such an application involving ethical concern is by incorporating simulation into the dental hygiene curriculum for a more controlled and safer environment conducive to learning (Ramlogan et al., 2021). This study addressed the gap in the literature in the lack of discussion regarding dental hygiene faculty utilizing dental manikin head device simulation-based training to teach local anesthesia within dental hygiene education. By focusing on the lived experiences of faculty, Chapter 2 will review the literature using the themes simulation, using dental manikin head devices, simulation technology in dental education, uncertainties related to simulation including faculty concerns implementing simulation and faculty apprehensions in losing the traditional teaching approach. Additionally, the chapter will discuss limitations and advantages of simulation, personal connection with simulation and learning, faculty development as a result of incorporating simulation, and student development using simulation. Chapter 2 includes the conceptual and theoretical frameworks guiding the study, literature on dental simulation and simulation technology, and the benefits and limitations of incorporating the simulation-based learning method.

CHAPTER 2: LITERATURE REVIEW

The practice of dental hygiene and dental anesthesia delivery demands a high level of skill, including meticulous manual dexterity, attention to detail, and the acquisition and maintenance of specific fine motor skills (Dixon et al., 2020; Haji et al., 2021). In addition to the didactic delivery of education, dental hygiene incorporates clinical laboratory portions that require students to practice on one another (Brand et al., 2010; Decloux & Ouanounou, 2020). While this is effective and necessary, it specifically becomes a challenge with anesthesia delivery due to ethical concerns and student practical apprehensions (Correa et al., 2017; Haji et al., 2021). Potential risks, adverse events, complication concerns, and student practical apprehensions add to the list of trepidations in initial administration of local anesthesia (Correa et al., 2017; Haji et al., 2021). Provided as a means for pain management, the practical application of local anesthesia creates ethical apprehensions as the administration of a potentially toxic anesthetic medication is being delivered for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021). Additionally, the application of anesthesia requires cognitive abilities, motor skills, procedural knowledge, and immense knowledge of the facial nerves and structures to determine proper placement and delivery of anesthetic (Correa et al., 2017; Dixon et al., 2020; Haji et al., 2021; Hanson, 2011). An effective measure to reduce human subject danger risk, potential for adverse events, and student apprehensions with such an application involving ethical concern is by incorporating simulation into the curriculum for a more controlled and safer environment, allowing students the opportunity to repeatedly perform aspects of necessary procedural skills in real-life scenarios while making errors, reinforcing ergonomics and skillset, increasing

procedural practice, and ensuring patient safety (Davitadze et al., 2022; Loutet et al., 2020; Ramlogan et al., 2021).

Hanson (2011) explained that researchers first started investigating the use simulation as a possible alternative to the use of human subjects for the instruction and evaluation of clinical skills within dental education. A little over a decade later, simulation technology has become a fundamental and transformative tool used in dental education; however, Dixon et al. (2020) mentioned that no virtual reality dental stimulator to date had been designed to be capable of providing validated, meaningful clinical feedback to dental students. By incorporating simulation-based learning using dental manikin head devices, students can learn and practice treatment skills on a manikin before applying such skills to real-life interactions (Imran et al., 2021). Simulation and associated technology can guide students towards mastery of skills through trial and error while being given the space for self-reflection and while being provided with feedback to achieve competence before advancing to patient care (Ramlogan et al., 2021).

The purpose of this qualitative phenomenological study was to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. Numerous studies have examined dental manikin head device use in dentistry (Dixon et al., 2020; Haji et al., 2021; Li et al., 2021; Moron, 2020; Nassar & Tekian, 2020; Serrano et al., 2020). However, there is minimal literature on the use of simulation in dental hygiene education. While simulation is not a new approach in health care education as programs have utilized it over recent decades as a teaching method to strengthen skill, enhance procedure, and reduce harm (Lateef, 2010; Perry et al., 2015; Ramlogan et al., 2021), the hands-on allied health profession of dental hygiene has rarely incorporated simulation in dental hygiene curricula. This study focused on the perceptions of dental hygiene faculty incorporating

simulation with dental manikin head devices in teaching local anesthesia in dental hygiene education as a precursor to working on live human subjects. Faculty are instrumental in providing the clinical portion of dental hygiene education and represent varying background expertise. This literature review encompasses simulation using dental manikin head devices, simulation technology in dental education, and uncertainties related to dental manikin head device simulation including faculty concerns implementing simulation and faculty apprehensions in losing the traditional teaching approach. Additionally, this review of the literature discusses the limitations and advantages of simulation with dental manikin head devices, personal connection with simulation and learning, faculty development as a result of simulation, and student development using simulation.

Conceptual and Theoretical Framework

The conceptual framework is a representation of the building blocks through which a study is conducted (Ravitch & Riggan, 2017). This conceptual framework includes the study's importance and why it matters, and serves as the foundation that gives a study its shape (Ravitch & Riggan, 2017). Through the research methodology, design, and interpretation of the data, the conceptual framework articulates the researcher's choices so that both the researcher and the reader can evaluate the findings that feed back into the conceptual framework (Ravitch & Riggan, 2017). It serves as a tool to guide those involved through the research process.

The focus of this study was to provide insight on the perceptions of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia in dental hygiene education. Numerous studies have examined dental manikin simulator use in dentistry (Dixon et al., 2020; Haji et al., 2021; Li et al., 2021; Moron, 2020; Nassar & Tekian, 2020; Serrano et al., 2020). However, few studies focus on the use in dental hygiene and local

anesthesia education. In evaluation of the lived experiences of dental hygiene faculty in using dental manikin head device simulation to teach local anesthesia in dental hygiene education as a precursor to working on live human subjects, the theoretical framework that directed this research was modeled after David Kolb's (1984) theory of experiential learning. In this model, teaching by modeling the experiential learning process begins with grasping a concrete experience as a learner and reflecting on it for optimal learning in a three-step process (Kolb, 1984). The learner first experiences the concrete learning experience such as simulation, reflects on the experience, then conceptualizes the thoughts and reflections from the learning experience while considering what could have been done differently for outcome enhancement, and finally applies the knowledge or skills following the learning to direct future practice (Davitadze et al., 2022).

In hands-on application of learning, such as within dental hygiene and in the use of local anesthesia for dental hygiene procedures, experience lends way to the pedagogy utilized by faculty. According to John Dewey (1938), neither progressive nor traditional education is the answer when it comes to educational theory. The philosophy on experience and education informs that traditional delivery of education may be preordained knowledge, offering up a strict authoritative approach rather than a focus on students' gaining growth and knowledge from actual learning experiences (Dewey, 1938). In order to make advancements within education, the approach should be intertwined with traditional education in a system that focuses on the students' learning interests (Dewey, 1938).

Dewey's (1938) concept of interconnectedness between education and experience directed this research in that learning occurs when students are permitted to take their learning into their own hands by expressing their curiosity and impulse without restriction or reprimand

by the educator. Simulation and simulation technology allows students to practice until mastery, embrace mistakes, and look to correct errors in a judgement-free zone (Haji et al., 2021; Ramlogan et al., 2021). When the educator views teaching and learning as a continuous process of reconstructing experience, it is possible to look to the future with the notion of taking each experience as a building block towards a foundation that influences future experiences (Dewey, 1938). When students are provided with the theoretical knowledge along with the opportunity for step-by-step instructions in practical application of local anesthesia, performance-anxiety and stress can be reduced (Haji et al., 2021). Traditional education is often inflexible in design, ignoring the capacities and interests of the learner, whereas progressive education allows for freedom and spontaneous creativity which allows for enhanced learning (Dewey, 1938; Schilpp & Hahn, 1989). The key to successful learning is having a foundation in education that is grounded in a theory of experience, one that offers growth, imagination, and skill strengthening (Dewey, 1938; Schilpp & Hahn, 1989).

Dental hygiene is a profession that is considered one of allied health, directly involving the concerns of individual's everyday lives in a continual quest to meet best practices for optimal oral and overall health (Asadoorian et al., 2019). This literature review explores simulation with dental manikin head devices and simulation technology with the conceptual framework approach in mind. A foundation in education coupled with innovations in technology through simulation experience prior to working on live human subjects sets students up for success and competence in their application (Ramlogan et al., 2021). Not only has the advancement in educational pedagogies served as an influence in developing a deeper understanding of theoretical concepts over time, but technological innovations have also influenced teaching methods (Ramlogan et al., 2021). Simulation provides a safer alternative in the practical application of the

administration of a potentially toxic anesthetic medication, but technological innovations have also influenced teaching methods (Ramlogan et al., 2021).

In evaluating the lived experiences of dental hygiene faculty in using dental manikin head devices simulation in teaching local anesthesia in dental hygiene education as a precursor to working on live human subjects, the guiding theoretical framework this research was rooted in was David Kolb's (1984) theory of experiential learning. In this model, teaching by modeling the experiential learning process begins with grasping a concrete experience as a learner and reflecting on it for optimal learning in a three-step process (Kolb, 1984). Simulation is a beneficial endeavor in the field of dental hygiene and local anesthesia education. The learner first experiences the concrete learning experience such as simulation, reflects on the experience, then conceptualizes the thoughts and reflections from the learning experience while considering what could have been done differently for outcome enhancement, and finally applies the knowledge or skills following the learning to direct future practice (Davitadze et al., 2022). In this theory, ideas are not fixed, but rather the learning process is developed through elements of thought being formed and re-formed based on experience (Kolb, 1984). In this study, dental hygiene faculty identified their lived experiences relating to the incorporation of simulation using dental manikin head devices to teach local anesthesia in dental hygiene education. To align with the research questions, faculty reported on the use of experiential learning in local anesthesia experiences, as well as the benefits and challenges associated with this method.

Simulation Using Dental Manikin Head Devices

Dental manikin head devices are phantom heads and simulation models that have plastic teeth and/or anatomical parts and provide a replication of hard and soft oral tissues while simulating patient care and procedural application in as close of a hands-on experience as

possible for the student operator in comparison to treatment on a live human subject (Farag & Hashem, 2022; Li et al., 2021). As a traditional approach to simulation in the initial stages of dental curricula, the first phantom dental manikin head simulator was created in 1894 by Oswald Fergus to improve realism in teaching oral anatomy and physiology to dental students (Perry et al., 2015; Serrano et al., 2020). Since 1894, dental manikin phantom heads have been the cornerstone of learning within dentistry, providing the opportunity to teach preclinical dental students operative procedures safely and efficiently, while advancing their dexterity skills in a real-life clinical environment (Li et al., 2021; Perry et al., 2015; Plessas, 2017).

Dental hygienists provide preventive care in oral hygiene by way of removal of hard and soft deposits from teeth both above and below the gingival margin, examination of patients for signs of oral diseases, taking and developing of dental radiographs, and providing education in proper oral care as it relates to systemic health (Bassett et al., 2011). Additionally, dental hygienists provide local anesthesia as a method of pain control to ensure patients are comfortable in receiving the most optimal level of care (Bassett et al., 2011). Local anesthesia is a safe and effective pain management method used to accomplish optimal patient comfort in dental treatment (Reed et al., 2012). Dental hygiene education in addition to the theoretical and didactic delivery of information incorporates clinical laboratory portions of the curriculum that necessitate students to practice on one another in both dental hygiene procedure and care and administration of local anesthesia (Brand et al., 2010; Decloux & Ouanounou, 2020). While teaching local anesthesia, this becomes a challenge due to ethical considerations and toxicity concerns (Decloux & Ouanounou, 2020; Haji et al., 2021; Mahajan & Derian. 2022; Sekimoto et al., 2017). However local anesthesia provided by dental hygienists has been consistently

documented since the 1970's as having a record of safe administration in dental hygiene care (Boynes & Bassett, 2016; Manski & Cartee, 2015; Reed et al., 2012; Smith et al., 2019).

Simulation Technology in Dental Education

The use of simulation technology in dental education dates to the 19th century (Buchanan, 2001; Perry et al., 2015). The method of computer-aided simulation learning has since been on the rise, especially in pre-clinical teaching (Haji et al., 2021). Simulation technology, the umbrella term that includes extended reality (XR), which encompasses virtual reality (VR), augmented reality (AR), and mixed reality (MR), in dentistry provides the opportunity for students to develop psychomotor skills for procedures by practicing pre-clinical, standardized learning competencies before they engage in patient-management (Haji et al., 2021). If simulation technology can allow for safety and ethical acceptance, it is beneficial to explore further. Extended reality, the umbrella term of simulation technology that encapsulates VR, AR, and MR in real and virtual combined environments, allows for a simulated human and computer-generated interactive environment (Arpaçay & Bağış, 2020; Morimoto et al., 2022). Arpaçay and Bağış (2020) explained XR is a concept involving these interactions created by computer technology and wearables and is used to help educate dental students as well as encourage the upkeep of skillset for experienced practitioners. For the purposes of this study, simulation technology will focus on the use of dental manikin head devices within the VR environment.

Virtual reality is a technology where the user is completely immersed in an artificial computer-simulated image and environment with real-time interaction and stimulation of their senses in a digital three-dimensional reality (Arpaçay & Bağış, 2020; Morimoto et al., 2022). Virtual reality technology is widely used in medical and dental education to reproduce the human body structure, pathophysiology, and clinical scenes with a sense of realism for surgical and

procedural simulation, planning, and intraoperative guidance (Morimoto et al., 2022). In dental education, VR simulation technology has been more recently used as an adjunctive to traditional clinical skill training prior to treatment on actual patients with the use of dental manikin head devices (Haji et al., 2021; Moussa et al., 2022; Perry et al., 2015; Serrano et al., 2020). Different levels of VR offer various experiences. Some more advanced interactions are accomplished with equipment using helmet displays and force feedback handles where the operator can experience visual, auditory, and tactile sensation while observing and receiving feedback in a near-realistic training environment (Li et al., 2021).

Augmented reality is a technology where visual knowledge and objects are digitally superimposed on the physical world in real space (Arpaçay & Bağış, 2020; Morimoto et al., 2022). According to Arpaçay & Bağış (2020) and Morimoto et al. (2022), this allows for individuals to interact with both at the same time. Augmented reality is being used in the teaching and learning of maxillofacial, restorative, and tooth morphology, as well as mastering technique for administering local anesthesia (Haji et al., 2021). In dental practice, computer-generated images in AR are overlaid on real-world images or settings and can be displayed on video projectors, computers, or tablets (Morimoto et al., 2022).

Mixed reality, which is a hybrid of AR and VR, is a technology that blends the physical world with the digital world (Morimoto et al., 2022). Mixed reality has become more popular recently as it mitigates VR's limiting real-world interactive environment and AR's inability to interact with three-dimensional items (Morimoto et al., 2022). Mixed reality is different in that it allows switching freely between the real world and a virtual environment (Li et al., 2022). According to Li et al. (2022), mixed reality allows for the enhancement of interactions, providing the opportunity to construct a virtual oral environment simulating oral hard tissues, soft tissues,

and dental instruments. This can reduce material consumption during skills training, indicating that it may be a better choice for a dental simulation method (Li et al., 2022).

In addition, haptic technology combines tactile sensation involving operator senses while interacting with computer-generated objects (Moussa et al., 2022). Haptic technology provides a robotic approach that enables two-way communication between the user and the environment, providing enhanced simulation for the student in the clinical setting for learning purposes (Haji et al., 2021). Haptic technology has been shown to enhance manual skills and perceived self-confidence for learners within clinical sessions (Moussa et al., 2022). Roy et al. (2017) explained that dental manikin head devices provide the opportunity to influence students' hand-eye coordination and dexterity. The use of haptic technology becomes a progressive approach when improving motor skills and student efficiency, as the verbal description of tactile sensation is difficult to explain (Roy et al., 2017).

The concept of simulation technology has generated interest as an alternative educational delivery method in training to allow for smoother transition into the clinical environment, reinforcement of ergonomics and skillset, and increased procedural practice and confidence (Pinar, 2020). In dental education, dental manikin simulation technology is often used as the technological delivery system in teaching psychomotor skills in preclinical dentistry (Farag & Hashem, 2022). Since its inception, dental manikin head devices within dental education have served as a foundation to teach a spectrum of techniques from routine to more complex procedures in dentistry (Marshall, 2016). In a VR environment, dental manikin head devices provide the opportunity to influence students' hand-eye coordination and dexterity in progression of skill development in a safe manner (Li et al., 2021; Plessas, 2017). These devices have been introduced in the education of dental anesthesia as haptic-based VR anesthesia injection training

simulator devices (Correa et al., 2017). This combination of systems provides the ability to receive force feedback with the needle insertion task during the anesthesia procedure of inferior alveolar nerve block (Correa et al., 2017). Dental manikin head devices using VR simulation technology are beneficial in reducing ethical patient risk, preventing discomfort and complications that can be detrimental to the patients' health, increasing the safety of students who practice on each other, and allowing automated performance evaluations (Correa et al., 2017).

Simulation for local anesthesia education is effective in that it provides standardization as every patient is different, improves the techniques and knowledge where students need to be dependent on the intraoral landmarks and explain how they determine the target location, and assists in developing a clearer understanding of the theoretical (Brand et al., 2010). Additionally, simulation improves student ergonomics, provides the opportunity for continual reassessment, allows easy accessibility for practice at any time, increases operator confidence, and allows for correction without embarrassment (Brand et al., 2010). Simulation allows for intentional error and reflection by providing the ability to enhance critical thinking skills in a preclinical education environment, thereby contributing to deeper learning experiences while ensuring patient safety (Brand et al., 2010; Lateef, 2020; Mustilwar et al., 2022).

Uncertainties Related to Simulation

The acquisition of simulation and simulation technology in dental hygiene education can be daunting to some as it may present a new undertaking when introduced into the curriculum (Clemente et al., 2021). New technique with the incorporation of dental manikin head devices may generate feelings of uncertainty from faculty, or even be perceived by faculty and students as an unknown (Delacruz, 2021). Feelings of uncertainty are expected as there are unknowns in

how this approach to education is to be implemented and what is to even be anticipated. According to Delacruz (2021), to mitigate uncertainties hesitancies among dental hygiene faculty in implementing technologies must be addressed. The notion that acceptance can lead to a focus on the potential for progression of positive social change must be reiterated. The fear of the unknown and reluctance to accept change are common among dental hygiene faculty members (Delacruz, 2021; Vogell, 2019).

Since simulation is involved in the direct assessment of students, institutions with minimal exposure to this technique and technology at its inception began seeing new ways in which simulation technology could help advance and alter the way dentistry is taught (Buchanan, 2001). At the time this study was written, over two decades had passed since Buchanan (2001) posited that simulation had the potential to influence the way educators teach and could greatly modify traditional methods of instruction in the field of dentistry. This was evident leading up to the COVID-19 pandemic when innovation and technology advancement flourished as it became a necessary approach in the matter of public health safety (Clemente et al., 2021). The COVID-19 pandemic left feelings of uncertainty across the nation in how hands-on dental educational material was going to be delivered and received (Clemente et al., 2021; Haridy et al., 2021). The pandemic sped up and promoted the use of simulation technology, urging the use of and shift to manikins and quickly increased the need for development of simulated teaching experiences (Clemente et al., 2021). However, much uncertainty remains from faculty being concerned about implementing simulation technique and technology and losing the traditional teaching approach.

Faculty Concerns Implementing Simulation

Simulation opens a new world of teaching and learning. Being a new technique incorporated in the curriculum, faculty concerns about simulation implementation have arisen.

Marti et al. (2021) evaluated the impact of preclinical simulation in local anesthesia training of predoctoral dental students to assess self-perception of their knowledge, confidence, experience, preparedness, and stress level during their local anesthesia experience. Faculty perceptions of local anesthesia competency were also assessed and revealed mixed results. Some faculty expressed an interest in participating in the simulation session themselves to provide any meaningful recommendations for students other than their perceived value of having the technology. Although it could be said for XR in general, AR has been shown to have concerning outcomes as educators have described feelings of unfamiliarity with the technology, technical errors, or reliability of internet connections resulting in frustration and cognitive overload (Kluge et al., 2022; Saidin et al., 2015). Furthermore, additional workload regarding simulation technology would be required of faculty, involving the intricacies of simulation procedures and the inner workings including computer-generated technology which results in dedicated time to be allotted, infrastructure, and capital (Raina et al., 2021).

Faculty concerns with simulation technology integration can be accomplished by applying the Technology Acceptance Model by Fred Davis (1989) into the process. This focus guides faculty in the measures they might take prior to the implementation of such technological systems (Marikyan & Papagiannidis, 2022). According to Davis (1989), the Technology Acceptance Model follows three key points which include perceived usefulness of technology, perceived ease of technology use, and user acceptance of information technology. The Technology Acceptance Model examines the processes relating to the acceptance of technology to predict the behavior of successful implementation of technology and provides a theoretical explanation for it (Davis, 1989). The model focuses on the perceived usefulness of technology and how it can result in improved performance, perceived ease of technology use and how it can

be utilized for advancement, and user acceptance of information technology and the value of accommodating such technology (Marikyan & Papagiannidis, 2022). These key points further align with this model by assisting dental hygiene faculty in using simulation technology, expressing the value of simulation technology acceptance, and portraying the direct and indirect effects simulation has on the progression of teaching local anesthesia within dental hygiene education.

Faculty Apprehensions in Losing the Traditional Teaching Approach

Simulation should work alongside the traditional teaching approach in that the underlying learning theory utilized can influence advantages in addressing student interaction, manipulation of virtual components, and teaching of complex concepts (Kluge et al., 2022). In the Marti et al. (2021) study, faculty remarked that simulation technology could be used as a supplemental and safer way to teach students local anesthesia, but clinical training would remain the milestone of training. Faculty expressed their perceptions of this approach being beneficial as students could make mistakes in a controlled environment while learning through repetition of techniques and interpretation of prior basic science concepts. It was concluded that faculty perceived this as an additional approach, rather than a replacement of the traditional teaching approach. Simulation technology that provides feedback in a virtual reality method should not be accepted solely as the form of feedback and evaluation in student learning, but rather as a supplement to the quality and effectiveness of instruction and feedback (Plessas, 2017). Recommendations for simulation technology training to enhance procedures include allowing the simulation procedures to occur under proper guidance and supervision, discussing this alternate approach in more detail, and closely evaluating the anatomical variations that would benefit the curriculum (Marti et al., 2021).

Limitations and Advantages of Simulation

Simulation with dental manikin head devices and simulation technology provides a multitude of opportunities and advantages to the world of education (Moussa et al., 2022). There are many flexibilities to learning with simulation and simulation technology (Moussa et al., 2022). Simulation with dental manikin head devices and simulation technology offer the ability to exhibit different circumstances for students and have proven to be beneficial to the learning experience (Moussa et al., 2022). However, limitations are present with potential technical issues for computer-aided simulators and the outcomes of virtual reality effectiveness in dental education remain controversial (Moussa et al., 2022).

Limitations

According to Farag and Hashem (2022), dental manikin phantom heads with plastic teeth have been used to simulate patient conditions and have been considered the mainstay simulation approach since their existence. However, phantom manikin heads do not simulate the major components of the oral cavity including the teeth and their supporting structures (Farag & Hashem, 2022). No dental cavities, known as caries, or tartar, known as calculus, can occur in or on plastic teeth, thus it is difficult for the teacher to explain and demonstrate real tactile sensation (Farag & Hashem, 2022; Perry et al., 2015). Additionally, the lack of natural factors including saliva and blood, movement of the tongue by the patient, and the reaction of the patient to pain all serve as connections and experiences that are lost when working on a manikin (Raina et al., 2021). Reed et al. (2012) explained that in local anesthesia, the provider relies heavily on visualization and palpation of the hard tissues to determine landmarks for injection sites. Manikin use diminishes that connection in treatment compared to a live human patient (Reed et al., 2012).

By providing education in an XR format, as compared to in-person traditional delivery, technical issues become a challenge (Perry et al., 2015). According to Raina et al. (2021), standardization with simulation is beneficial and ideal for grading purposes and to assure each student gets the same experience. However, compared to the standard design of a manikin head simulator, every live patient will look and feel different, and procedure is certainly dependent on the individual anatomy of the patient (Raina et al., 2021). Furthermore, major disadvantages that could present as limitations of simulation-based training approaches are the high initial purchase, installation, and maintenance cost, along with time-consuming staff training (Perry et al., 2015; Raina et al., 2021).

Advantages

Simulation is instrumental in achieving safety and minimizing risk when the primary goal of dental education and clinical training should be providing education, with patient safety and well-being in mind (Raina et al., 2021). Simulation offers a safe, hassle-free, and risk-reduced environment in which students can learn and educators can serve as guides. Standardization with simulation is an advantage and is ideal for grading purposes to assure each student gets the same experience (Raina et al., 2021). Despite the potential limitations of technical issues, the flexibility that technology provides may enhance the understanding of anatomy and procedure (Moussa et al., 2022). Prior to the COVID-19 pandemic, simulation with phantom manikin heads and simulation technology were merely innovation and advancement. However, these approaches have since transformed education as a matter of public health (Clemente et al., 2021). During the COVID-19 pandemic, this approach became the preferred method when working on patients for educational purposes was limited or impossible (Seki et al., 2020). Seki et al. (2020) affirmed that virtual patient simulation development for the acquisition or promotion of critical

reasoning skills is an effective part of treatment competency design when the number of live patient encounters is insufficient. Simulation also reduces the risk of water-borne diseases, as no water pipes or suction systems are needed, as well as the reduction of airborne contamination risk (Perry et al., 2015). The use of patient computer-assisted simulation has proven to be especially beneficial in fields that require many hours of study or that have manpower shortages (Seki et al., 2020). Both circumstances can occur in dental hygiene education (Seki et al., 2020). By investigating the use of extended reality as a possible alternative to the use of human subjects for the instruction, evaluation, and practical application of clinical skills, competence can be attained by students safely (Clemente et al., 2021; Perry et al., 2015).

In local anesthesia administration, ethical considerations have been questioned as students are introducing potentially toxic anesthetic medication into the bloodstream of peers for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021). By utilizing XR with dental manikin head simulator technology, human risk is reduced by minimizing the potential for toxicity (overdose) on live patients (Clemente et al., 2021; Marti et al., 2021; Perry et al., 2015). Additional concerns include infection, hematoma, trismus, and nerve impairment (Marti et al., 2021). Local anesthetic administration has come a long way in its history to be accepted into dental hygiene practice (Bassett et al., 2011). Dental hygienists and institutions are limited by statutes or rules that apply to each specific state (Bassett et al., 2011). Procedure differs between states where some limit dental hygienists to administrating infiltration injections only, with restrictions against administering nerve block anesthesia (Bassett et al., 2011). At the time of this writing, only Texas and Delaware did not permit dental hygienists to administer local anesthesia, while the law in Georgia and Mississippi had passed and was in the stage of rules and regulation (Texas

Dental Hygienists' Association, 2023). However, of the states that permit dental hygienists to administer local anesthesia, New York, South Carolina, and Alabama were three states that at the time of this writing limited dental hygienists to administer nerve block anesthesia, only permitting local infiltration anesthesia (American Dental Hygienists' Association, 2023b; Manski & Cartee, 2015; Pocket Dentistry, 2016), arguing that infiltration injections are easier to perform and provide a higher level of safety (Bassett et al., 2011). Nerve block anesthesia administration is a highly complicated procedure that involves injection into main nerve bundles of larger areas of the mouth, creating a greater risk for causing serious issues such as hematoma, permanent or partial paresthesia, stroke, cardiac arrhythmia, and syncope (Bassett et al., 2011; Michigan House Legislative Analysis Section, 2002). Although reports have suggested infiltration injections are safer than nerve block injections, some reports have affirmed that nerve block anesthesia can even happen during infiltration injections (Daubländer et al., 1997; Garisto et al., 2010).

States are responsible to cover nerve block anesthesia administration material because dental examinations include it, even if state mandates prevent hands-on application (Moussa et al., 2022). By incorporating simulation technology, dental hygiene education can participate in hands-on experiences of nerve block anesthesia administration to prepare states that need proper instruction. A study by Mladenovic et al. (2019) was performed to evaluate the effectiveness of a mobile augmented reality simulator for local anesthesia training with dental students who were administering inferior alveolar nerve block anesthesia for the first time. A control group with 19 students and an experimental group with 22 students showed the experimental group had an anesthesia success rate of 90.9% compared to 73.7% for the control group (Mladenovic et al.,

2019). Based on these findings, simulation technology proved more beneficial in local anesthesia competency as the experimental group had a higher success rate compared to the control group.

Simulation gives students an opportunity to develop necessary skills prior to patient interaction through practice in a controlled environment (Li et al., 2021). Simulation technology helps to guide educators as they help students to develop from beginners to competent experts. With the concept of simulation, Imran et al. (2021) elucidated that students are allowed continuous training practice while improving their skills in various procedures and increasing their ability in tactile sensation before proceeding to work in patient's oral cavity. Additional advantages of simulation technology have been shown to reduce the material waste and financial cost for the institution, as water sewerage pipelines or monthly maintenance costs are minimized, as well as decrease the use of infection control supplies (Imran et al., 2021)

Personal Connection with Simulation and Learning

The concept of personal connection was a common theme in research relating to XR use (Farag & Hashem, 2022; Perry et al., 2015; Plessas, 2017). The face-to-face connection in education, and especially in a hands-on allied health profession, is important. However, XR removes the possibility of such connection. According to Moussa et al. (2022) and Serrano et al. (2020), there is a challenge in providing dental education because to acquire theoretical knowledge the required spatial imagination and patient-centered training on traditional manikin simulation does not resemble realistic clinical situations. Simulation technology may present difficulties in realism as the lack of connection with human variables factors in as a concern (Perry et al., 2015). Phantom dental manikin heads lack some of the realism found to be beneficial with live human experience (Perry et al., 2015). The lack of saliva, blood, human resistance, and common human connection is not experienced with simulation technology (Perry

et al., 2015). Additionally, simulation technology offers a poor representation of the soft tissues and pertinent points of reference within the oral cavity (Brand et al., 2010; Mladenovic et al., 2019). However, according to Perry et al. (2015), such technological advances may be beneficial to the education of dental students as these advances add experience and patient management skills earlier in the curriculum and prior to the delivery of direct patient care. This could potentially negate the disadvantage of the lack of personal connection as patients may be more comfortable with a confident and competent provider who has attained prior experience with simulator technology.

Faculty Development as a Result of Incorporating Simulation

Faculty, whether they are seasoned or novice educators, may be reluctant to change standard procedure they are accustomed to. However, embracing implementation that will result in enhanced understanding and empowerment can lead to faculty professional development, which in turn can influence student development (Vogell, 2019). Faculty calibration is defined as the consistent application of theories and evaluation representing both standardized instruction and standardized assessment of student performance (Casa, 2015; Vogell, 2019). Standardization by way of dental manikin simulation helps with faculty calibration because it guides them in standardizing their teaching practices (Li et al., 2021). Previous studies have shown that dental simulators create time-saving strategies for faculty because calibration is higher and faculty feel more comfortable providing the education (Li et al., 2021; Nassar & Tekian, 2020). However, Buchanan (2001) postulated simulation must be adapted to the needs of individual schools to reach their fullest potential. Simulation can decrease time in preclinical laboratory settings, easily allow for mandatory remediation on simulators when necessary to replace some aspect of actual patient care and reduce the reliance on patients for certain types of procedures. Additionally,

simulation can be used to address problems with faculty staffing of preclinical courses or simply as an approach to free up preclinical faculty time from demanding constraints in order to encourage more learning opportunities (Buchanan, 2001).

Regardless of the reasoning for institutional implementation, Buchanan (2001) conjectured advanced simulation would offer an excellent opportunity for dental educators to review and revamp curricula to meet the needs of their institutions and enhance student learning. Over the decades, advancements in simulation have been shown to improve the quality of dental education outcomes by offering applications in different dental disciplines and various clinical procedures (Moussa et al., 2022). Technology-enhanced and simulation-based teaching and learning plays a pivotal role in delivering dental education (Buchanan, 2001; Imran et al., 2021). According to Imran et al. (2021), simulation has been shown to help students develop high psychomotor skills leading to proficiency as clinicians; however, technological advancements are necessary in dentistry to achieve competency before working on a live patient. In faculty development, training in using the technology and transitioning novice students to competent clinicians using simulation technology as an approach is worth further study. Limited studies have discussed the incorporation of simulation technology in the curriculum due to low educational standards, unclear scoring mechanisms, problems integrating this technology in dental curricula, and challenges with student or teacher feedback mechanisms. Studies have primarily focused on technical skills and have created a need to bridge this gap in modern simulations with non-technical skills and faculty development within institutions.

Student Development Using Simulation

For students, the use of simulation increases development with an enhancement of student learning experiences, an enhancement of tactile skill, and promotion of critical thinking

skills (Almasri, 2022; Gottlieb et al., 2011). Ergonomic development and technical performance are enhanced with simulation technology, specifically with virtual reality simulation of dental manikin head device use (Gottlieb et al., 2011). One of the features of simulation technology is that some manikin head devices are equipped with light and auditory notifications, both of which guide the operator to know when the target is achieved. Students acquire a clearer understanding of the theoretical concepts working with simulation without the anxieties of working on a live patient so that correction can be made without student embarrassment and continued until mastery (Li et al., 2021).

Preclinical training is imperative to students' development of the fine motor skills necessary for the dental profession (Perry et al., 2015). Many students struggle with nerves and application of local anesthetic administration for the first time (Hanson, 2011; Mladenovic et al., 2019; Zafar et al., 2021). It is imperative that students receive sufficient preclinical training prior to transitioning to successful patient management on a human subject (Mladenovic et al., 2019; Zafar et al., 2021). Simulation training has been shown to improve student ergonomics, provide continual reassessment, offer ease of availability for students to access at any time, increase confidence, enhance performance, provide correction without embarrassment, and enhance critical thinking skills in an environment that allows for intentional error to occur so that deeper learning can be achieved while ensuring patient safety (Brand et al., 2010; Gottlieb et al., 2011; Lateef, 2020; Mustilwar et al., 2022). Students can work on their manual dexterity and enhance problem solving and critical thinking skills. In a study by von Sternberg et al. (2007), two dental student groups performed a dental procedure referred to as an apicectomy on pig cadaver models. One group received prior simulation training and the other did not, leaving the outcome to reveal better performance from the virtual simulator trained group compared to the group who

performed directly on cadaver models. The skills acquired from this simulation experience were transferable to physical reality and the students improved significantly in the ability to objectively self-assess their performance after virtual training (von Sternberg et al., 2007).

In a study by Zafar et al. (2022) to determine the effectiveness of a mobile three-dimensional AR simulator for local anesthesia training, a mobile simulator with three modes for learning: study, three-dimensional simulation, and augmented reality was presented (Zafar et al., 2022). The Zafar et al. (2022) study utilized surveys with open-ended and Likert-scale questions comprising of five response options and a response rate of 90.1%. The results found that 76.6–88.2% of students participating in the study agreed that the three-dimensional anatomical structure simulation technology improved their technique skills (Zafar et al., 2022). The study's findings also revealed that student participants felt improvement in their understanding of local anesthesia administration (Zafar et al., 2022).

Summary

The considerable amount of literature regarding the implementation of simulation in dental education suggests using this approach and technology as a precursor to teach local anesthesia in dental hygiene education may warrant positive outcomes (Moussa et al., 2022). Since the practice of dental hygiene and dental anesthesia delivery demands proficient fine motor skills and meticulous manual dexterity, if students have an opportunity to learn on manikin simulation before applying their skills and technique to real-life situations, this may result in safer and more competent practical application (Imran et al., 2021). As a means of pain control, anesthesia delivery is beneficial, yet its ethical considerations in practice are concerning to those being anesthetized for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021). To mitigate the

potential risks and adverse reactions to human subjects, it behooves educational institutions to utilize simulation-based learning to improve teaching, enhance learning, and reduce risks. As a method of training and simulation in local anesthesia competency, students can learn practical skills and develop competence in a safer environment that allows for intentional error and influences deep reflective learning (Ramlogan et al., 2021). By investigating the use of simulation as a precursor to the treatment of live human subjects for the application and enhancement of clinical skills in local anesthesia delivery, competence can be attained safely (Hanson, 2011; Zafar et al., 2021). Both faculty and student development can be enhanced once ease of uncertainties and adaptation or acceptance of limitations has been achieved with an innovative opportunity for education and institutions to advance. Chapter 3 will focus on the methodology of this study including the sample population, materials, and procedures used to gather and analyze the data.

CHAPTER 3: METHODOLOGY

This study explored the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. A qualitative phenomenological study approach was employed to study the lived experiences of faculty using simulation. The purpose of this study also explored if educators could guide students by incorporating simulation in the development of treatment skills on a manikin before applying to real-life interactions, thereby offering a safer and less intimidating approach to learning (Imran et al., 2021). Numerous studies have examined dental manikin simulator use in dentistry (Dixon et al., 2020; Haji et al., 2021; Li et al., 2021; Moron, 2020; Nassar & Tekian, 2020; Serrano et al., 2020). However, few studies have focused on the use of dental manikin simulators in dental hygiene education. This study sought to address the gap in the literature as there is a lack of discussion regarding simulation using dental manikin head devices in teaching local anesthesia within dental hygiene education. The intention of this study was to address the perceptions of faculty in the exploration of incorporating simulation with dental manikin head devices as a precursor to teaching local anesthesia within dental hygiene education.

This study sought to answer the following research questions:

- Research Question 1: How do dental hygiene faculty describe the use of simulation with dental manikin head devices when teaching local anesthesia education?
- Research Question 2: How do dental hygiene faculty describe the benefits and challenges in preparing students for administering local anesthesia?

The conceptual framework serves as a guiding tool for those involved in the research process (Ravitch & Riggan, 2017). John Dewey's (1938) concept of interconnectedness between education and experience directs this research conceptually in that learning occurs when students

are permitted to take their learning into their own hands by expressing their curiosity and impulse (Dewey, 1938; Schilpp & Hahn 1989). Simulation allows students to practice until mastery, embrace mistakes, and look to correct errors in a judgement-free environment without restriction or reprimand by the educator (Haji et al., 2021; Ramlogan et al., 2021). David Kolb's (1984) theory of experiential learning was the theoretical framework that guided this research as the experiential learning process begins with experience and is followed by learner reflection. The learner processes the learning experience and applies the knowledge or skills following the creation of learning from reflection.

This qualitative phenomenological study utilized semi-structured interviews to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. Data was gathered from eight participants after the researcher reached three milestones in the research process. The first of these milestones was obtaining approval of the study's proposal by the researcher's dissertation advisors. The second of these milestones was obtaining appropriate exemption permission to conduct the study by the Office of Research Integrity at the University of New England. This approval letter is available in Appendix A. The final milestone was obtaining approval and the requested faculty names of potential participants who have or had experience as clinical faculty teaching in local anesthesia from program directors of accredited dental hygiene institutions with entry-level associate and baccalaureate degree programs in four states within the Northeastern United States, as verified on the Commission on Dental Accreditation website (Commission on Dental Accreditation, 2023). This email is available in Appendix B. Emails were then sent to the provided participants with publicly available email addresses. Emails were sent with a recruitment letter as an

attachment explaining the purpose of the study and to gauge interest in their participation. This email is available in Appendix C. The researcher received a positive response.

Site Information and Demographics

In seeking to understand the experiences of dental hygiene faculty in using simulation with dental manikin head devices in teaching local anesthesia, it was important to understand their lived experience within the setting of clinical academia in dental hygiene programs. There is a selective group of institutions within the Northeastern United States that use simulation with dental manikin head devices to teach local anesthesia. Therefore, the setting of this study took place in institutions within four states with accredited dental hygiene entry-level associate and baccalaureate degree programs throughout the Northeastern United States. The Northeastern United States is made up of nine states including Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. There were 45 accredited dental hygiene entry-level programs within the Northeastern United States (American Dental Hygienists' Association, 2023a) while this study was underway. These programs were verified by the researcher through the Commission on Dental Accreditation's (2023) website, which also included additional information such as dental hygiene entry-level program directors, on-site evaluation years, and current accreditation status. The researcher removed their own institution to avoid any conflict of interest. Permission to conduct the study and collect data from faculty participants was obtained by program directors prior to this study. Program directors provided faculty names that were involved in teaching local anesthesia. Emails were then sent to the provided participants with publicly available email addresses.

Participants and Sampling Method

Participants were chosen through purposeful criterion sampling, then snowball sampling to determine appropriate faculty for recruitment from institutions in four states with accredited dental hygiene entry-level programs in the Northeastern United States. Bloomberg and Volpe (2016) explained "the logic of purposeful sampling lies in selecting information-rich cases" (p. 148). Criterion-based sampling is one form of purposeful selection that may be used. Moser and Korstjens (2018) defined criterion-based sampling as the most prominent criterion used in phenomenology in that participants meet predefined criteria and have a shared experience yet vary in characteristics and individual experiences. All participants sampled from institutions in four states within the Northeastern United States were assigned a pseudonym to protect their confidentiality. This study enlisted eight participants who had lived the experience of providing clinical instruction using simulation with dental manikin head devices to teach local anesthesia within dental hygiene programs. Depending on the state and dental hygiene program, the participant population included clinical dental hygiene full-time faculty, part-time adjunct faculty, clinical course coordinators, and supervising dentists.

Instrumentation and Data Collection

The preferred method of collecting data in qualitative phenomenological research is in-depth interviewing (Bloomberg & Volpe, 2016). The in-depth interviewing process is a dedicated conversation where rich information is obtained by focusing on components of the research questions provided (Bloomberg & Volpe, 2016). In this study, by assessing the phenomena through conversation of the lived experiences of participants who utilized simulation with dental manikin head devices to teach local anesthesia in dental hygiene education, rich data was acquired. All communication came from the researcher's University of New England email.

A faculty name request for potential participants of clinical faculty teaching in local anesthesia was sent to program directors of accredited dental hygiene institutions with entry-level associate and baccalaureate degree programs in four states within the Northeastern United States, as verified on the Commission on Dental Accreditation (2023) website. Emails were then sent to the provided participants with publicly available email addresses to delineate participation in the study as being strictly voluntary.

Interviews were conducted with eight clinical dental hygiene faculty teaching in local anesthesia through a video-conferenced Zoom meeting where the principal investigator elicited information from the participants following a semi-structured interview design. Consent was obtained from participants prior to scheduling the interviews regarding recording for transcription purposes. Prior to the start of each interview, the researcher provided a personal introduction, informed the participant on the purpose of the study, and the Participant Information Sheet, which is the informed consent, was reviewed with each participant as required by the University of New England's Office of Research Integrity. The Participant Information Sheet is available in Appendix D. The informed consent included the option to withdraw from the study at any time. Each interview lasted approximately 45 minutes to one hour and included the same questions in a semi-structured interview design.

This study's interview questions are listed in Appendix E. The participants were provided with an opportunity to ask questions. None of the participants requested to opt out of the study and none of the participants objected to being audiotaped. The participants were given the option to either be on or off camera. Prior to beginning each interview, all participants were reminded to not discuss their involvement and employment at any institution to ensure confidentiality and that if mentioned it would be redacted from the transcript. The researcher assured each

participant that privacy and confidentiality would be maintained throughout each step of the research process.

Recorded interviews were transcribed through the Zoom application's automatic audio transcription. The researcher verified and reviewed each transcript. The participants were then sent the transcript of the interview session via email to verify that the information was portrayed correctly. Interviewees verified the accuracy of the transcript during member checking. Member checking is a technique where the participant reviews and validates the credibility of the data or results when the transcript is returned to them (Birt et al., 2016). Participants were asked to return the verified information via email within seven calendar days. The data was stored in a password-protected personal laptop computer accessible only by the researcher. Data will be destroyed three years following this study's completion. The researcher ensured compliance with all regulations set forth by the integrity protocol enforced by the University of New England.

Data Analysis

Upon data collection, the study underwent a comprehensive analysis under the guidance of the foundational principles of John Dewey's (1938) notion of the interconnectedness between education and experience as well as David Kolb's (1984) theory of experiential learning. These frameworks played a pivotal role in shaping the direction of the research and served as essential perspectives that illuminated the path of inquiry. Acting as crucial lenses, they lent valuable insights to the unfolding exploration, effectively shaping the entire research process. Manual coding of the collected data was accomplished using the copy-and-paste function on Microsoft Word and stored on the researcher's password-protected personal laptop computer (Linneberg & Korsgaard, 2019). The researcher labeled the text of different segments with codes that described the meaning of the segment. This manual coding procedure was accomplished using the

following six-step process as identified by Smith et al. (2009): (a) read and re-read the transcript, as well as listen to the audio recording numerous times, (b) take notes on the descriptive, linguistic, and conceptual comments, (c) develop emergent themes, (d) search for connections across themes, (e) move to the next case, and (f) look for patterns across cases. Coding was completed manually in a Word document. No computer software coding programs were used. Once all the data had been coded, the researcher analyzed the codes to identify specific connections that create broader overarching themes.

Limitations, Delimitations, and Ethical Issues

As with any study, limitations, delimitations, and ethical issues exist and need to be clearly identified. According to Ross and Bibler Zaidi (2019), to provide meaningful information to the reader, the goal of the researcher should be to present all potential issues that may arise in a study. In doing so, the true significance of the work can be effectively conveyed and demonstrated. Illustration can be made for how the study can influence a larger field of focus and present ideas for potential areas of future exploration (Ross & Bibler Zaidi, 2019).

Limitations

Limitations could present weaknesses within a research design, thereby influencing the study's design, outcomes, and conclusions (Ross & Bibler Zaidi, 2019). Interviews using only eight participants are limited in that the results cannot be generalizable. Moreover, interviewing only faculty from four states within the Northeastern United States limited the study further. Interview response rate could have been present as a limitation due to technical difficulties (Creswell & Guetterman, 2019).

Delimitations

There was no conflict of interest as the researcher was not a faculty member at any of the institutions where the interviews were conducted and participation in the study was strictly voluntary. The researcher was also not employed at any of the institutions in a non-faculty capacity. The specific population from which the sample was drawn delimits this study as the intent was to focus on the Northeastern United States. Another delimitation of this study could have been the time constraints and length of the study.

Ethical Issues

The researcher must be fully aware of the basic ethical principles for the study of human subjects. The *Belmont Report* released by the National Commission for the Protection of Human Subjects in Biomedical and Behavioral Research (1979) established ethical principles for conducting research involving human subjects. Following the *Belmont Report* is crucial for phenomenological research. The researcher adhered to the *Belmont Report*'s principles (respect for persons, beneficence, and justice) and applications (informed consent assessment of risks and benefits, and the selection of human subjects) (National Commission for the Protection of Human Subjects, 1979) in a structured way to ensure protection for all. Additionally, the researcher was at risk of ethical issues about researcher bias having experienced dental manikin head simulator technology themselves. However, bracketing was embraced as a means of opening the mind to allow for perspective change and enhancement (Weatherford & Maitra, 2019). With this concept, the researcher maintained reflexivity and awareness for oneself, the concern for participant voice, care for the study, and connection with others (Weatherford & Maitra, 2019). The researcher removed their own institution to avoid any conflict of interest or bias.

This study involved minimal risk for participants. Participants' risk of invasion of privacy or loss of confidentiality was minimized by using pseudonyms for each of the participants' names and by eliminating any personally identifying information from the study. Participants had the opportunity to review their transcribed interview for accuracy and were given the choice to have their cameras off during the interview. Participants had the right to skip or not answer any questions for any reason.

Every precaution was taken to protect the participants' rights by deidentifying personal identifiable information including faculty names and their institutions and preserve integrity by adhering to the *Belmont Report's* standards for research ethics in maintaining respect for persons, beneficence, and justice (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). The data was stored in a password-protected personal laptop computer accessible only by the researcher. The researcher ensured compliance with all regulations. The study data collected will be retained for three years after the completion of the study and then destroyed. In compliance with regulations set forth for the University of New England's Office of Research Integrity, the study's data may be accessed upon request by representatives of the University (e.g., faculty advisors, Office of Research Integrity, etc.) when necessary.

Trustworthiness

Trustworthiness occurs when the reader is reassured that the study is necessary and has significance and value (Merriam & Tisdell, 2016). Trustworthiness is essential in determining the need for data regarding the perceptions of dental hygiene faculty in using simulation with dental manikin head devices to teach local anesthesia and how it can benefit dental hygiene education. A researcher must be thorough in their process to maintain trustworthiness (Merriam

& Tisdell, 2016). Ensuring that credibility, transferability, dependability, and confirmability have been thoroughly addressed are all means of directing trustworthiness (Lincoln & Guba, 1985).

Credibility

Lincoln and Guba (1985) postulated that credibility establishes the truth of research findings in that researchers and readers can recognize the explained experience when confronted with it. Lincoln and Guba (1985) proposed that credibility is achieved through various means, such as prolonged engagement with the participants, persistent observation, cross-examination of data from multiple sources, member checking, and maintaining a clear audit trail of the details of the research process. This research employed these standardized steps to ensure credibility in this research including prolonged participant engagement, thorough data collection, and reflection throughout the research process (Lincoln & Guba, 1985). A member checking process was used to ensure credibility of the findings and interpretations from the collected data (Lincoln & Guba, 1985). By employing these strategies, the researcher aimed to enhance the credibility of the findings and ensure that the findings accurately represented the perspectives and experiences of the participants (Lincoln & Guba, 1985).

Transferability

Transferability means the research can be duplicated or conducted in the same manner within other environments, contexts, and settings (Merriam & Tisdell, 2016). Since participants were asked to describe their lived experiences, this study will be able to be transferred and applied in the focus of educators implementing technology as an approach to education in other contexts. Administrators and faculty members in various educational programs in health disciplines may be able to utilize the data gathered and analyzed in this study to assist in their efforts related to implementing technology in education. These administrators and faculty

members will be able to do so by learning of the experiences of faculty members who participated in this study.

Dependability

Dependability, also known as internal validity and reliability, indicates the ability of processes and procedures within a study to be verified, applied, and replicated (Bloomberg & Volpe, 2016). This study employed semi-structured interviews to gather data. These interviews followed a protocol that confirmed each interview was completed in the same method for each participant. Also, to ensure validity and reliability, interviews were recorded, transcribed, and provided to each participant for verification of proper transcription.

Confirmability

Relying on the constructs of precision and accuracy from the study itself, confirmability allows for the researcher to get as close to an objective reality as possible (Stahl & King, 2020). Interview transcripts were checked and re-checked to ensure objective results. The researcher ensured that interpretations and findings were derived strictly from the data. In doing so, the researcher established that credibility, transferability, and dependability were all achieved (Lincoln & Guba, 1985).

Summary

Chapter 3 described this study's qualitative phenomenological research methodology, including the study's sample population, research instrument, and procedures that were used to gather and analyze the data. This study aimed to explore the lived experiences of dental hygiene faculty in using simulation with dental manikin head devices to teach local anesthesia in dental hygiene education. While analyzing and collecting qualitative data throughout the research, the researcher maintained a high level of ethical expectations, confidentiality, and validity, thereby

assuring the trustworthiness of the findings. Based on the data obtained, Chapter 4 illustrates the study's analysis method and presents the study's results and findings.

CHAPTER 4: RESULTS

This chapter will discuss this study's research design and analysis methods and will present this study's results and findings. The purpose of this qualitative phenomenological study was to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. This study sought to answer the following research questions:

- Research Question 1: How do dental hygiene faculty describe the use of simulation with dental manikin head devices when teaching local anesthesia education?
- Research Question 2: How do dental hygiene faculty describe the benefits and challenges in preparing students for administering local anesthesia?

The research design employed for this study utilized semi-structured interviews to examine the participants' lived experiences by answering the study's research questions. John Dewey's (1938) concept of interconnectedness between education and experience and David Kolb's (1984) theory of experiential learning were the frameworks that directed this study as guiding principles. These frameworks served as critical lenses through which the study's exploration unfolded and offered valuable perspectives to shape the research process. This study employed a comprehensive approach that encompassed several key components: the guidance of Dewey's (1938) and Kolb's (1984) frameworks, a thorough review of existing literature, and an inductive analysis of qualitative interview data. Through these steps, the researcher aimed to illuminate the alignment and disparities between participants' lived experiences with the concepts, challenges, and supportive practices discussed in the literature review.

Analysis Method

A qualitative phenomenological research design was employed to gather data of the lived experiences of dental hygiene faculty using simulation with dental manikin head devices in teaching local anesthesia. This study's research design utilized semi-structured interviews. The data gathered was obtained through in-depth interviewing that adhered to this specific interview format. The interview protocol's open-ended nature allowed participants to communicate in a conversational style and expand on their lived experiences while simultaneously providing their insights into how these experiences influenced their teaching methods. These interviews yielded rich data. The remainder of the chapter will include a description of the selected participants and a description of the emergent themes and subthemes which became evident during the process of coding.

Manual coding of data was accomplished using the copy-and-paste function on Microsoft Word at the individual transcript level and the coded data was stored on the researcher's password-protected personal laptop computer (Linneberg & Korsgaard, 2019). No computer software coding programs were used. The researcher labeled the text of different interview segments with codes that described the meaning of the segment. This manual coding procedure was accomplished using the following six-step process as identified by Smith et al. (2009): (a) read and re-read the transcript, as well as listen to the audio recording numerous times, (b) take notes on the descriptive, linguistic, and conceptual comments, (c) develop emergent themes, (d) search for connections across themes, (e) move to the next case, and (f) look for patterns across cases. Once all the data had been coded, the researcher analyzed the codes to identify specific connections. This analysis created broader overarching themes. The researcher validated the results with the theoretical framework and literature review.

Presentation of Results and Findings

The semi-structured interviews took place via Zoom over a three-week period in June 2023 through early July 2023. The participants met the qualifications listed on the Participant Information Sheet in Appendix D. This study's participants ranged from clinical course coordinators to laboratory faculty from institutions within four states in the Northeastern United States. All participants had backgrounds in clinical practice before entering academia, with experience in teaching ranging from less than one year to 32 years. However, each of the eight participants in the study came from various educational backgrounds prior to teaching in dental hygiene programs. Participants' experience serving as clinical faculty in local anesthesia education ranged from less than one year to 24 years. Some participants that were newly appointed faculty members in teaching local anesthesia had only taught using simulation, while others who had taught for longer had experience teaching local anesthesia before simulation methods began in dental hygiene education.

The first set of questions in the semi-structured interviews asked each participant to provide background demographic information. Participants were asked to describe their educational background and how long they had been teaching in dental hygiene academia. Participants were also asked to report how long they had been teaching as clinical faculty in local anesthesia education and how long they had been teaching local anesthesia education using simulation. The researcher assigned pseudonyms to protect the confidentiality of all participants. This demographic information about each participant using their pseudonyms can be found in Table 1. The descriptions below were designed to provide the reader with important demographic context for each participant within this study.

Table 1

Profile of Participants

Participant Name (Pseudonym)	Education	Years Teaching in Dental Hygiene Academia	Years Teaching as Clinical Faculty in Local Anesthesia Education	Years Teaching with Simulation in Local Anesthesia Education
Michelle	Master of Science in Education	18	17	4
Brianna	Master of Health Administration	25	18	2
Antoinette	Master of Science in Education	32	18	5
Geraldine	Doctor of Education	21	18	5
Seamus	Master of Science in Biology	2	<1	<1
Lucille	Doctor of Medicine in Dentistry	8	7	5
Niamh	Master of Arts in Health Education	26	1	1
Aileen	Master of Science in Education	25	24	5

Participant 1: Michelle

Michelle held significant experience as a clinical course coordinator and faculty member teaching local anesthesia. She shared several important insights in her interview regarding the progression of local anesthesia education within the field of dental hygiene with her 17 years of teaching involvement in local anesthesia and 18 years teaching dental hygiene in academia. She held noteworthy experience in teaching local anesthesia with and without simulation methods. When inquiring of her confidence levels in using simulation as a clinical faculty member teaching local anesthesia, Michelle replied, “I feel very confident and comfortable with it, and every time I use it, I come up with other ideas of maybe doing something different next year.”

Michelle described her heightened motivation for continuous improvement in teaching methods. Michelle's motivation was increased by attending conferences and poster sessions and observing what is available for dental hygiene educators. She acknowledged that such conferences and poster sessions had inspired her to brainstorm new approaches for students to grasp the concepts better in local anesthesia. Michelle indicated that simulation, coupled with the use of Objective Structured Clinical Examinations (OSCEs), a type of examination utilized in evaluating clinical competence within medicine and dentistry (Al-Hashimi et al., 2023), is the key to enhance student learning. This examination involves students participating in activities at multiple stations and includes standardized tasks and simulations of patient care (Al-Hashimi et al., 2023). Michelle strongly felt that simulation coupled with OSCEs had served as a great way to increase students' competency in dental hygiene local anesthesia education. Michelle had witnessed that "the students felt much more confident when they got to working on their lab partners." She explained that prior to doing so students would learn hands-on activities like this solely in the classroom, and then had to replicate such activities in the clinical component of their educational experience.

Michelle expressed the emotions associated with simulation in teaching local anesthesia by saying "it still doesn't really get it all. Simulation doesn't do it all because once they work on the real patient, it's a whole different feel, anyway. But it kind of gets them over the hump." She went on to explain that having students participate in OSCEs with simulated heads prior to working on a live human subject increased their confidence. She said it "really strengthened their confidence when they had to go into clinic. And I think that was a real great additive." Michelle addressed the impact of the COVID-19 pandemic being what prompted more simulation in

dental hygiene programs. Although she described her sense of empathy for the students and the effects of the pandemic, she said:

> The COVID-19 pandemic was what prompted things because we couldn't really go into [students'] mouths, you know? We weren't supposed to be practicing on them. So, because of minimal contact with each other, we were made to create things from COVID. So, it really was a silver lining for us, you know as horrible as COVID was and these poor students, we were able to take that and utilize and create something new and keep it even after COVID, and that's what we're doing. We had to think outside the box, and that's not a bad thing. So, it created something else that we didn't have before, and we thought, well, we could still keep this. And that's what we're doing.

Michelle went on to add her feelings regarding how important it is to educate students about using proper communication with patients when administering local anesthesia. Although dental manikin head devices cannot communicate with the operator, coupled with OSCEs and practicing the language with students that will be communicated to patients, and then acting this out on their peers Michelle considered to be imperative. According to Michelle, "…and even communicating with the patient is another thing because what do [students] always say [to patients]? Do you want to be numb? And the answer is no because [patients] don't want needles." Michelle stressed "you have to speak to [patients] a different way." She went on to emphasize that "[patients] have to be part of the decision-making so you can't just say, do you want to be numb?" Michelle explained, "you have to show [patients] and talk to them and explain why, and really, you know, face-to-face, talk to [patients] about what this is all about, so I say, do not ask." Michelle felt communication needed to be addressed alongside learning technique as students must feel comfortable to clearly relay, in her words, that "I'm the operator. I have a technique I'd

like to use to make you comfortable." She stressed that by practicing how to explain [the procedure], students will "learn how to communicate better with the patients." This communication, according to Michelle, is a crucial aspect in students' learning how to provide comprehensive dental care and pain control measures for patients.

Participant 2: Brianna

Brianna had immense experience as a local anesthesia clinical course coordinator and faculty member, having taught local anesthesia for 18 years. She shared several important insights regarding the progression of this discipline within dental hygiene academia over 25 years of her involvement in the field. She held an extensive amount of experience teaching local anesthesia with and without simulation methods. Brianna had utilized a computer-generated simulation program, along with dental manikin head devices, and expressed her strong feelings in support of enhanced student learning. Brianna described such feelings by saying that, "I just want to give the students variety and I think that it helps with their learning." When it comes to teaching local anesthesia using simulation, Brianna expressed her strong feelings in support of using numerous teaching methods. She had committed to the goal of doing "anything I can do to kind of make it fun for [students]" since she knew local anesthesia is a demanding course packed with a lot of information. When inquiring how she felt about her confidence level as a clinical faculty member teaching local anesthesia who had used simulation for the two years since it had been incorporated into the curriculum, Brianna replied:

> I started looking at it when I first learned the software, that it seemed somewhat difficult for me because I was always hands-on teaching local anesthesia. Now as an educator, I have to learn how to move the mouse the right way and do all of these computer things to create an injection, so I don't know that I was really a big advocator for it. I tried it first, so

I learned it myself, it was a little tough to learn but my students took to it very easily and the results that I saw in clinic were so obvious.

Brianna further indicated how she felt the COVID-19 pandemic greatly influenced a shift in how dental hygiene education is taught. She explained, "…it was due to COVID obviously that we were approached about a radiology simulator. And that's where it all started. They mentioned they had a local anesthesia simulator as well." Brianna expressed that "I just like the fact that we were in COVID and we had an alternative to the hands-on."

Participant 3: Antoinette

Antoinette held remarkable experience as a clinical course coordinator and faculty member teaching local anesthesia. Antoinette had contributed 32 years to teaching in dental hygiene academia and held the most years in academia of this study's eight participants. Antoinette shared several important insights in her interview regarding the progression of local anesthesia education within the field of dental hygiene. She held 18 years of teaching involvement in local anesthesia education, five of those years teaching with simulation. She provided noteworthy perceptions related to teaching local anesthesia with and without simulation methods. When Antoinette was asked if she felt confident and competent using simulation as a clinical faculty member teaching local anesthesia, she replied "I think so, yes. Absolutely. But I'm also, you know, always willing to learn something new."

Antoinette expressed her strong beliefs on using various teaching methods to enhance student learning outcomes. Antoinette also incorporating OSCEs using simulation with dental manikin heads, Antoinette was a firm believer in the value of providing short videos to students for demonstration purposes. She felt it was important to keep information and teaching methods

appealing and updated, saying “and just keep building on that and getting rid of things that students aren’t accessing.”

Antoinette also expressed she felt strongly regarding faculty intraprofessional collaboration within a program to be an effective educator. Intraprofessional collaboration refers to the partnership of two or more disciplines within the same profession (Janssen et al., 2017). Antoinette stated:

> We work really, very closely with the anatomy and physiology professors, [the] head and neck anatomy professor, focusing in on the coursework and reminders, and also the pharmacology professor. The course I teach is pretty focused on really just local anesthesia, however I feel like there’s a huge focus on review of medical history and case studies and putting the whole picture together, and treatment planning the anesthesia. It’s put in a good place in the program. But yeah, I think actually working with colleagues, too, and you know they've gone to different webinars and different presentations, and just seeing what works. We just had a professional development day, so I worked with another faculty member, and we talked about OSCEs and simulation. Finding someone I guess within your team who really loves it, and you know is going to kind of share what worked and what didn't work so well. Yeah, so just keeping the information threaded throughout your program in different courses as best you can.

Antoinette went on to describe how the COVID-19 pandemic transitioned dental hygiene education in teaching local anesthesia, as the COVID-19 pandemic was monumental in prompting simulation teaching methods. She described how “during COVID is when we were able to purchase the simulation. So COVID actually gave us the opportunity to purchase and work with simulation in multiple courses. And in COVID, we were so limited.” She added, “post

COVID, with all the changes that happened, we learned what we can do and also limitations to that." Antoinette expressed how she felt the real facilitators in using simulation when teaching local anesthesia were due to the pandemic and faculty intraprofessional collaboration. Antoinette stated:

> There's been a number of webinars, especially since COVID. And taking really full advantage of the, you know, short 1 hour or 2-hour webinars, I noticed that in using simulation, whatever the topic, say it's radiology simulation or, using a typodont in clinical simulation, there's common themes in how you're presenting that information, so it doesn't have to be local anesthesia simulation necessarily. You know any course on simulation, you can get bits and pieces that can apply them to that particular course that you're working with.

"Typodont" (2023) indicates that a typodont is an educational model of the oral cavity, consisting of artificial teeth, gingiva (gums), and a palate. A typodont is used by dental and dental hygiene students to allow them to practice certain dental procedures on the plastic teeth of a model before performing the procedures on live patients ("Typodont," 2023). Antoinette described her feelings using simulation to teach local anesthesia in that she felt it is important to use simulation to teach local anesthesia with interactive activities to encourage critical thinking. She explained:

> So, they were basically doing some activities, but using you know, more of that background and the knowledge piece of it. But again, incorporating that within the simulation so, some of the simulation was, you know, more physical. Another is, you know, mental and physical. So, it was, switching up a bit is key. The combination of simulation with kind of like more lecture material that you could have done just in the

> classroom that you put that in the simulation area. It was kind of a good combination, you know, not just all hands-on, but what you might have done in the classroom, we can do in that environment, too, and they don't even realize how much they are really having to think.

Participant 4: Geraldine

Geraldine had 21 years of experience as a faculty member teaching local anesthesia. Geraldine shared several important insights in her interview regarding the progression of local anesthesia education within the field of dental hygiene with her 18 years of teaching involvement in anesthesia education, five of which involved simulation. Geraldine also provided noteworthy experience teaching local anesthesia with and without simulation methods. When inquiring if she feels confident and competent to teach local anesthesia using simulation as a clinical faculty member, she replied, “Oh yeah. Not a problem. Yeah.” Geraldine expressed that since she had been teaching local anesthesia to students on each other as live patients for so long, simulation had just made such teaching easier. She believed in “integrating it in different facets,” including the use of OSCEs with simulation using dental manikin head devices and allowing for “lots of practice times for the students.”

Geraldine also attributed the push for more simulation as a response to the COVID-19 pandemic. She stated, “…and we started really getting these simulation heads during COVID. Because we needed to.” Geraldine reported she used some simulation prior but considered most of her real experience in using simulation to teach local anesthesia as being “post COVID.” According to Geraldine, the various methods of teaching with simulation allowed her to experience first-hand how procedural steps in hands-on application had contributed to

"confidence-building in students," as it allowed for structure because each portion "builds slowly on the next."

Participant 5: Seamus

Seamus had contributed to the field of dental hygiene education for two years and held less than one year of experience as a part-time clinical faculty member teaching local anesthesia. Since he joined academia only recently before this study was conducted, Seamus shared interesting insights related to teaching local anesthesia with simulation only. When the researcher inquired whether he felt confident and competent using simulation as a clinical faculty member teaching local anesthesia, Seamus replied:

> Yeah. I mean, within the scope of what I was teaching, absolutely. Yeah, because I thought it was pretty basic and, you know, I went through bullet points essentially of what I really need to know and I sometimes overprepare just because I want to make sure I have the answers to any questions that students may have. So, I looked at multiple resources, not just the ones that are offered to us. Yeah, so I did feel prepared actually going in. There's probably a couple of instances where you're not going to have the answers to everything, but you know for the most part, within the scope of what I know, I feel like I felt really pretty prepared for that. I felt prepared for the actual course.

Seamus felt taking on a course of such immense information was "super challenging" but felt grateful to be a part of the laboratory faculty guiding students in technique. Seamus explained, "within the realm of what we need to know, what we're teaching, it is great because you can go over the details of what works and ultimately, it's like, what's best for the patient." Seamus went on to describe how he "learned a lot about being patient with students and knowing that everyone's learning curve is obviously different and just knowing how this course can really

help them in their career, when they're actually out there practicing." He was clear in expressing how important his goal in teaching this course had been to be "how do you make students feel comfortable?" using simulation and then working on each other to ultimately provide the best care possible for their patients.

Participant 6: Lucille

Lucille had considerable experience in this study as a supervising dentist faculty member teaching local anesthesia, having contributed eight years to teaching in dental hygiene academia. Lucille shared several important insights in her interview regarding the progression of local anesthesia education within the field of dental hygiene as compared to her dental education background and experience. She provided noteworthy experience teaching local anesthesia with and without simulation methods during her seven years of local anesthesia teaching involvement, five which involved teaching with simulation. When inquiring if she felt confident and competent in using simulation as a clinical faculty member teaching local anesthesia, Lucille replied, "I do. I feel more confident and confident in the hands-on portion. I feel confident in using simulation where it's applicable." Lucille went on to explain:

> My experience is that the dental hygiene approach to teaching local anesthesia is head and shoulders above what I learned in dental school. I don't remember anything as detailed or as comprehensive when I was in school. So, when I became part of this, I really had to step back because they schooled me as far as the dental hygiene faculty's methods of teaching and at that point I was still in private practice and my dental assistant said to me, how much better I was now that I was using the dental hygiene approach to providing local anesthesia.

Lucille expressed that she did not use much simulation prior to the COVID-19 pandemic, as it was at that time that full manikin heads were able to be purchased. She stated, “it wasn't until we purchased those that I think we did a whole lot with simulation. So that was probably 2020.” Lucille expressed the importance of using various teaching methods, as she had taught using OSCEs with simulation using dental manikin head devices to enhance student learning outcomes.

Participant 7: Niamh

Niamh had captivating experience as a clinical course coordinator and faculty member teaching local anesthesia. Having contributed a total of 26 years of teaching in dental hygiene academia, Niamh shared several important insights in her interview regarding the progression of becoming a newly appointed clinical course coordinator of local anesthesia. She reported teaching local anesthesia for one year, that one year teaching including simulation. When asked if she felt confident using simulation as a clinical faculty member teaching local anesthesia, Niamh replied, “definitely, yes.” In teaching this discipline, Niamh expressed her positive feelings by saying, “I love it, you know, initially I was a little intimidated by the whole thing because it is a big course, definitely.” Niamh explained:

> We have a lot of students, right? So, the logistics of managing lecture and lab were a challenge, but I feel really, I'm very confident that I did a good job, and it went off without a hitch, but the prep work was a lot, but I enjoy it. I love teaching it. I feel like it's empowering to the students. I get to teach them something new that they can do, something that they have control over for their patient’s comfort.

According to Niamh, using simulation to teach local anesthesia is an extremely beneficial approach to enhancing student learning outcomes. When discussing simulation, Niamh expressed:

> It's extremely helpful. I love it. I can't imagine doing it any other way. Because there is such a high degree of, you know, the students are very stressed, they're very nervous, they are, for many reasons. I think the fact that they get a chance, they get an opportunity, numerous opportunities, to practice on the manikin before actually going in on their student partners, it puts them at ease. I can't imagine teaching it any other way.

Participant 8: Aileen

Aileen had substantial experience as a clinical course coordinator and faculty member teaching local anesthesia. She shared several crucial insights in her interview regarding the progression of local anesthesia education within the field of dental hygiene. Having contributed 25 years to teaching in dental hygiene academia, Aileen held the most years teaching local anesthesia education out of this study's eight participants with a total of 24 years of teaching local anesthesia education. Five of those years had been spent teaching local anesthesia education using simulation. Aileen held significant experience in teaching local anesthesia with and without simulation methods. When asked if she felt confident and competent using simulation as a clinical faculty member teaching local anesthesia, she expressed, "I do. Yeah. At first, you know, after I took the course many years ago, not at first." Aileen went on to share her unique perspective:

> The reason why I always liked teaching it in the lab is because I had to review it every time. So, for 24 years, every fall, I'm reviewing it. But, yes, not at first, but teaching it really makes you understand it and feel confident with it. Because you really do have to

know what you're doing, especially with local anesthesia, so yes, I do feel confident now, not after the first year or two. But I always had support and, you know, hands-on together with the student you could talk it out together.

Aileen emphasized that she believed “simulation is key.” However, like anything in dental hygiene, she explained, students need to use more critical thinking skills. She said, “[students] need to recognize what they're doing, not just doing it; recognize it, why they're doing it and just envisioning it all together.” When it comes to teaching with simulation, Aileen strongly felt that “we need to be doing more of this actually.”

The next series of questions in the semi-structured interviews provided the participants in this study the opportunity to provide information to answer the study’s two research questions. The findings from the data answered the study’s two research questions. The data was categorized based on similar patterns or groupings. The following details the thematic findings from the data analysis process. The findings reported in the chapter include four major themes and their subsequent subthemes. The first theme, empowerment, yielded two subthemes. The second theme, beneficial preparation, yielded two subthemes. The third theme, concerns as a challenge, yielded three subthemes. The final theme, support, yielded two subthemes.

Thematic Analysis of Interview Data

The researcher employed an inductive approach to organizing the data collected from the interviews into themes without a predefined set of codes (Linneberg & Korsgaard, 2019). This enabled the themes to derive meaningful insights directly from the participants' lived experiences. The following table depicts the data’s evident themes and subthemes. These themes contain contextual support. This support includes significant words, phrases, or ideas gleaned from the transcript data. These words, phrases, or ideas are used to answer each of the two

research questions. These themes relied on allowing the words and content of the data to naturally convey their own significance (Linneberg & Korsgaard, 2019). Table 2 lists the four themes that were revealed by the study data. Table 2 also includes a breakdown of each theme's corresponding subthemes.

Table 2

Themes and Subthemes

Theme	Subtheme
Empowerment	Faculty Motivation to Teach
	Student Confidence Levels
Beneficial Preparation	Standardization
	Promotion of Self-Efficacy
Concerns as a Challenge	Unrealism
	Time Constraints
	Training
Support	Funding
	Faculty Calibration

Theme and subtheme development involves a systematic process of coding. The researcher takes raw qualitative data and develops a communicative narrative from the data in the form of a word, a paragraph, or a phrase and identifies this with a label (Linneberg & Korsgaard, 2019). This label, in a form of a word or short phrase, designates the summary of the idea or concept being discussed (Linneberg & Korsgaard, 2019). The themes and subthemes

derived from each participant's interview represent the relevant notions and relate them to each of the study's two research questions.

Theme 1: Empowerment

The first theme that emerged through each of the participants' lived experiences was empowerment. All participants in this study reported feeling some sense of empowerment, whether this stemmed from their motivation to teach such an important discipline or their desire to help students become more confident in an area where fear can be a crippling factor. Both subthemes, faculty motivation to teach and student confidence levels, are interrelated. Both subthemes enhance the main theme of empowerment. They display the strong influence using simulation in teaching local anesthesia has on dental hygiene education.

Subtheme 1: Faculty Motivation to Teach

Faculty teaching local anesthesia have many obstacles to overcome. Many of the participants found that the challenges that come with teaching this course strengthen their motivation to teach it. This yielded the first subtheme. Faculty reported making every attempt to ease students in their journey of knowledge and application of local anesthesia. Teaching with simulation made overcoming these challenges more feasible. Michelle shared her motivation to get students to realize "if I could touch this simulation first instead of touching a live patient, it will increase my confidence levels" which then allows students to be able to complete the task and build their level of competence. Brianna detailed the sense of empowerment she has being a faculty member teaching this discipline:

> My experience is that it gives my students a broader way to provide care. You know, when I was a practicing dental hygienist, before local anesthesia was legal to do in this state, it was somewhat challenging to be able to provide that overall care. To be the

> overall clinician you had to get your dentist in to give the local anesthesia, or if a patient had root sensitivity. It just didn't seem like it was fluid care. I always was excited to learn it and I have that same excitement with my students.

Brianna went on to add that she tries to motivate students by instilling in them that similar excitement:

> You're going to learn a new, it's not simply scaling the teeth, you're going to learn a new skill, and this is going to be a skill that you're going to call upon when you're doing your most advanced work. This is in conjunction with you as a periodontal therapist. Taking it from that freshman level, where they're just learning instrumentation and the basics of hygiene to now, this is what it would be like to be a fully licensed clinician in this state. What are your skills? What are your awarenesses [*sic*] with your patient as far as what can you provide to your patient?

Brianna went on to share, "I guess it's kind of the excitement of learning, you know? It's local anesthesia. And we are teaching it a different way than I had ever been taught." Antoinette addressed the importance of taking "ownership" while teaching by informing students that she recalls her first time learning local anesthesia. She described how she communicates with students by sharing with them, "I remember shaking myself. And, and I needed to desensitize myself." Antoinette reported her experience motivating students by assuring them that practice in the simulation area will "alleviate their fears."

Geraldine described the incorporation of simulation in teaching local anesthesia as a goal to "give them all the resources that existed" so students would be comfortable. She added, "and of course if you're using a form of simulation, you can be in the room looking over the students." Geraldine described, "I just think it's a phenomenal course to teach, because there is a

motivation to help students through." Geraldine and Seamus both addressed the motivation to teach as empowerment to "get the nervous students through." Seamus described:

> I learned a lot about, you know, being patient with students and knowing that everyone's learning curve is obviously different and that this course can really help them in their career, like when they're actually out there. And my goal in this course from my aspect was like, how do you make them feel comfortable? Because this course is one that, as you know, like being in it, these students are very nervous. All students are, you can see them get nervous the moment they have a syringe in their hand.

Seamus explained the empowerment in being motivated to teach students the importance of realizing that every step of this course builds them up to the proper treatment of their patients:

> …for them, the first reaction is like, wow, I'm holding a needle that can cause, you know, a reaction to someone, systemically at that level, which is pretty powerful. So, knowing how to let them know how powerful it is, what they're doing and how delicate you have to be with these patients and why it's important to know techniques and how to give certain injections the right way. That's kind of what I really focus in on, and also the systemic factors like vitals, what to know with blood pressure, heart rate, respiration. There are things that we have to look for that are important, and you can't just be focused on just getting it done. A lot of times students, they're just doing the action. So, I wanted them to understand like the importance of it and why it is important to go over the book and the PowerPoint slides so that's what I generally focus in on.

Lucille explained her motivation to teach this discipline being the empowerment of students realizing that there is a "why of everything before doing it." She went on to describe the importance of using "additional approaches with simulation and OSCEs" because it strengthens

and motivates students to realize that "to succeed, I have to think about what I'm doing before I do it." Niamh expressed her motivation to teach the discipline as the empowerment to the students itself, as Antoinette also shared. Niamh said:

> …to teach them something that they can do, that they have control over their patient's comfort, and they don't have to rely on the dentist because I remember a time before we could administer local anesthesia. I clearly remember a time when I had to wait for the dentist to come in and I always talk about that to my students where I would have a scaling and root planing patient and I would let the doctor know the patient is here, topical is in their mouth, we would wait, and the doctor would come in, give the anesthesia, he would leave and then sometimes it wasn't enough or whatever it was. He had to come back in and I always, I like to tell the story to my students about how, you know, what a difference and how it's so nice to be autonomous and to be able to have control over this yourself.

Scaling and root planing is a more extensive dental cleaning procedure that involves mechanical debridement of bacterial biofilm and calculus down to the root of the affected teeth to resolve tissue inflammation (Rethman et al., 2021).

Aileen described her motivation to teach this discipline and that the empowerment she feels stems from the individualized teaching, "because unlike clinic, you can have five students. You can't say, okay, go on to that next procedure. With local anesthesia, you're sitting with them doing that." Aileen expressed her favorite part of teaching this discipline to be calming the students and teaching them one-on-one. She said, "the greatest part of it is just the hands-on direct, you know, helping them get through that fear." Aileen added:

> I love to break things down to teach it. I mean, simulation is key, I believe. But with anything in dental hygiene, they need to recognize what they're doing, not just doing it; recognize it, why they're doing it, and just envisioning it all together.

Subtheme 2: Student Confidence Levels

The final subtheme, student confidence levels, is derived from the overarching theme of empowerment. Faculty longed to provide students with the strength to know they will learn a different discipline that will substantiate their ability to provide the optimal level of patient care. Faculty yearned for students to believe in their own abilities and reduce fear and shaking by using simulation as the first step prior to providing anesthesia on a live patient. Michelle reported students have expressed how they feel much more confident learning using simulation with dental manikin head devices. She said:

> They can be nervous and shake their hands like crazy, so simulation gives them the opportunity to be comfortable with that instrument, with that cartridge, needle, things they've never even experienced before. I mean, think about it, they're so used to fulcruming with the instrument, going subgingivally, now they've got to think about mucobuccal folds, you know, height of injection. It's outside the box thinking of what they've learned all this time. So, having that simulated head, I think, does calm them and gives them more confidence, and really does help them learn better.

Brianna felt similarly. She reported, "because the students, it's their first time injecting someone, are nervous, apprehensive, there's been a lot of tears because of the apprehension." She added, "but I do find that my students like it, a lot of them say it's their favorite class." Brianna expressed that by using simulation, their learning is "built on every week," and "the students

eventually do get more comfortable with it, but initially there's a lot of lot of anxiety." She recalled:

> Yeah, so all the years prior that we didn't have the simulator, it took so much longer for the students to feel comfortable with giving injections and these last two years, maybe it's the student, I think it's the simulator, but they are just much more comfortable clinically, much more confident because that was always the thing that was lacking with the students is that confidence.

Antoinette expressed her feelings related to using simulation as being a "huge emotional relief" for faculty and students alike. She said:

> We see less of the shaking. The handshaking, the nervousness, that the confidence level is amazing when they get to that clinical portion because they've already worked with the simulation head in the chair. They have skills that are already met. So, by the time they get into the clinic and they're putting an actual needle on and, inserting into live tissue, they've already done everything but puncture the tissue and go into that area.

Antoinette explained learning with simulation to be "part of desensitizing" where they can practice and become comfortable. "So, they can do a little practice on their own," Antoinette explained when students work with simulation in pairs, "they could do some self-directing, self-directed learning and then kind of identify with their partner what's not going so well." Antoinette explained that by letting students know that "there are stages before they even are allowed to get to the point of having a live needle, they will have that syringe in their hand with the ball, they'll have the simulation head," and it will serve as an empowerment for them in understanding that "there are benchmarks they need to meet in order to be allowed to be in the clinical setting." She expressed that providing a similar method of education where students first

acquire the knowledge, apply the skill in simulation, and then finally work on their peer, that it contributes to their confidence levels. Antoinette said:

> …so, I think having those parameters in place and having the ability to have simulation and they get comfortable with their typodonts and their instruments, and they are familiar with that clinical process, and it only is natural when you get to local anesthesia that you have that same next step. You have the knowledge step, you have the psychomotor skill step, and then you actually get to that live patient care step.

Typodonts serve as educational tools that mimic an oral cavity, allowing students to practice on a plastic tooth model prior to a live patient ("Typodont," 2023). Antoinette went on to explain the benefits in using simulation to teach local anesthesia. She said:

> So, the teaching aspect is in the beginning, day one, even introducing local anesthesia, students tend to be a little apprehensive with the course. And I want to say out of all the courses, it's the one that they are the most challenged with emotionally, or it can be a challenge and not only from maybe their personal experience with local anesthesia, but the fact that now they're going to put this drug into someone else's body and they could potentially hurt them.

Like Antoinette, Geraldine expressed, "if they're dealing with simulation, they don't have to worry about hurting anybody and they can gain confidence." Geraldine went on to explain:

> I think the simulation is really good because we're not dealing with cross contamination, with a patient jumping in the chair, you know, all of those things. And it allows the students, because basically they've never had a syringe in their hand before, to feel comfortable with, how do I hold the syringe? Yes, this is the area. So, before they go in somebody's mouth, they already have a feel for the process. I see students can be

> extremely nervous. But it is amazing how they deal with their nervousness and come out on the end, sometimes being the strongest clinicians that are giving local anesthesia.

Seamus recognized the importance of teaching using simulation to contribute to an increase in student confidence levels. He said:

> I think going over the basics in the course from beginning to end is really important and then knowing how to inject with a manikin. So, it really gave them an idea of how to sit properly, clock position, angulation, adaptation, like knowing just the basic fundamentals, I think for the students, they like the feedback. I think they enjoyed it as well because it kind of lowers their anxiousness and because they're like, and it's crazy, because this is a manikin head so like they shouldn't be nervous, but they do shake initially. I think the main reason for simulation in my eyes is the practice before you know you're doing it with an actual person. They want to know that they're doing it correctly, so I think that's where the nerves come from.

Lucille reported simulation offers students "more opportunity for practice" in a more comforting environment. She explained, "if they feel afraid or shaky, the more times you can develop the grasp, the approach, the whatever, on something that might not be a live patient, I think they get more confident." Like Lucille, Niamh considered teaching this discipline to be rewarding because of the shift in "student confidence." She explained that "they're better prepared going into clinic" and that witnessing the improvement in students' confidence had been remarkable. "I saw such a difference in some of them," Niamh continued with a similar observation to the one made by Seamus, "their very first time, even on the manikin, their hands are shaking, and then in a couple of weeks, their hands are not shaking." Niamh expressed strong

feelings regarding teaching with simulation. She said, “Simulation is extremely helpful. I love the manikins. I can't imagine teaching this without them honestly.”

As mentioned in the data above, Aileen also expressed a sense of empowerment teaching local anesthesia using simulation for the students as “the students will be more confident.” She stated the biggest challenge in teaching this discipline is “the fear of the students.” Aileen explained, “Anxiety takes over, I think that's the biggest challenge, and just talking them down from that.” However, in empowering students to know that simulation will guide them towards gaining more confidence, she stated, “even if they've done it on each other after learning with simulation, and weren’t successful, they can go back to the simulation and try it again.”

Theme 2: Beneficial Preparation

Simulation in local anesthesia education is beneficial in that it guides teaching methods and prepares students. The second theme that emerged through the examination of each of the participants’ lived experiences was beneficial preparation. All dental hygiene faculty participants in this study reported the benefits of using simulation to teach local anesthesia in that simulation gives students an advantage in the learning process. Whether due to the concept of standardization or promotion of self-efficacy in students, the subthemes yielded from this theme, faculty clearly reported these as benefits in preparing students for administering local anesthesia.

Subtheme 1: Standardization

Michelle reported repetition as being key in standardizing learning for students to be well-prepared for administering local anesthesia. She stated, “I think that it's multiple times of holding that instrument where they weren't having multiple times before, when they would have the classroom session.” Brianna also expressed her beliefs in standardization by implementing

repetitive “computerized simulation activities and homework assignments.” After witnessing the students continually participating in these activities, she reported:

> They really knew landmarks well, technique still needed a little bit of work, but their landmarks, the angle of the syringe, just like where in general they're giving this particular injection, for what teeth are they trying to anesthetize? Every time we meet in lab, I will have a handout that the students get, a listing of all the penetration sites, and the type of needle they're going to be using, and their landmark for the injection, so I have all of those typed out and we go over those.

Brianna explained that after all those activities, the students are prepared. Antoinette also reported repetition to standardize learning in following certain procedural steps. She expressed, “and, you know, good retraction, positioning, and angulation, as well as target areas. So that is part of [using] simulation, those first steps in preparation before actually touching the live needle or going into the clinic to work on patients.”

Antoinette and Niamh discussed a crucial point when it comes to standardization in that it promotes “safety.” Procedural steps are followed using simulation so that students are aware of each step that needs to be achieved before they proceed. Antoinette mentioned standardization as being beneficial even “legally and ethically.” She explained:

> …you've gone through that process that, if there was a challenge, if something happened with patient care, if we ever were called into a court of law, what is the standard? The standard is the student has to pass the examinations. the final examination, they have to pass an OSCE going through the simulation, and then they have to pass a clinical on each other, and then they finally see a patient. So, if there was something, we feel very confident that they have gone through all these standards of education, and simulation is

a part of that, and if they would have backtracked, we can be confident of quality assurance for patient care.

Geraldine, Michelle, and Lucille explained that simulation helps standardize application in that it helps with "student practice time" where students can focus in on procedure and "practice their approach." Seamus discussed the importance of standardization in continually teaching "the fundamentals from the breakdown in the beginning, from beginning to end." Niamh expressed similar feelings in that the students "would have this opportunity, multiple times before they actually went in and worked on injecting each other." Niamh and Aileen explained that standardization using simulation promotes "confidence and preparation" in students which is beneficial to enhancing student learning outcomes.

Subtheme 2: Promotion of Self-Efficacy

This study's findings revealed that participants felt when students had ample opportunities to learn how to administer local anesthesia using simulation on a dental manikin head device first, feelings of self-efficacy were promoted. Michelle reported an "increase in their competence levels" because students had "more time to practice because it's a fake patient, a simulated patient, and they say, when I go into clinic, I won't be so nervous about it." Brianna spoke to students' self-efficacy when learning with simulation. She said, "the confidence, their comfort, they're just, their understanding, they have a much better understanding of when and how to use local anesthesia, that confidence level, that fear, has diminished quite a bit." Brianna described giving students that one-on-one instruction as it leads to "hearing them." She continued, "a lot of times a little story will come out about a challenge and seeing how to work with that specific person, as to what the trigger is and try to avoid that trigger," and personalizing

this experience helps them thrive. Antoinette expressed noticing how preparing students using simulation helps promote students' self-efficacy:

> And I really just over the years, I realized how important it is to have the knowledge but then to have that lab part of it, that pre-clinical or pre whatever you're doing, using the simulation, again to whatever degree that is, before you actually get to the clinical care, and the confidence in the students in passing that and saying, oh, that's another checkoff. Yep, I can pass a written exam, multiple choice, essay, whatever, I could do activities, papers, you know, whatever is needed for the course, but now I actually can do this on a simulation head without a real live clinical patient yet and, check off, I'm ready for the next step in providing care.

Antoinette also noted that simulation has transformed practice in recognizing that "the competence, the efficiency, and the safety" of students leads to enhancement of self-efficacy. Antoinette stated:

> …again, the competence that I am retracting well, I am already in my position, I know what my target is, I believe it's right in this area, like the student is in their little zone, like I think that's the spot. It's just, you know, yeah, the efficiency. And I want to say even time efficiency, the less time that it takes to do, as well as that huge safety feature of, you know, preparation. You know, the faculty team is saying, wow, what a difference, especially those who have seen it in the past. That preparation that comes with simulation and the improvement in their confidence.

Geraldine explained that since simulation offers the opportunity for "self-guided practice" under the supervision of faculty, simulation allows students to "take the responsibility for some of their own learning," and contributes to students' ability to self-reflect. She reported

that due to this, “the students may be a bit more relaxed because it is a simulation and not a person,” leading to enhanced self-efficacy in procedure. Geraldine, Seamus, Lucille, and Niamh reported “observing the ease in the students.” Niamh expressed using simulation in local anesthesia had transformed practice even in the “students’ mannerisms and their whole demeanor, just from beginning to end.” Niamh and Aileen both explained there is a noticeable change in how students are “very nervous in the beginning” and by the end “they're very comfortable.” Niamh expressed, “Some of them were like, I'll never be ready, because they all go in so nervous.” Niamh then explained, “they [students] feel better after” as there is a notable change in their level of confidence by the time they get to work on live patients.

Theme 3: Concerns as a Challenge

Dental hygiene faculty reported the challenges in preparing students for administering local anesthesia. Analyzing these challenges provided evidence of the study’s third theme, concerns as a challenge. This theme emerged through analyzing each of the participants’ lived experiences and yielded the subthemes of unrealism, time constraints, and training. All dental hygiene faculty participants in this study reported challenges incorporating simulation teaching local anesthesia. Whether due to the lack of realism offered by dental manikin head devices, time constraints in teaching using an additional approach, and training or lack thereof, faculty clearly reported their feelings regarding each.

Subtheme 1: Unrealism

All participants reported that dental manikin head devices lack realism. Teaching with a combination of simulation and traditional methods was recommended by all participants. When inquiring about barriers to using simulation, Michelle agreed that “simulation helps” but “it's not the be all, end all, because once you touch the real patient, it’s a bit different.” Michelle

expressed that although there are unrealistic features when working with the dental manikin head devices, “[practicing with them] instills confidence in the student” and still makes them “more comfortable.” She continued, “[simulation] makes them confident with the whole holding of the syringe. It's a whole different instrument they're holding. So, it's a whole different way of holding, doing fulcrum, holding your instruments, sitting.” Michelle recognized that getting students comfortable with these actions is crucial to their learning. Both Michelle and Brianna acknowledged they were disheartened with simulation prototypes in existence. Brianna explained in her research of certain manikin head simulators, “it didn't simulate the real-life experience. There [were] only certain injections that you could really do on it, it wasn't like a wide variety of different injections.” Antoinette reminisced of a certain prototype some years earlier having “calibration differences.” She spoke about her journey successfully discovering how to use common simulation elsewhere in a program for local anesthesia purposes. Antoinette found that teaching with the same model used for instrumentation when students are first learning in the program helps students learn. Brianna expressed:

> The students said they liked simulator heads because it gave them a little confidence before they went into the clinical, but we didn’t have the corresponding needles at the time. So now I find that model is just not all that helpful. And, you know, truly using a simulation, the same heads they use to learn instrumentation, the heads have the forehead on them. And it has cheeks and a tongue. And the retraction and the positioning and the target area with the angle of the syringe, you know, also adjusting the bevel, all of those skills, we can do really nicely with the same head they use for instruments.

As a positive to the concern of unrealistic dental manikin head device features, Brianna reported that there is a “constant,” where it is “nice to have the faculty step back and not interact

so much because [students] were only doing certain skills with the simulator." She continued, "we didn't have frenums, right? Students don't have to work around a frenum or the saliva or a tongue moving or a patient moving. Those things, all those factors were constant because you have a simulation head." She expressed this as a positive because it fine-tuned their focus to "just the skills." A frenum is one of the anatomical structures within the oral cavity that consists of a thin membrane of fibrous connective tissue and is present superficial to muscle attachments (Jindal et al., 2016). Brianna said:

> They really were achieving what was expected to be achieved during simulation. Done, check off, looks good, success, and now we'll move on to the next step. So, it was really helpful to focus in on what those goals were for that simulation.

Geraldine acknowledged regarding simulation, "I think it's great for the practice end of it. And maybe putting some of the fear aside, but when I see the real light bulbs going on is when they go in a student partner's mouth." She continued to express, "because not all the structures are on this simulator head," working on a live patient allows them to locate all the landmarks and really "see what we're talking about." Geraldine explained that there are things that are not seen on a simulator head, "so I think the simulator is great for those early nerves, but the light bulb is when they get in the mouth. They've got the foundation, but then they need the reality of it." Geraldine confirmed that a combination of the approaches is good and that it should never be one over the other. She expressed, "I would never want to see a student go from just training on a simulator to actually giving anesthesia on a live patient during patient care" and that they need to pass assessments to grant such permission. Geraldine explained that students need a reality check as a part of their learning to say "there's tissue here. Oh, I've got to work with the tongue. Oh,

I've got saliva. Oh, the patient coughed. Oh, if I'm way back here, they could gag, you know, all of that."

Lucille felt the same as Geraldine in simulation being offered before and as a "supplement to having that actual mouth to go in" and in combination being necessary. Lucille reported, "there is a space for both, and I don't think one should replace another at all." Seamus agreed that a combination in the teaching approach is crucial. He mentioned it being unethical if students did not administer on a live patient while within a program. Seamus said:

> I think it's so unethical to not have, not know what it feels like to do infiltration under the scope of like an institution and having faculty present to kind of guide you. That is the most, I think that's the best way to, kind of help teach anybody is like to have oversight. If you're saying going into, using a simulation only, it just doesn't seem ethical to like just do it on simulation and not an actual person because it's two totally different things. Like you start blanking on very basic, basic things because when you see an actual patient and if you don't have the basic fundamentals, then you're going to have issues.

Seamus reported the positives in simulation helping, but clearly stated where there are differences. He said:

> …they've watched the videos and looked at the PowerPoints and they've read what they've read, what they're expected to do, and the expected reading, but like they don't really know, because the mucobuccal fold where they're injecting, on the simulation head is like very, very dense and thick. It's not like it is for an actual person.

The mucobuccal fold indicates the point at which the mucosa of the lips or cheeks turns to go toward the gingival (gum) tissue (Pocket Dentistry, 2015). Seamus expressed, "simulation helps more in preparing them in terms of the basic fundamentals and they do feel prepared with

it. I think they all come out like we feel better. I think they do feel better because simulation happened prior." Lucille expressed the concerns in identifying landmarks, or the structural components within the oral cavity and the head and neck region (Pocket Dentistry, 2015). She explained, "there are some landmarks that really can't be replicated outside of a live human patient. Different levels of mastery of anatomical landmarks are a concern with simulation." Niamh also expressed her concern with replication of landmarks and when comparing simulation as a technique to different simulation technologies that are offered. In reference to simulation technologies, she said:

> They're just not reality. To me, the heads are the closest thing, you know, the manikins are the closest thing to an actual human. The virtual reality stuff is very cool. You know, it's very modern and cool. But it's not as realistic to me as sitting down and your positioning, when your manikin is in the chair, and getting your fulcrums and your positioning and where are you sitting and all that stuff that, that's the most realistic to me. You know, I think it's as close. Obviously, it's not exact. It doesn't feel exactly like mucosa, human mucosa, but it's as close I think as you're going to get.

In all of Aileen's years of experience, she had been teaching local anesthesia with skulls since the very beginning of her career. Within the last five years of Aileen's teaching experience, she found more advanced manikin head devices had been utilized. Aileen still preferred to teach using the different devices. She said:

> …you need to see the skull and you need to envision where everything is. The skull is great because you can see the bone. But the simulation heads have the flesh as well. So, you can, can you feel the bone? You won't be able to see it. I feel like after they're using a simulation, they don't feel so scared to do on each other. Although anatomy is different

> on everyone and we tell them that, but just, you know, the simulation allows them different experiences. I think everybody should be using a simulation before they start.

Subtheme 2: Time Constraints

In a discipline loaded with information and the need to work towards competence for patient care, time is a common concern among some participants. Michelle expressed that it is "a challenge to try to get all that material in. It takes time. And really just a finesse." Michelle explained that she will be making adjustments for the next time she teaches the course by adding another session so that she can rectify time concerns to "incorporate some more sessions live and simulated" to enhance learning. Brianna exclaimed she wishes she "had more time in lab." She added to combat time and add to familiarity:

> …as far as the simulator, because it's only been used recently, I think I want to tweak my course and expand on my course. I may use more of the simulator pictures or just incorporating the simulator into other parts of their learning just so they're seeing it more often.

Brianna went on to explain:

> In the beginning, students are very hesitant to do this skill and so you have to have a lot of patience and you don't want to feel like you're rushing them either. You want to make sure that they're really getting what they need to get out of out of their instruction.

Additionally, Brianna expressed that having a smaller student to faculty ratio would help with time concerns and encourage "putting out much more confident, skilled, competent hygienists." Antoinette expressed her concerns with time constraints "being responsible to try to cover all the bases" and when simulation was added, "it added a lot more" so "you just try to have enough time, and really time utilized in getting the faculty calibrated. But, yeah, finding the

hours" was a concern. On the contrary, Niamh and Aileen felt there is enough time and that the course with added simulation does not present as a concern. Niamh explained it is not a concern for her because there is a system in place, and the most challenging issue she had encountered related to the students' anxiety levels and stress. Aileen also spoke to having a specific system in place that guides procedure and influences students' experiences.

Subtheme 3: Training

When it comes to training, all faculty participants in this study reported they had minimal to no training. Most of their simulation training was self-taught. The majority of participants stated that they immediately started without any formal training or that no training was received. Some reported training was not necessary as simulation uses dental manikin head devices and is not much different than navigating a live patient from an educator's standpoint, except for the fact that it simulates a live experience. Michelle and Geraldine both reported self-guided training. Geraldine exclaimed, "we taught ourselves! We had been doing it so long before we needed all the simulation, and it was on people. That, you know, using a simulator was, just a patient that didn't talk back!" Brianna expressed her journey with self-directed training when beginning with computer generated simulation as "I tried it first, so I learned it myself, it was a little tough to learn." She said:

> So, I started looking at it when I first learned the software, that it seemed somewhat difficult for me because I was always hands-on teaching local anesthesia. Now as an educator, I have to learn how to move the mouse the right way and do all of these computer things to create an injection, so I don't know that I was really a big advocator for it.

Antoinette exclaimed she did not receive much training "other than webinars." She mentioned the paradigm shift in education since the COVID-19 pandemic and how it influenced

virtual education and the ability for self-directed learning because “there’s been a number of webinars, especially since COVID” and it was helpful to take “full advantage of, you know, a short 1 hour or 2-hour webinar.” She found that any course in simulation was beneficial because “you can get bits and pieces that can apply to that particular course that you’re working with.” Seamus reported self-directed training and “very, very basic training, if any. It wasn’t very in depth.” He recalled, “I think I went over some CE [continuing education] courses that were available. Like online, prior to being involved in teaching it. I tried to do my due diligence to read over whatever literature we had.” He reported viewing videos regarding simulation in teaching local anesthesia and “the videos would go through the basics. So, that actually really did help me prepare. That was actually enough for me to feel like I was comfortable.”

Lucille indicated she had no formal training in using simulation, but she had “mentors” and she “followed their lead.” She went on to express that due to the COVID-19 pandemic, there was no training. She said, “It was like, well, now we can’t be in their mouths” so it led to “on the spot training.” Lucille mentioned a self-guided approach once that happened that forced faculty members to be like “Let’s just see how we can make this work. And what can you teach and not teach using the manikin. What can we approximate in there, what is just going to be a guess?” Niamh and Aileen also claimed that they “jumped right in.” Niamh expressed that she followed her “mentors’ lead” and participated in “observation.” Aileen mentioned her use of manikin head skulls since the beginning of her teaching career in local anesthesia. Thus, when she acquired the more advanced manikin heads, no training was necessary. Aileen also expressed her sense of gratitude for her mentors and colleagues, who would work together in brainstorming and learning for the betterment of teaching this discipline.

Theme 4: Support

The study's final theme, support, includes that of administrative support in the form of funding and purchase acceptance, as well as departmental support in the calibration of faculty teaching local anesthesia. Most of the faculty participants interviewed felt supported by their administration. However, when it comes to the Commission on Dental Accreditation (2023), the national accreditation standards followed by accredited programs, Brianna explained, "a smaller student to faculty ratio" would encourage more effective teaching in support of faculty and student learning advancement. Antoinette expressed her concerns as the incorporation of simulation requires more support in terms of time and hiring of faculty. She exclaimed, "I believe we need more support."

Subtheme 1: Funding

Any time a new approach is considered that requires specific armamentarium, or the equipment and instruments used in the delivery of dental care (Medical Dictionary for the Dental Professions, 2012), cost becomes a factor. When discussing using simulation in teaching local anesthesia, "barriers do exist," according to Michelle, "the cost of this can be a little bit expensive and a lot of schools may not want to invest in those heads, so it is costly." But when this type of approach is used for board exams anyway, Michelle implied "they [schools] should really have them in their programs." Michelle felt "there could be barriers to schools saying, no, we're not purchasing all those heads." However, Brianna said regarding using the simulation heads in multiple courses, "I think it's really good for the department and for the budget when we're using common simulation. Nothing worse than getting the simulation and then not using it, and we are overusing the heads that were purchased."

Antoinette, Geraldine, and Lucille expressed that the COVID-19 pandemic was the reason simulation heads were purchased. Antoinette said, “So COVID actually gave us the opportunity to purchase and work with simulation in multiple courses.” Geraldine confirmed cost is a concern, but the support was received during the COVID-19 pandemic because that was when “we started really getting these simulation heads. Because we needed to. So much of that part has been post COVID because of that support.” Lucille recalled administrative support, where, when the COVID-19 pandemic hit, faculty were asked what they needed to proceed. The answer provided were the tools for simulation. The administration in response provided the funding to purchase the manikin heads. Seamus remarked that he understood from his colleagues that the simulation manikin heads are “apparently very, very, very expensive” so faculty members are told to be “very careful with them” and track who has the heads, which number heads are assigned to which students, and who has accountability for each head. Aileen described cost being an issue and that it would be helpful to acquire more simulation heads as she taught with one. She said, “So we could use more of those heads, yeah, we just don’t have enough of them.”

Subtheme 2: Faculty Calibration

Support of collegial faculty was considered by participants as being imperative to successfully teaching a course like local anesthesia. When simulation is added as an approach, participants deemed faculty calibration as being necessary to allow for effective teaching to occur. It was considered crucial by participants for everyone to be on the same page when delivering information and in the specific language used to deliver that information. Michelle voiced her concern related to the difficulty of getting all the faculty calibrated. She said:

> I want to have all of them but it's really hard to have all the adjuncts able to come. I have to figure out how to do that. It's so hard to get adjuncts to come in. You know they're busy with something else. They may be working in private practice."

Adjunct faculty members have other obligations that may hinder the ability for calibration activities. Michelle also expressed:

> …you do have people who develop habits over time. Their methods are going to be different for sure, but everyone should be safe. Habits that they've developed from their practice. And yeah, that may be well and good for them, but when you're talking to students you cannot deviate.

Brianna also remarked that the desire to learn something new does not always come easily to or is not accepted fully by faculty members who are not full-time. She explained they have other obligations, and this may come off as too demanding of their time. She said:

> Sometimes it's hard to get other faculty to really adopt new methods, especially adjunct faculty, it's hard for them, to be at the same, students have requirements, they have these simulation requirements. I just wish my faculty would review the simulator prior to coming in lab that day, that's the only barrier I see because I'll make a reference to this is what they were shown in the video but my instructors didn't see that video so they really don't know that they could also benefit by using the same techniques and language and everything that is, that they're seeing on the simulator, so that's my only barrier is getting my faculty to do enough pre-work, pre, prep work before it.

On the contrary, Seamus reported participating in faculty calibration activities. He explained, the faculty goes through the simulation approach "multiple times before going through it with the students." Seamus explained, "the reason for that is just to be standardized

across the board." He went on to explain, "everyone should be standardized and teaching it the same way, so we always run through it together."

Summary

This was a phenomenological study of lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. The study emphasized the lived experiences of faculty and their perceptions teaching this discipline using simulation. This study's purpose also explored whether faculty could guide student learning by incorporating simulation in the development of treatment skills on a manikin before applying to real-life interactions, thereby offering a safer and less intimidating approach to local anesthesia education (Imran et al., 2021). The study's data revealed four themes and each of their related subthemes. The study's data shed light on the significant correlations between its themes and subthemes. The findings from the data answered the study's two research questions. Participants revealed positive experiences using simulation and coding revealed and confirmed the need to use this approach as an additional approach to introduce this new skill to dental hygiene students prior to working on live patients. Chapter 5 explores the themes presented in this chapter and discovered in the data in response to the study's research questions. The interpretation and importance of the findings will be discussed, as well as the implications of the findings. Chapter 5 concludes with recommendations for action and further study.

CHAPTER 5: CONCLUSION

The purpose of this qualitative phenomenological study was to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. Numerous studies have examined dental manikin head device simulator use in dentistry (Dixon et al., 2020; Haji et al., 2021; Li et al., 2021; Moron, 2020; Nassar & Tekian, 2020; Serrano et al., 2020). However, the limited literature available on the use of simulation in dental hygiene education indicates the need to increase the awareness of faculty perceptions using simulation while teaching local anesthesia. This study aimed to address the gap in the literature as there is a lack of discussion regarding dental manikin head simulation use in teaching local anesthesia within dental hygiene education. While simulation is not a new approach in dental and medical education (Lateef, 2010; Perry et al., 2015), the hands-on allied health profession of dental hygiene has rarely incorporated simulation technique in dental hygiene curricula to teach local anesthesia education. This study focused on the lived experiences of dental hygiene faculty who do use dental manikin head device simulation in teaching local anesthesia education from schools in four states within the Northeastern United States. This chapter discusses the implications of the findings and concludes with recommendations for action and further study.

This was a phenomenological study of lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. The study emphasized the lived experiences of faculty and their perceptions teaching this discipline using simulation. This study's purpose also explored whether faculty could guide student learning by incorporating simulation in the development of treatment skills on a manikin before applying to real-life interactions, thereby offering a safer and less intimidating approach to local anesthesia education

(Imran et al., 2021). Eight semi-structured interviews were conducted to answer this study's research questions. The study's first research question asked how do dental hygiene faculty describe the use of simulation with dental manikin head devices when teaching local anesthesia education? The second research question asked how do dental hygiene faculty describe the benefits and challenges in preparing students for administering local anesthesia? The study's data revealed four themes and each of their related subthemes. The study's data shed light on the significant correlations between its themes and subthemes. The findings from the data answered the study's two research questions. Participants revealed positive experiences using simulation and coding revealed and confirmed the need to use this approach as an additional method to introduce this new skill to dental hygiene students prior to working on live patients.

Interpretation and Importance of Findings

Qualitative research has been described as a research design comprised of ongoing knowledge sought out by people to make meaning of the activities or experiences that they engage in as they occur (Merriam & Tisdell, 2016). The conceptual framework is a representation of the building blocks through which a study is conducted, including its importance and why it matters (Ravitch & Riggan, 2017). The purpose of this qualitative phenomenological study was to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. The conceptual framework that served as a guiding tool for this research process in this study was John Dewey's (1938) concept of interconnectedness between education and experience. This concept directed this study conceptually in that learning occurs when students are permitted to take their learning into their own hands by expressing their curiosity and impulse. Dewey (1938) posited that the key to successful learning is having a foundation in education grounded in a theory of real-world

experiences that offer growth, imagination, and skill strengthening. The focus of this study was to provide insight on how dental hygiene faculty perceive simulation using dental manikin head devices to teach local anesthesia in dental hygiene education.

The framework is the foundation that gives a study its shape (Ravitch & Riggan, 2017). This study's theoretical framework that directed this research was modeled after David Kolb's (1984) theory of experiential learning. In this model, teaching by modeling the experiential learning process begins with experience, followed by learner reflection. The learner processes the learning experience and applies the knowledge or skills following the creation of learning from reflection. Through the research methodology, design, and interpretation of the data, the conceptual framework articulates the researcher's choices so that both the researcher and the reader can evaluate the findings that feed back into the conceptual framework (Ravitch & Riggan, 2017). Eight semi-structured interviews were conducted to answer this study's research questions. This section outlines the interpretation and important findings of the following two research questions that guided the study:

Research Question 1

Dental hygiene faculty participants were asked to describe the use of simulation with dental manikin head devices when teaching local anesthesia education. Participants mostly reported positive experiences related to the use of simulation with dental manikin head devices in teaching local anesthesia education. The first theme, empowerment, most closely aligns with this study's first research question. This theme yielded the interrelated subthemes. These subthemes were faculty motivation to teach and student confidence levels. Both subthemes enhance the main theme of empowerment and display the strong influence using simulation in teaching local

anesthesia has on dental hygiene education. The findings from the data answered this study's first research question and related to the literature presented.

The concept of simulation through simulation-based learning has generated interest as an alternative educational approach in health care training. Davitadze et al. (2022) and Loutet et al. (2020) indicated that this simulation approach to learning allows for smoother transition into the clinical environment through skill development by replicating real-life scenarios, reinforcement of ergonomics and skillset, increased procedural practice, and ensured patient safety. This study confirmed that participants felt teaching with simulation in local anesthesia made overcoming challenges that come with teaching it more feasible. All participants reported making every attempt to ease students in their pursuit of knowledge and application of local anesthesia by using simulation, which strengthened their motivation to teach it. Antoinette and Geraldine both agreed that teaching with simulation allowed for smoother transition and ease for students, and this served as their motivation to teach using simulation. Geraldine explained, "[students] don't have to worry about hurting anybody and they can gain confidence." Brianna described her motivation when teaching local anesthesia with simulation as "teaching it a different way than I had ever been taught," confirming this different approach to be a stimulating experience for students to develop their skills and faculty to promote an exciting method in doing so.

Imran et al. (2021) postulated that educators can guide students by incorporating simulation in the development of treatment skills on a manikin before applying these skills to real-life interactions, thereby offering a safer and less intimidating approach to learning. Data gathered from this study confirmed this finding. Michelle mentioned her drive to get students to recognize "if I could touch this simulation first instead of touching a live patient, it will increase my confidence levels." According to Imran et al. (2021), this simulation approach also allows

students to practice until mastery, embrace mistakes, and look to correct errors in a judgement-free zone without restriction or reprimand by the educator. This study confirmed Dewey's (1938) theory that when the educator views teaching and learning as a continuous process of reconstructing experience, each experience can be viewed as a building block towards a foundation that influences future experiences. Geraldine, Seamus, and Lucille described the empowerment in getting students to recognize the importance of critical thinking in providing patient care. Lucille explained her motivation to teach this discipline being the empowerment of students realizing that there is a "why of everything before doing it." She went on to describe the importance of using "additional approaches with simulation and OSCEs [Objective Structured Clinical Examinations]" because doing so strengthens and motivates students to realize that "to succeed, I have to think about what I'm doing before I do it." Seamus explained the empowerment in being motivated to teach students the importance of realizing that every step of this course builds them up to provide proper treatment for their patients.

The standard procedure for local anesthesia education on live human subjects introduces increased student apprehension, prospective ethical dilemmas, and hazard in the practical application and administration of a potentially toxic anesthetic medication for nontreatment purposes (Decloux & Ouanounou, 2020; Haji et al., 2021; Hanson, 2011; Marti et al., 2021; Mladenovic et al., 2019; Zafar et al., 2021). Although local anesthesia administration has been deemed a safe and effective method used to manage pain and accomplish optimal patient comfort in dental treatment (Reed et al., 2012), and consistently documented since the 1970's as safely delivered by dental hygienists (Boynes & Bassett, 2016; Manski & Cartee, 2015; Reed et al., 2012; Smith et al., 2019), it is still of concern where student anxieties exist. Ramlogan et al. (2021) indicated that an effective measure to reduce human subject danger risk with such an

application involving potential for adverse events is by incorporating simulation into clinical education. It was suggested by Ramlogan et al. (2021) that this would provide students with the opportunity to first perform aspects of necessary procedural and specific skills within a realistic, safe, and controlled environment. Geraldine described the incorporation of simulation in teaching local anesthesia as a goal to "give [students] all the resources that existed" so they would be comfortable and motivated to get through.

Clemente et al. (2021) and Haridy et al. (2021) explained that the COVID-19 pandemic left feelings of uncertainty across the nation in how hands-on dental educational material was going to be delivered and received. Clemente et al. (2021) postulated that the COVID-19 pandemic sped up and encouraged more education to start being practiced on dental manikin head devices within dental education. The data collected in this study affirmed this shift in the educational approach. All participants who taught local anesthesia prior to the COVID-19 pandemic agreed that the pandemic promoted the urgency for the shift to manikins and quickly increased the need for development of simulated teaching experiences. Brianna indicated how she felt the COVID-19 pandemic greatly influenced a shift in how dental hygiene education is taught. She explained, "…it was due to COVID obviously that we were approached about a radiology simulator. And that's where it all started. They mentioned they had a local anesthesia simulator as well." Geraldine attributed the push for more simulation as a response to the COVID-19 pandemic. Geraldine stated, "…and we started really getting these simulation heads during COVID. Because we needed to." Antoinette also described how the COVID-19 pandemic transitioned how dental hygiene education teaches local anesthesia, as the pandemic was monumental in prompting simulation teaching methods. Lucille explained that she did not use much simulation prior to the COVID-19 pandemic, as the pandemic was what prompted the

purchase of full manikin heads. She stated, “it wasn't until we purchased those that I think we did a whole lot with simulation. So that was probably 2020.”

Seki et al. (2020) affirmed that during the COVID-19 pandemic simulation became the preferred method for educational purposes when working on patients was limited or impossible. Michelle said:

> The COVID-19 pandemic was what prompted things because we couldn't really go into [students’] mouths, you know? We weren't supposed to be practicing on them. So, because of minimal contact with each other, we were made to create things from COVID. So, it really was a silver lining for us.

Following the COVID-19 pandemic, simulation using the dental manikin head devices offered the ability for more practice time and provided an alternative to hands-on education. Lucille reported simulation offers students “more opportunity for practice” in a more comforting environment. Brianna articulated that she liked the fact that due to the COVID-19 pandemic, “[they] had an alternative to the hands-on” teaching approach. Michelle described the additional approach:

> … we were made to create things from COVID. So, it really was a silver lining for us, you know as horrible as COVID was and these poor students, we were able to take that and utilize and create something new and keep it even after COVID, and that's what we're doing. We had to think outside the box, and that's not a bad thing. So, it created something else that we didn't have before, and we thought, well, we could still keep this. And that's what we're doing.

This study confirmed Kolb’s (1984) theory of experiential learning that teaching by modeling the experiential learning process begins with experience followed by learner reflection.

According to Geraldine, the various methods of teaching with simulation allowed her to experience first-hand how procedural steps in hands-on application had contributed to "confidence-building in students," as teaching with simulation allowed for structure because each portion "builds slowly on the next." This study confirmed Kolb's (1984) finding that the learner processes the learning experience and applies the knowledge or skills following the creation of learning from reflection. Additionally, Buchanan (2001) conjectured advanced simulation would offer an excellent opportunity for dental educators to review and revamp curricula to meet the needs of their institutions and enhance student learning. Over the decades, advancements in simulation have been shown to improve the quality of dental education outcomes by offering applications in different dental disciplines and various clinical procedures (Moussa et al., 2022). Brianna reported that it was "nice to have the faculty step back and not interact so much because [students] were only doing certain skills with the simulator." These findings could offer insight into enhanced faculty development in that observation of student experiential learning can help faculty learn more about what to improve in their teaching methodologies.

Participants mostly reported perceiving a sense of empowerment as they witnessed an increase in student motivation levels using simulation with dental manikin head devices in teaching local anesthesia education. Lucille and Niamh considered teaching this discipline to be rewarding because of the shift in "student confidence." According to Ramlogan et al. (2021), as a method of training and simulation in clinical education, students can learn practical skills and develop competence in a safer environment that allows for intentional error and influences deep reflective learning. When implementing simulation as a part of the teaching approach, participants confirmed simulation can eliminate fear, anxieties, and the shaking that is common

in local anesthesia education. Michelle reported students have expressed how they feel much more confident learning using simulation with dental manikin head devices. She said, “they can be nervous and shake their hands like crazy, so simulation gives them the opportunity to be comfortable with that instrument, with that cartridge, needle, things they've never even experienced before.”

Participants discussed their feelings of empowerment in teaching students a different discipline, like local anesthesia, as using simulation fosters students’ strength when providing patient care. Seamus recognized the importance of teaching using simulation in contributing to an increase in student confidence levels. He said, “it kind of lowers their anxiousness” because “they do shake initially. I think the main reason for simulation in my eyes is the practice before you know you're doing it with an actual person.” Lucille explained, “if they feel afraid or shaky, the more times you can develop the grasp, the approach, the whatever, on something that might not be a live patient, I think they get more confident.”

Participants agreed that the confidence students gain in the belief of their own abilities is heightened when simulation is used as a precursor in administering local anesthesia on a live patient. Brianna reported:

> Yeah, so all the years prior that we didn't have the simulator, it took so much longer for the students to feel comfortable with giving injections and these last two years [students] are just much more comfortable clinically, much more confident because that was always the thing that was lacking with the students is that confidence.

This study confirmed Dewey’s (1938) findings that expressed the key to successful learning is having a foundation in education grounded in a theory of real-world experiences that offer

growth, imagination, and skill strengthening. Antoinette expressed her feelings related to using simulation as being a “huge emotional relief” for faculty and students alike. She said:

> We see less of the shaking. The handshaking, the nervousness, that the confidence level is amazing when they get to that clinical portion because they've already worked with the simulation head in the chair. They have skills that are already met. So, by the time they get into the clinic and they're putting an actual needle on and, inserting into live tissue, they've already done everything but puncture the tissue and go into that area.

Geraldine agreed:

> So, before they go in somebody's mouth. They already have a feel for the process. I see students can be extremely nervous. But it is amazing how they deal with their nervousness and come out on the end, sometimes being the strongest clinicians that are giving local anesthesia.

Hanson (2011) and Zafar et al. (2021) found that competence can be attained safely with the use of simulation as a precursor to the treatment of live human subjects for the application and enhancement of clinical skills in local anesthesia delivery. Niamh explained she witnessed improvement in students’ confidence levels after realizing they are “better prepared going into clinic.” Niamh and Seamus reported experiencing similar observations. Niamh explained “I saw such a difference in some of them.” Niamh recalled “[students] hands are shaking, and then in a couple of weeks, their hands are not shaking.” Niamh expressed strong feelings regarding teaching with simulation. She said, “Simulation is extremely helpful. I love the manikins. I can't imagine teaching this without them honestly.” Aileen agreed by expressing her feelings of “a sense of empowerment teaching local anesthesia using simulation for the students” as she has witnessed “the students will be more confident.” She stated the biggest challenge in teaching this

discipline is “the fear of the students.” Aileen explained, “Anxiety takes over, I think that's the biggest challenge, and just talking them down from that.” Both faculty and student development can be enhanced once ease of uncertainties has been achieved using simulation, leading to innovative opportunities for education and institutions to advance the success of their programs.

Research Question 2

Dental hygiene faculty participants were asked to describe the benefits and challenges in preparing students for administering local anesthesia. Participants mostly reported similar benefits and challenges in preparing students for administering local anesthesia. The findings from the data answered this study’s second research question and related to the literature presented. The second theme, beneficial preparation, most closely aligned with the first portion of this study’s second research question where participants described the benefits in preparing students for administering local anesthesia. This theme yielded the subthemes standardization and promotion of self-efficacy. The third theme, concerns as a challenge, most closely aligned with the second portion of this study’s second research question where participants described the challenges in preparing students for administering local anesthesia. This theme yielded the subthemes unrealism, time constraints, and training. Finally, the fourth theme, support, most closely aligned with this study’s second research question in its entirety, depending on the participant and what they had experienced. This theme yielded the subthemes funding and faculty calibration.

The second theme, beneficial preparation, yielded subthemes standardization and promotion of self-efficacy. Serrano et al. (2020) indicated that dental education is one of the few disciplines where invasive procedures must be performed on live human subjects under minimal supervision to achieve the clinical competence necessary to provide independent patient care.

Additionally, Dixon et al. (2020) and Haji et al. (2021) noted that the practice of local anesthesia delivery in dental hygiene requires attention to detail, meticulous manual dexterity, and demands the acquisition and maintenance of specific fine motor skills. The theoretical framework that guided this study, Kolb's (1984) theory of experiential learning, is based on the premise of a three-step process that teaching by modeling the experiential learning process begins with grasping a concrete experience as a learner, reflecting on it for optimal learning, and conceptualizing it for outcome enhancement. Simulation can be viewed as an approach to experiential learning and a beneficial endeavor in the field of dental hygiene and local anesthesia education. In this study, participants identified their lived experiences relating to the incorporation of simulation using dental manikin head devices to teach local anesthesia in dental hygiene education.

According to Raina et al. (2021), standardization with simulation is beneficial and ideal for grading purposes and to assure each student gets the same experience. However, compared to the standard design of a manikin head simulator, every live patient will look and feel different, and procedure is certainly dependent on the individual anatomy of the patient (Raina et al., 2021). All participants in this study reported the benefits of using simulation to teach local anesthesia in that simulation gives students an advantage in the learning process. Whether due to the concept of standardization or promotion of self-efficacy in students, the subthemes yielded from the second theme, faculty clearly reported these as benefits in preparing students for administering local anesthesia. Kolb's (1984) postulated that ideas are not fixed, but rather that the learning process is developed through elements of thought being formed and re-formed based on experience. Michelle described, "I think that it's multiple times of holding that instrument where they weren't having multiple times before, when they would have the classroom session."

According to Davitadze et al. (2022), the learner first experiences the concrete learning experience, reflects on the experience, then conceptualizes the thoughts and reflects on that experience. During reflection, the learner considers what could have been done differently for outcome enhancement and finally applies the knowledge or skills following the learning to direct future practice. Brianna shared her beliefs in standardization by implementing repetitive "computerized simulation activities and homework assignments." She described, "They really knew landmarks well, technique still needed a little bit of work, but their landmarks, the angle of the syringe, just like where in general they're giving this particular injection, for what teeth are they trying to anesthetize?" This study affirmed the findings from Moussa et al. (2022) that despite the potential limitations encountered with simulation, simulation may enhance the understanding of anatomy and procedure.

Local anesthesia administration is a safe and effective method used to manage pain and accomplish optimal patient comfort in dental treatment (Reed et al., 2012). According to Raina et al. (2021), simulation is instrumental in achieving safety and minimizing risk when the primary goal of dental education and clinical training should be providing education, with patient safety and well-being in mind. Simulation offers a safe, hassle-free, and risk-reduced environment in which students can learn and educators can serve as guides. Antoinette and Niamh agreed with the crucial point that, when it comes to standardization in simulation, simulation promotes "safety." Simulation promotes the practice of procedural steps being followed so that students are aware of each step that needs to be achieved before they proceed. Antoinette remarked standardization as being beneficial even "legally and ethically." She explained that if ever health care was questioned by a court of law, "we feel very confident that [students] have gone through

all these standards of education, and simulation is a part of that, and if [authorities] would have backtracked, we can be confident of quality assurance for patient care."

According to Li et al. (2021), students acquire a clearer understanding of the theoretical concepts working with simulation without the anxieties of working on a live patient so that correction can be made without student embarrassment and students can continue until mastery. This study's findings revealed that participants felt when students had ample opportunities to learn how to administer local anesthesia using simulation on a dental manikin head device first, students' feelings of self-efficacy were promoted. Almasri (2022) and Gottlieb et al. (2011) found that the use of simulation increases development with an enhancement of student learning experiences, an enhancement of tactile skill, and promotion of critical thinking skills. This study's findings affirmed that student self-efficacy is promoted as participants were able to witness the effects simulation had on minimizing errors through continuous training in a safe environment. Many students struggle with nerves and application of local anesthetic administration for the first time (Hanson, 2011; Mladenovic et al., 2019; Zafar et al., 2021). Antoinette described that simulation has transformed practice in recognizing that "the competence, the efficiency, and the safety" of students leads to enhancement of self-efficacy.

Mladenovic et al. (2019) and Zafar et al. (2021) indicated that it is imperative that students receive sufficient preclinical training prior to transitioning to successful patient management on a human subject. Simulation training has been shown to improve student ergonomics, provide continual reassessment, offer ease of availability for students to access at any time, increase confidence, enhance performance, provide correction without embarrassment, and enhance critical thinking skills in an environment that allows for intentional error to occur so that deeper learning can be achieved while ensuring patient safety (Brand et al., 2010; Gottlieb et

al., 2011; Lateef, 2020; Mustilwar et al., 2022). Students can work on their manual dexterity and enhance problem solving and critical thinking skills. Ramlogan et al. (2021) explained that students can learn practical skills and develop competence in a safer environment that allows for intentional error and influences deep reflective learning when training and simulation is used in clinical education. Antoinette remarked on, "[the] preparation that comes with simulation and the improvement in their confidence." Antoinette stated:

> …again, the competence that I am retracting well, I am already in my position, I know what my target is, I believe it's right in this area, like the student is in their little zone, like I think that's the spot. It's just, you know, yeah, the efficiency.

The third theme, concerns as a challenge, most closely aligns with the second portion of this study's second research question where participants described the challenges in preparing students to administer local anesthesia. This theme yielded the subthemes unrealism, time constraints, and training. Dental education is complex in delivery, as attaining theoretical knowledge requires spatial imagination and traditional manikin simulation does not resemble realistic clinical situations in patient-centered training (Moussa et al., 2022; Serrano, et al., 2020). The advancement of the field of dental hygiene encourages the enhancement of safe and effective educational methodologies. The lack of discussion in the literature regarding the use of dental manikin head devices within local anesthesia education is a concern as there are methods that are more likely to avoid potential risks, adverse reactions, and hesitancies in the administration of anesthetic medication for nontreatment purposes (Haji et al., 2021; Hanson, 2011). Dental manikin head simulator training can also allow for intentional error and reflection for real student learning in dental anesthesia delivery.

According to Farag and Hashem (2022), dental manikin phantom heads with plastic teeth have been considered the mainstay simulation approach since their existence and have been used to simulate patient conditions. However, according to Perry et al. (2015), phantom dental manikin heads lack some of the realism found to be beneficial with live patient experience. Phantom dental manikin heads do not simulate the major components of the oral cavity including the teeth and their supporting structures (Farag & Hashem, 2022). Participants in this study confirmed these are concerns they faced when teaching local anesthesia with simulation. Raina et al. (2021) also added the lack of natural factors including saliva and blood, movement of the tongue by the patient, and the reaction of the patient to pain all serve as connections and experiences and are lost when working on a manikin. All participants agreed with these findings and the Perry et al. (2015) findings that the lack of saliva, blood, human resistance, and common human connection is not experienced with simulation technology. Geraldine shared that students need a reality check as a part of their learning to say "there's tissue here. Oh, I've got to work with the tongue. Oh, I've got saliva. Oh, the patient coughed. Oh, if I'm way back here, they could gag, you know, all of that." However, many participants viewed this as a positive as well, in that distracting factors like saliva, blood, and human movement are removed, which allows students to focus on procedure and skill. Brianna explained, "Students don't have to work around a frenum or the saliva or a tongue moving or a patient moving. Those things, all those factors were constant because you have a simulation head."

The application of anesthesia requires cognitive abilities, procedural knowledge, and immense knowledge of the facial nerves and structures to determine the proper placement and delivery of anesthetics (Correa et al., 2017; Hanson, 2011). Reed et al. (2012) explained that in local anesthesia, the provider relies heavily on visualization and palpation of the hard tissues to

determine landmarks for injection sites. Lucille, Geraldine, and Niamh shared their concerns in identifying landmarks, or the structural components within the oral cavity and the head and neck region (Pocket Dentistry, 2015). Lucille explained, “there are some landmarks that really can't be replicated outside of a live human patient.” Lucille went on to affirm, “Different levels of mastery of anatomical landmarks are a concern with simulation.” Geraldine expressed, “not all the structures are on this simulator head,” and that working on a live patient allows students to locate all the landmarks and really “see what we're talking about.” Niamh also expressed her concern with replication of landmarks when using simulation. According to Reed et al. (2012), manikin use diminishes that connection in treatment compared to a live human patient. Additionally, simulation technology offers a poor representation of the soft tissues and pertinent points of reference within the oral cavity (Brand et al., 2010; Mladenovic et al., 2019). Niamh agreed with the poor representation and explained:

> [Simulation technologies are] just not reality. To me, the heads are the closest thing, you know, the manikins are the closest thing to an actual human. The virtual reality stuff is very cool. You know, it's very modern and cool. But it's not as realistic to me as sitting down and your positioning, when your manikin is in the chair, and getting your fulcrums and your positioning and where are you sitting and all that stuff that, that's the most realistic to me. You know, I think it's as close. Obviously, it's not exact. It doesn't feel exactly like mucosa, human mucosa, but it's as close I think as you're going to get.

Li et al. (2021) and Nassar and Tekian (2020) described that dental simulators create time-saving strategies for faculty because calibration is higher, and faculty feels more comfortable providing the education. However, Buchanan (2001) originally postulated that simulation must be adapted to the needs of individual schools to reach their fullest potential.

Simulation can decrease time in preclinical laboratory settings, easily allow for mandatory remediation on simulators when necessary to replace some aspect of actual patient care and reduce the reliance on patients for certain types of procedures (Li et al., 2021; Nassar & Tekian, 2020). This study's findings revealed most participants expressed that time is a concern. Two participants expressed there was enough time and that the course with added simulation did not present as a concern. Michelle, Brianna, and Antoinette all indicated that they wished they had more time to cover all the material and to get the most out of using the added simulation-based approach.

In the Marti et al. (2021) study, faculty remarked that simulation technology could be used as a supplemental and safer way to teach students local anesthesia, but clinical training would remain the milestone of training. The faculty in the Marti et al. (2021) study expressed their perceptions of this approach being beneficial as students could make mistakes in a controlled environment while learning through repetition of techniques and interpretation of prior basic science concepts but concluded that this should be used as an additional approach. The participants in this study agreed with those findings and expressed that simulation using dental manikin head devices should not replace the traditional teaching approach. Lucille reported, "there is a space for both, and I don't think one should replace another at all." Lucille felt the same as Geraldine in simulation being offered before treatment on a live patient and as a "supplement to having that actual mouth to go in." All participants in this study indicated that the combination of both simulation and the traditional teaching approach is necessary. Geraldine expressed, "I would never want to see a student go from just training on a simulator to actually giving anesthesia on a live patient during patient care." She added that "[students] need to pass assessments to grant that permissible." Seamus expressed that if programs were to use simulation

only, “it just doesn't seem ethical to like just do it on simulation and not an actual person because it's two totally different things.” Aileen stated in response to unrealistic characteristics in simulation that although such lack of realism can be viewed as a concern, lack of realism is also a benefit because “although anatomy is different on everyone and we tell them that,” she continued, “the simulation allows them different experiences. I think everybody should be using a simulation before they start.”

Kluge et al. (2022) found that simulation should work alongside the traditional teaching approach in that the underlying learning theory utilized can influence advantages in addressing student interaction, manipulation of virtual components, and teaching of complex concepts. It was questioned that there was no formal training in the field associated with this approach and that faculty may be apprehensive to adopt a new method in fear of losing the traditional teaching approach. Plessas (2017) described that simulation technology provides feedback in a method that should not be accepted solely as the form of feedback and evaluation in student learning but rather as a supplement to the quality and effectiveness of instruction and feedback. All participants in this study reported they had minimal to no faculty training in using simulation to teach local anesthesia. However, rather than seeing this lack of training as a concern, participants viewed the lack of training simply as the progression in their teaching journey. Since simulation offered extra practice time and was a supplemental practice for study, it only instilled confidence and competence in students, rather than apprehension in faculty. Most participants revealed their simulation training was self-taught, whether they “jumped right in,” or that no training was received. Some felt training was not necessary as the practice of using simulation is not much different than navigating a live patient from an educator’s standpoint, except for the fact that it simulates a live experience. Michelle and Geraldine both reported self-guided training. Geraldine

exclaimed, “we taught ourselves! We had been doing it so long before we needed all the simulation, and it was on people. That, you know, using a simulator was, just a patient that didn't talk back!”

Marti et al. (2021) found that recommendations for simulation technology training to enhance procedures include allowing the simulation procedures to occur under proper guidance and supervision, discussing this alternate approach in more detail, and evaluating the anatomical variations that would benefit the curriculum. This aligned with what Brianna reported. Brianna said it is “nice to have the faculty step back and not interact so much because they were only doing certain skills with the simulator.” She explained using simulation allowed faculty to focus on the students’ technique. Brianna shared her journey with self-directed training when beginning with computer generated simulation as “I tried it first, so I learned it myself, it was a little tough to learn.” Antoinette exclaimed she did not receive much training “other than webinars.” Seamus reported self-directed training and “very, very basic training, if any. It wasn't very in depth.” Lucille indicated she had no formal training in using simulation, but she had “mentors” and she “followed their lead.” When questioned if they had received any training, Niamh and Aileen also expressed that they “jumped right in.” Niamh shared that she followed her “mentors’ lead” and participated in “observation.” Aileen mentioned that her use of manikin head skulls since the beginning of her teaching career in local anesthesia meant that she found additional training unnecessary. Aileen also expressed her sense of gratitude for her mentors and colleagues who would work together in brainstorming and learning.

Finally, the fourth theme, support, aligns with this study’s second research question in its entirety depending on the participants and what they had experienced. This theme yielded the subthemes funding and faculty calibration. Perry et al. (2015) and Raina et al. (2021) found that

the major disadvantages that could present as limitations of simulation-based training approaches are the high initial purchase, installation, and maintenance cost, along with time-consuming staff training. This study confirmed the Perry et al. (2015) and Raina et al. (2021) findings. All participants in this study indicated that support is necessary from an administrative and departmental standpoint for successful implementation of a simulation-based training approach. Michelle and Aileen expressed that cost is a major disadvantage in successful implementation. However, both Michelle and Brianna acknowledged that funding this approach is only beneficial for the program and students, so it behooves institutions to purchase what is needed for learning and examination purposes. As a positive, Antoinette, Geraldine, and Lucille all credited the COVID-19 pandemic as being the reason simulation heads were able to be purchased by their institutions. Seamus and Aileen remarked on the importance of accountability and caution of each faculty member and student to keep track of the dental manikin head devices due to the high cost and scarcity. Seamus explained faculty are told to be "very careful with [the dental manikin head devices]" as they are "apparently very, very, very expensive." Aileen shared, "we just don't have enough of [the dental manikin head devices]."

According to Li et al. (2021), simulation using dental manikin head devices helps with faculty calibration because it guides faculty in standardizing their teaching practices. Some participants reported the struggle in support of faculty calibration in preparing to teach using this approach. Michelle and Brianna expressed the difficulty in getting faculty calibrated to teach this discipline. Michelle shared, "It's so hard to get adjuncts to come in. You know they're busy with something else. They may be working in private practice." Brianna agreed, expressing that adjunct faculty members have other obligations that may hinder their ability to engage in simulation calibration activities. Brianna said, "Sometimes it's hard to get other faculty to really

adopt new methods, especially adjunct faculty, it's hard for them." Brianna expressed, "I just wish my faculty would review the simulator prior to coming in lab that day, that's the only barrier I see." Brianna reported she finds struggle in "getting my faculty to do enough pre-work, pre, prep work before [teaching]."

This study data successfully answered this study's research questions. Further this research supported the theories, concepts, and findings presented in the literature review. Through the exploration of the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia, this study affirmed that this teaching method allows for educators to guide students in the development of skills and competence prior to a live patient interaction, in a safer and less intimidating approach. This study's research questions and findings were supported by Dewey's (1938) concept of interconnectedness between education and experience and Kolb's (1984) theory of experiential learning.

Implications

Dental education is complex in delivery, as attaining theoretical knowledge requires spatial imagination (Moussa et al., 2022; Serrano, et al., 2020). While simulation is not a new approach in dental and medical education, the field of dental hygiene has rarely incorporated simulation technique in its curricula to teach local anesthesia education to strengthen skill, enhance procedure, and reduce harm to patients (Lateef, 2010; Perry et al., 2015). Moussa et al. (2022) and Serrano et al. (2020) noted traditional manikin simulation does not resemble realistic clinical situations in patient-centered training. However, simulation with dental manikin head devices could still provide a beneficial student learning experience, as evident with the participants' perceptions in this study's findings. The gap in the literature regarding the lack of discussion in using simulation with dental manikin head devices to teach local anesthesia within

dental hygiene education correlates to the smaller population of participants in the study's data collection. This study focused on the lived experiences of dental hygiene faculty in the exploration of incorporating simulation with dental manikin head devices in teaching local anesthesia as a precursor to working on live human subjects.

Institutions with dental hygiene programs must recognize they are facing an evolving landscape. Dental hygiene faculty are being challenged to adapt and develop new teaching methods to reach different levels of student learning styles in changing times. As confirmed by Clemente et al. (2021) and Haridy et al. (2021), the COVID-19 pandemic left feelings of uncertainty in dental education programs across the nation regarding how hands-on dental educational material was going to be delivered and received. This paradigm shift in dental education was sped up by the COVID-19 pandemic, prompted the use of simulation, urged the shift to manikins, and quickly increased the need for development of simulated teaching experiences (Clemente et al., 2021). Prior to the COVID-19 pandemic, Clemente et al. (2021) informed simulation with phantom manikin heads and simulation technology was merely innovation and advancement. However, these approaches have since transformed education as a matter of public health (Clemente et al., 2021). Lucille said she did not use much simulation prior to the COVID-19 pandemic, as "it wasn't until we purchased those [heads] that I think we did a whole lot with simulation. So that was probably 2020."

The advancement of the field of dental hygiene encourages the enhancement of safe and effective educational methodologies. As a precursor to working on live human subjects, the literature found that simulation could be beneficial in guiding students towards competence (Brand et al., 2010; Gottlieb et al., 2011; Lateef, 2020; Mustilwar et al., 2022). However, the lack of discussion in the literature regarding the use of dental manikin head devices within local

anesthesia education is a concern as there are methods that are more conducive to avoiding potential risks, adverse reactions, and hesitancies in the administration of anesthetic medication for nontreatment purposes (Haji et al., 2021; Hanson, 2011). Dental manikin head simulator training can also allow for intentional error and reflection for real student learning in dental anesthesia delivery.

Recommendations for Action

This study's findings provided a sample of dental hygiene faculty's perceptions using simulation with dental manikin head devices to teach local anesthesia education. As a precursor to working on live human subjects, simulation was found to be beneficial in guiding students in skill development, easing anxieties, and building confidence levels, as evident the participants' reported lived experiences. Institutions, including their administration and faculty, should seek to increase data, awareness, and understanding of additional educational methodologies to enhance student learning outcomes. As Imran et al. (2021) indicated, since the practice of dental hygiene and dental anesthesia delivery demands proficient fine motor skills and meticulous manual dexterity, students should have an opportunity to gain experience with manikin simulation before applying their skills and technique to real-life situations. This may consequently produce a safer and more competent practical application during patient care.

All participants reported benefits in teaching local anesthesia using simulation with dental manikin head devices. However, some participants reported challenges, hopes, and recommendations for action. Antoinette shared her hopes for future development, "I'd love a company to come up with the perfect simulation head or something that gets added to what we already have." She went on to explain, "an add on feature, that we might be able to purchase for a student. That would be great." This researcher believed that a common understanding and

mission to improve educational methodologies in a changing climate where educators are looking to reach students' different learning styles and enhance learning outcomes would be advantageous. Aileen shared her hopes for future development when she said, "I would have loved more of the [simulation heads], we only have one." She expressed, "So, we could use more of those heads that, you know, that light up and they can feel it, it would be very helpful if I could have more. Unfortunately, we only have one." Institutions should evaluate their programs when determining funding for incorporating methods that will improve the outcomes of student learning for examination purposes and to promote the development of skills in providing more comprehensive patient care.

Recommendations for Further Study

This study explored the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. The data that was collected and analyzed into the presented findings related to this group of participants consisting of eight dental hygiene faculty who had experience teaching local anesthesia using simulation with dental manikin head devices. The aim was to address the gap in the literature as there is a lack of discussion regarding simulation using dental manikin head devices in teaching local anesthesia within dental hygiene education. The intention of this study was to address the perceptions of faculty in incorporating simulation with dental manikin head devices as a precursor to teaching local anesthesia within dental hygiene education. The impact of this study was limited by the study's size and scope. There is a selective group of institutions within the Northeastern United States that use simulation with dental manikin head devices to teach local anesthesia. If possible, a more robust study with a much larger sample representing a larger selection of faculty who have had this experience could provide a deeper picture of the phenomenon.

Further, regarding faculty development, training in using the specific simulation technique or technology and transitioning novice students to competent clinicians using this as an approach is worth further study. According to Imran et al. (2021), limited studies have discussed the incorporation of simulation technology in the curriculum due to low educational standards, unclear scoring mechanisms, problems integrating this technology into dental curricula, and challenges with student or teacher feedback mechanisms. Studies have primarily focused on technical skills and have created a need to bridge this gap in modern simulations with non-technical skills and faculty development within institutions. Prior to this study, this researcher had not considered the wide range of simulation devices and approaches beyond the dental manikin head device. However, having completed this study, this researcher now feels that studying the experiences of dental hygiene faculty using all the different types of simulation techniques and technologies available to compare their effectiveness would likely provide valuable insight into understanding the most effective approaches to teaching local anesthesia. This would also widen the size and scope of the study to include faculty at institutions that were limited to this specific type of simulation due to cost.

Conclusion

Simulation training has been shown to foster deeper learning while ensuring patient safety (Brand et al., 2010; Gottlieb et al., 2011; Lateef, 2020; Mustilwar et al., 2022). The problem this study addressed was the lack of discussion regarding simulation including the use of dental manikin head devices being used by faculty within dental hygiene institutions when teaching local anesthesia in dental hygiene education (Hanson, 2011; Zafar et al., 2021). The purpose of this study extended to explore if educators can guide students by incorporating simulation in the development of treatment skills on a manikin before applying these skills to

real-life interactions, thereby offering a safer and less intimidating approach to learning (Imran et al., 2021). Eight semi-structured interviews were conducted to answer this study's research questions. This study's first research question asked how do dental hygiene faculty describe the use of simulation with dental manikin head devices when teaching local anesthesia education? This study's second research question asked how do dental hygiene faculty describe the benefits and challenges in preparing students for administering local anesthesia? This was accomplished by reviewing the literature regarding simulation using dental manikin head devices, simulation technology in dental education, uncertainties related to simulation including faculty concerns implementing simulation and faculty apprehensions in losing the traditional teaching approach, limitations and advantages of simulation, personal connection with simulation and learning, faculty development as a result of incorporating simulation, and student development using simulation.

This study's participants mostly reported positive experiences related to the use of simulation with dental manikin head devices in teaching local anesthesia education and clearly designated the benefits and challenges in preparing students to administer local anesthesia. Four themes emerged from this study's findings including empowerment, beneficial preparation, concerns as a challenge, and support. The conceptual framework that served as a guiding tool for this research process in this study was Dewey's (1938) concept of interconnectedness between education and experience. This study's theoretical framework was modeled after Kolb's (1984) theory of experiential learning. Participants recommended additional simulation opportunities for purchase and development. Furthermore, this research study may help address the gap in the literature given the lack of discussion regarding dental manikin head simulation use in teaching local anesthesia within dental hygiene education.

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Appendix A. IRB Approval Letter

UNIVERSITY OF NEW ENGLAND
INNOVATION FOR A HEALTHIER PLANET

Office of Research Integrity
Institutional Review Board

Biddeford Campus
11 Hills Beach Road
Biddeford, ME 04005
(207) 602-2244 T
(207) 602-5905 F

Portland Campus
716 Stevens Avenue
Portland, ME 04103

DATE OF LETTER: 17 May 2023

PRINCIPAL INVESTIGATOR: Allison Castro
FACULTY ADVISOR: Ian Menchini, EdD

PROJECT NUMBER: 0523-14
RECORD NUMBER: 0523-14-01

PROJECT TITLE: Exploring the Lived Experiences of Dental Hygiene Faculty Using Simulation with Dental Manikin Head Devices to Teach Local Anesthesia

SUBMISSION TYPE: New Project
SUBMISSION DATE: 5/15/2023

ACTION: Determination of Exempt Status
DECISION DATE: 5/17/2023

REVIEW CATEGORY: Exemption Category # 2(ii)

The Office of Research Integrity has reviewed the materials submitted in connection with the above-referenced project and has determined that the proposed work is exempt from IRB review and oversight as defined by 45 CFR 46.104.

You are responsible for conducting this project in accordance with the approved study documents, and all applicable UNE policies and procedures.

If any changes to the design of the study are contemplated (e.g., revision to the research proposal summary, data collection instruments, interview/survey questions, recruitment materials, participant information sheet, and/or other approved study documents), the Principal Investigator must submit an amendment for review to ensure the requested change(s) will not alter the exempt status of the project.

If you have any questions, please send an e-mail to irb@une.edu and reference the project number as specified above within the correspondence.

Best Regards,

Bob Kennedy, MS
Director of Research Integrity

Appendix B. Request for Faculty Recruitment Email

Dear [Department Chair/Director],

My name is Allison Castro. I am presently a doctoral student at the University of New England (UNE) and conducting a study titled *Exploring the Lived Experiences of Dental Hygiene Faculty Using Simulation with Dental Manikin Head Devices to Teach Local Anesthesia* for my dissertation. The purpose of this research study is to gather the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. If simulation in local anesthesia education is used in your entry-level dental hygiene program, I am seeking your assistance by requesting the names of faculty who provide clinical instruction in local anesthesia education. This may include clinical dental hygiene full-time faculty, part-time adjunct faculty, clinic coordinators, or supervising dentists. I am seeking eight participants who teach local anesthesia with the intention of inviting them via their publicly available email addresses on the institutions' website to participate in my doctoral research study.

Participation in this research is completely voluntary and faculty are not obligated to partake in this research unless they choose to do so. The only reason for the name request is for me to specifically contact local anesthesia faculty via their publicly available email addresses to inquire if they would like to voluntarily participate in this research. Participation will consist of one recorded interview of approximately 45 minutes to one hour. The interview will be conducted on Zoom at a time of the participants' convenience. If there are more than eight people who express interest, only the first eight will be selected to interview. All data will be kept confidential and pseudonyms will be used to protect the identities of respondents. Participating institutions will not be specifically named or described directly or indirectly to ensure confidentiality. All identifying information, including faculty names and their institutions will be deidentified. Participants will be asked not to designate any institutions specifically by name, size, location, or any other identifying factors. Participants will be asked to describe their lived experiences, not any activities or experiences of the institutions themselves to avoid any potential for identification.

At this time, would you consider providing the names of the clinical dental hygiene local anesthesia faculty? I will then contact the faculty via their publicly available email addresses. I understand privacy is important and assure you that the sole purpose is to contact them to inquire of their participation.

If you would like additional information or have any questions, please contact me via email at acastro3@une.edu.

Thank you for your consideration of participation in this study.

Sincerely,
Allison Castro MPH, RDH
Doctoral Student
University of New England

Appendix C. Participant Recruitment Email

Dear [Faculty Participant],

My name is Allison Castro. I am presently a doctoral student at the University of New England (UNE) and conducting a study titled *Exploring the Lived Experiences of Dental Hygiene Faculty Using Simulation with Dental Manikin Head Devices to Teach Local Anesthesia* for my dissertation. The purpose of this research study is to gather the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. I am seeking eight participants to participate in my doctoral research study. Your name was provided by the department chair, not because they have agreed upon participation on your behalf, but rather solely because you may have interest in being a potential participant.

You are eligible to participate in this study if you are:

- Over 18 years old
- Clinical dental hygiene full-time faculty, part-time adjunct faculty, clinic coordinator, or supervising dentist
- Teach local anesthesia in a dental hygiene program
- Use or have used simulation with dental manikin head devices to teach local anesthesia

Participation in this research is voluntary. Participation will consist of one recorded interview of approximately 45 minutes to one hour. The interview will be conducted on Zoom at a time of your convenience. If there are more than eight people who express interest, only the first eight will be selected to interview. All data will be kept confidential and pseudonyms will be used to protect the identities of respondents. Participating institutions will not be specifically named or described directly or indirectly to ensure confidentiality. All identifying information, including faculty names and their institutions will be deidentified. Participants will be asked not to designate any institutions specifically by name, size, location, or any other identifying factors. You will be asked to describe your lived experiences, not any activities or experiences of the institutions themselves to avoid any potential for identification.

Please review the attached Participant Information Sheet which outlines the specific details of this study including confidentiality and privacy measures.

If you are interested in sharing your experience using simulation with dental manikin head devices to teach local anesthesia, please contact me via email at acastro3@une.edu and we can set up a time for an interview over Zoom.

If you would like additional information or have any questions, please reach out to me at the above listed email.

Thank you for your consideration of participation in this study.

Sincerely,
Allison Castro MPH, RDH
Doctoral Student, University of New England

Appendix D. Participant Information Sheet

Version Date:	05/12/2023
IRB Project #:	0523-14
Title of Project:	Exploring the Lived Experiences of Dental Hygiene Faculty Using Simulation with Dental Manikin Head Devices to Teach Local Anesthesia
Principal Investigator (PI):	Allison Castro
PI Contact Information:	acastro3@une.edu

INTRODUCTION

- This is a project being conducted for research purposes. Your participation is completely voluntary.
- The intent of the Participant Information Sheet is to provide you with important details about this research project.
- You are encouraged to ask any questions about this research project, now, during or after the project is complete.
- The use of the word 'we' in the Information Sheet refers to the Principal Investigator and/or other research staff.

WHAT IS THE PURPOSE OF THIS PROJECT?

The general purpose of this research project is to explore the lived experiences of dental hygiene faculty using simulation with dental manikin head devices to teach local anesthesia. Eight participants will be invited to participate research as part of the principal investigator's dissertation research.

WHY ARE YOU BEING ASKED TO PARTICIPATE IN THIS PROJECT?

You are being asked to participate in this research project because you are over the age of 18 and are a clinical dental hygiene full-time faculty member, part-time adjunct faculty member, clinic coordinator, or supervising dentist who has had experience in teaching local anesthesia using simulation with dental manikin head devices.

WHAT IS INVOLVED IN THIS PROJECT?

- You will be asked to participate in one semi structured interview with the principal investigator that will last approximately 45 minutes to one hour over a video-conferenced Zoom meeting.
- You can choose a pseudonym to be used in place of your name for the study.
- You will be given the opportunity to leave your camera on or off during the interview, and your interview will be recorded using Zoom.

- You will be emailed a copy of your interview transcript to review for accuracy. You will have seven calendar days to respond or the PI will assume that you have no comments and the transcript will assumed to be accurate.

WHAT ARE THE POSSIBLE RISKS OR DISCOMFORTS INVOLVED FROM BEING IN THIS PROJECT?

The risks involved with participation in this research project are minimal and may include an invasion of privacy or breach of confidentiality. You have the right to skip or not answer any questions, for any reason.

Please see the 'WHAT ABOUT PRIVACY & CONFIDENTIALITY?' section below for steps we will take to minimize an invasion of privacy or breach of confidentiality from occurring.

WHAT ARE THE POSSIBLE BENEFITS FROM BEING IN THIS PROJECT?

There are no likely benefits to you by being in this research project; however, the information we collect may help us understand the lived experiences of dental hygiene faculty incorporating simulation with dental manikin head devices in teaching local anesthesia.

WILL YOU BE COMPENSATED FOR BEING IN THIS PROJECT?

You will not be compensated for being in this research project.

WHAT ABOUT PRIVACY AND CONFIDENTIALITY?

We will do our best to keep your personal information private and confidential. However, we cannot guarantee absolute confidentiality. Your personal information may be disclosed if required by law. Additionally, your information in this research project could be reviewed by representatives of the University such as the Office of Research Integrity and/or the Institutional Review Board.

The results of this research project may be shown at meetings or published in journals to inform other professionals. If any papers or talks are given about this research, your name will not be used. We may use data from this research project that has been permanently stripped of personal identifiers in future research without obtaining your consent.

- Data will only be collected during one on one participant interviews using Zoom, no information will be taken without your consent, and transcribed interviews will be checked by you for accuracy before they are added to the study.
- Pseudonyms will be used for all participants and any personally identifying information will be stripped from the interview transcript.
- All names and e-mails gathered during recruitment will be recorded and linked to a uniquely assigned pseudonym within a master list.
- The master list will be kept securely and separately from the study data and accessible only to the principal investigator.

- The interview will be conducted in a private setting to ensure others cannot hear your conversation.
- You will be given the option to turn off your camera during Zoom interview.
- After you have verified the accuracy of your transcribed interview the recorded Zoom interview will be destroyed. Once all transcripts have been verified by the participants of this project, the master list of personal information will be destroyed.
- All other study data will be retained on record for 3 years after the completion of the project and then destroyed. The study data may be accessed upon request by representatives of the University (e.g., faculty advisors, Office of Research Integrity, etc.) when necessary.
- All data collected will be stored on a password protected personal laptop computer accessible only by the principal investigator.

WHAT IF YOU WANT TO WITHDRAW FROM THIS PROJECT?

You have the right to choose not to participate, or to withdraw your participation at any time until the Master List is destroyed without penalty or loss of benefits. You will not be treated differently if you decide to stop taking part in this project.

If you request to withdraw from this project, the data collected about you will be deleted when the master list is in existence, but the researcher may not be able to do so after the master list is destroyed.

WHAT IF YOU HAVE QUESTIONS ABOUT THIS PROJECT?

You have the right to ask, and have answered, any questions you may have about this research project. If you have questions about this project, complaints or concerns, you should contact the Principal Investigator listed on the first page of this document.

WHAT IF YOU HAVE QUESTIONS ABOUT YOUR RIGHTS AS A RESEARCH PARTICIPANT?

If you have questions or concerns about your rights as a research participant, or if you would like to obtain information or offer input, you may contact the Office of Research Integrity at (207) 602-2244 or via e-mail at irb@une.edu.

Appendix E. Interview Questions

Demographic Questions

1. Tell me about yourself and your dental hygiene career (e.g. education, years of experience, areas of specialty, length of teaching, currently working in the clinical environment as well as academia?).

2. What is your title at your institution (e.g. clinical dental hygiene full-time faculty, part-time adjunct faculty, clinic coordinator, or supervising dentist providing clinical instruction in local anesthesia)

Study Questions

3. How long have you taught local anesthesia in dental hygiene education? Are you currently teaching it?

4. Describe your experience teaching local anesthesia in dental hygiene education.

5. How long have you used simulation as part of your approach in teaching local anesthesia?

6. Describe your experience using simulation in teaching local anesthesia in the field of dental hygiene education?

7. Describe your training as an educator using simulation in teaching local anesthesia.

8. Did you (do you) feel prepared and competent to teach local anesthesia using simulation?

9. What type of guidance did you find most helpful using simulation to teach local anesthesia?

10. What do you perceive were facilitators as you incorporated simulation in your teaching approach?

11. What do you perceive were barriers in using simulation as part of your approach in teaching local anesthesia?

12. Have you experienced any events that have transformed your teaching practice in local anesthesia since incorporating simulation? If yes, please describe them.

13. Do you feel the students grasp concepts, technique, and procedure easier when learning how to administer local anesthesia using simulation? If so, how?

14. What are the rewards of using simulation when teaching local anesthesia?

15. What are your most challenging issues related to teaching local anesthesia with or without simulation?

16. Is there anything else you would like to add that we have not already addressed?