Fall 12-14-2021

Impact of Theory-Based Interventions on Meaningfulness of Undergraduate Nursing Pharmacology Student Learning

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IMPACT OF THEORY-BASED INTERVENTIONS ON MEANINGFULNESS OF UNDERGRADUATE NURSING PHARMACOLOGY STUDENT LEARNING

by

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A dissertation submitted in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy in Nursing
School of Nursing

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School of Nursing

The University of Texas at Tyler
November 2021

The University of Texas at Tyler
Tyler, TX

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Dedication

I dedicate this dissertation work to my wonderful, brilliant, and supportive husband, Dr. Allen Mauldin, without whose constant and sustained championing of my nursing career and education would not have progressed as it has; without his daily encouragement this milestone would not have been possible. Words fail me to express my profound gratitude and admiration.

Acknowledgments

Throughout the many phases of this dissertation journey, I was the beneficiary of a great deal of guidance, support, and assistance. I would first like to express my deepest and sincere thanks to my advisor and Chair of my dissertation committee, Dr. Ellen Fineout-Overholt. She has always been generous of time, guidance, counsel, direction, navigation, encouragement and advice. Her insightful feedback and leveraging of my strengths have fine-tuned my thinking and elevated my research aspirations.

I would also like to thank Dr. Danita Alfred for being the professor I aspire to be; she is knowledgeable, patient, passionate, and sincere, and taught me much about quantitative analysis and statistics, in particular. She also graciously served on my dissertation committee. Gratitude also to Dr. Jayne Josephsen, whose presentation about nursing education and cognitive load theory directly led to the inspiration for this dissertation study. She also graciously served on my dissertation committee.

In addition, I would like to acknowledge my colleague and friend, Dr. Carmen Vela, for her unwavering support and interest in my doctoral research, as well as being someone who has become a mentor. She consistently and happily offered her time, resources, and perspectives to assist me in my pursuits. Carmen was always available for thought-provoking discussions and served as a sounding board for ideas and project development. She was a consistently positive voice in my dissertation journey and I will be forever grateful.

And finally, to Ms. Cady Clark, I extend much gratitude for the inspiration that ignited the fire in me to pursue higher education and excellence in nursing. She always exhibited a standard that is uncommonly high and one that I seek to emulate.

Table of Contents

List of Tables

List of Figures & Forms

Abstract

IMPACT OF THEORY-BASED INTERVENTIONS ON MEANINGFULNESS OF UNDERGRADUATE NURSING PHARMACOLOGY STUDENT LEARNING

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November 2021

Objective: Nursing pharmacology is a complex and content-dense course, often cited as difficult for nurse educators and students and a reason for not progressing in nursing curricula. Even nurses who experience high academic performance report feeling ill-prepared to adequately perform medication management for nursing practice in the current fast-paced environment. The objective of this five-chapter portfolio is to explain the development and implementation of a two-pronged intervention to facilitate meaningful learning of pharmacology principles within nursing students. Chapter 1 describes an overview of the approach to the intervention.

Methods: Chapter 2 describes one prong of the study intervention, the Pharmacology Phamily Project (PPP), its basis in Cognitive Learning Theory (CLT), and its outcomes and recommendations for use. The PPP addresses how to effectively learn pharmacology. Chapter 3 describes the second prong of the study intervention, an actual, unfolding, real-time case study,

its basis in Transformational Learning Theory (TLT), and how it provides clinical context that first-semester nursing school students may lack. The case study introduces motivation for learning pharmacology. Chapter 4 describes implementation of the two-prong study intervention, Context and Motivation for learning. An intervention group received both prongs and the comparison group received traditional pharmacology education. Meaning learning (ML) was an intermediate learning outcome, and Learning Achievement, as a traditional outcome, evaluated the effectiveness of the two-pronged intervention.

Conclusion: Chapter 5 summarizes the potential impact of the ML approach for nursing educators and students, as well as a program of research for meaningful learning across health professions education.

Chapter 1: Overview of Research Focus

Nursing students are challenged with learning extensive amounts of material, much of which is complex, and necessary to pass the licensure exam as well as successfully transition to a safe, practicing registered nurse (Foster et al., 2017; Kavanagh & Szweda, 2017; Tinnon & Newton, 2017). Many students who have previously been academically successful find it difficult to understand, process, and retain this information. Pharmacology often is one of the first courses that students encounter that has its own language, a breadth and depth of information that is daunting, and requires much permanent memorization (Foster et al., 2017). Because of these factors, nursing faculty often feel compelled to present vast content information in lecture/slide deck fashion as opposed the more creative formats that other nursing courses have adopted (flipped classroom, e.g.). The lecture format feels comfortable to many nurse educators because this is the method by which they were taught in their pharmacology courses in nursing school. It is easy to emulate what is familiar. However, this passive learning strategy has been shown to produce lower exam scores when compared to active learning in complex courses (Freeman et al., 2014). To better prepare graduate nurses for the rigors of safe medication management, new teaching methods in nursing pharmacology are needed; patient lives may be at stake (Foster et al., 2017).

Practice Readiness Gap

There is much in the literature regarding the preparation-to-practice gap – the difference between what is taught and learned in nursing programs and what is necessary to know to provide safe and competent care to patients (Craft et al., 2017; Graf et al., 2020; Huston et al., 2018; Kavanaugh & Szweda, 2017). This lack of practice readiness has been documented for many years, however, the increasing acuity levels of patients, the speed of technological

innovation development, and the increasing complexities of providing healthcare have all intensified this gap (Graf et al., 2020; Huston et al., 2018; Kavanaugh & Szweda, 2017). Nursing educators, hiring managers, and new graduate nurses report that this gap also can result in a lack of competency and practice readiness, anxiety, high turnover, and adverse patient outcomes (Huston et al., 2018; Kavanaugh & Szweda, 2017). Academe is generally successful in preparing nursing students to pass the licensure exam, however, broadening the focus to better preparing students for practice competency may benefit the healthcare industry and it customers (Foster et al., 2017; Huston et al., 2017; Kavanaugh & Szweda, 2017).

Theoretical Framework

While there is much in the literature regarding innovative teaching and learning strategies in nursing pharmacology, few researchers utilized theoretical principles as underpinnings for their studies. Theories provide concepts and constructs that guide informed interventions and research designs. When the same theory is employed across different studies addressing a similar problem, a systematic review may provide robust answers to research questions. (Lor et al., 2017); therefore, utilizing theoretical underpinnings is beneficial to nursing science.

Cognitive load theory (CLT) is particularly applicable to teaching and learning pharmacology because of the large quantity of information to be mastered as well as the complexity of the content. According to CLT, when new content is presented, the receiving student has the ability to process a limited amount simultaneously, which can then be stored in long-term memory. Conversely, long-term memory is limitless and processed information remains until needing to be recalled. Chapter 2 describes how CLT was used to craft a learning assignment in nursing pharmacology. There are strategies described in CLT to improve effective processing into long-term memory that have informed the development of the Pharmacology

Phamily Project (PPP) – one prong of the study intervention. The goal in designing the PPP was to assist nursing pharmacology students to efficiently and effectively process medication information and commit it to long-term memory.

Transformational learning theory (TLT) describes the processes by which adult learners can alter their frames of reference; these include pre-existing patterns of thinking, feeling, and behaving, as well as personal points of view. When presented with new information, learners also are seeking to make sense of it in the context of previous experience. Combined with reflection, learners can transform perceptions and challenge previously held beliefs to create new perspectives. Chapter 3 describes how TLT was used in nursing pharmacology class and combined with a reflective assignment with the goal of introducing clinical context. The unfolding case study is the other prong of the study intervention, which was designed using the tenets of TLT to introduce a clinical context into the didactic pharmacology course. The goal is that in hearing the details of the case study from two separate points of time, students will have to challenge their beliefs regarding pharmacological management principles, the role of a nurse, the landscape of institutional policies, and the import of making patient safety a priority.

Meaningful learning (ML) is differentiated from rote learning in that meaningful learners are able to connect new information with previous knowledge as an anchor for the new learning and serve as a retrieval mechanism for future recall (De Sousa et al., 2015; DiCarlo, 2009; Mcalpine, 2004). In contrast, rote learning is memorizing without understanding or context. For example, many nursing pharmacology students attempt to learn large amount of content by rote memorization (e.g., using flash cards) without true understanding or connection. Chapter 4 brings together CLT, TLT and MLT in an effort to help students understand context for nursing pharmacology by offering them an opportunity to learn in a way that knowledge is stored past

the confines of the course, and will be available throughout their careers within nursing practice. Teaching pharmacology in this way is essential to ensuring safe medication management for future patients. The quasi-experimental study described in Chapter 4 includes four outcome variables: 1) clinical context for ability to carry out pharmacological interventions, measured by the Student Beliefs as Context for Learning Pharmacology scale (SBCLP; pre and post intervention); 2) meaningful learning, assessed by the Student Satisfaction and Self-confidence in Learning scale (SSSL; post intervention); 3) motivation to learn nursing pharmacology, measured by the Health Professions Motivation to Learn Pharmacology scale (HPMLP; post intervention) and 4) learning achievement (unit exam grades; post intervention). Chapter 5 focuses on the impact of this study as well as the necessity of teaching pharmacology in this way to ensure safe medication management for the benefit of future patients.

Chapter 2: A Novel Teaching Strategy in Nursing Pharmacology: Learning Using Cognitive Load Theory

(Published as Mauldin, B. (2021). A novel teaching strategy in nursing pharmacology: Learning using cognitive load theory. *Nursing Education Perspectives*. Advance online publication. https://doi.org/10.1097/01.NEP.000000000000814). Permission granted to include in portfolio (L. Block, personal communication, September 20, 2021).

Abstract

Nursing pharmacology is a complex and content-dense course that is often difficult for educators and students. Cognitive load theory explains why utilizing slide decks for instruction overloads the working memory and impedes processing information into long-term memory. An instructional design change in a baccalaureate nursing pharmacology course provided an example of understanding the impact of cognitive load theory. The Pharmacology Phamily Project is a multimodal, multiphase assignment in which students created a case study video about a unique medication and presented it via discussion board for peer feedback and learning. Student investment improved over traditional past semesters, and student-to-instructor feedback was positive.

Successfully mastering pharmacology principles is integral to nurses' clinical ability and obligation to provide safe and effective care to patients in any clinical setting. However, recently graduated nurses who passed a pharmacology course, which is often the low-bar goal for students, were not persuaded that they felt prepared to administer medications with confidence (East & Hutchinson, 2015; Khan & Hood, 2018; Sherman et al., 2012). In addition, novice registered nurses (RNs) are disproportionately associated with medication errors (as high as 75 percent by one estimate) and near misses, often reflecting inadequate knowledge (Hickerson et al., 2016). Helping students assimilate and own their knowledge of pharmacology so that they have access to that knowledge as they care for patients could have benefits beyond education – it could save lives.

Pharmacology is a required course in nursing education and one that many nursing students approach with trepidation. Content-heavy, these complex courses require knowledge, understanding, and synthesis of anatomy, physiology, and pathophysiology. Students in these courses often struggle with learning the language of pharmacology while simultaneously being challenged to memorize vast quantities of new information.

Pharmacology is typically taught in didactic format, with the teacher lecturing from slide decks that are jargon-dense and lengthy (Gill et al., 2018). The varied learning styles of the students may or may not be addressed as faculty plan the unidimensional delivery of the dense content volume. As a result, students rarely remember more than a fraction of the passively lectured information. Students are left to learn in supplementary ways of their own making (e.g., flash cards, study groups), often leading to frustration and anxiety (Gill et al., 2018). Considering principles of cognitive function during the instructional design phase of building a course may help students readily engage in learning (i.e., make the information stick). Cognitive

load theory is a framework describing how individuals acquire, store, and retrieve information. Using this framework in planning pharmacology instruction may have utility in improving student learning outcomes. A novel teaching strategy in nursing pharmacology incorporating multiple learning styles and the science of cognitive load theory was initiated within the first semester of a baccalaureate nursing program at a public university. The Pharmacology Phamily Project (PPP) was both an individual and class effort and demonstrated successful learning outcomes for both the teacher and the students.

Background and Significance

Nursing students rely upon their educators to guide their learning with the goal of becoming safe practicing nurses. Many nurse educators learned pharmacology in the same traditional lecture format they use to teach it, with emphasis on rote memorization (Lanz & Davis, 2017; Pate & Posey, 2016; Sherman et al., 2012). Other nursing courses have evolved to be more student-focused; however, nursing pharmacology has largely remained teacher-centered (Kaylor, 2014). This dated format does not actively engage students in higher order thinking, nor does it facilitate the development of the critical reasoning required for effective patient care (Arora et al., 2020; Kaylor, 2014; Wilson & Ward, 2013).

Pharmacology is a foundational course in nursing curricula; students are expected to incorporate pharmacological principles within all clinical courses that follow. The National Council of State Boards of Nursing (NCSBN) weights pharmacological and parenteral therapies-focused questions on the NCLEX-RN® heavily at up to 18 percent (NCSBN, 2019). This is greater than every other category, except management of care, which is up to 23 percent (NCSBN, 2019). Even with this emphasis, many licensed RNs report feeling unprepared for

medication management, which includes patient assessment and outcomes, medication administration, and patient teaching (Hezaveh et al., 2014).

Cognitive Load Theory

According to cognitive load theory, there are three interfaces with information during learning: 1) sensory memory (input of information), 2) working memory (processing of information), and 3) long-term memory (archiving of information). Humans can store vast amounts of data in their long-term memory (Leahy & Sweller, 2016). Working memory can hold a limited number of pieces of new information prior to archiving into long-term memory (Mayer & Moreno, 2003). In a pharmacology course, students are bombarded with large amounts of new information in lectures (inputting). This can subsequently lead to a decrease in learning, as the working memory becomes overloaded, essentially clogging the processing and hindering the ability to archive important pharmacology information. Figure F.1 (see Appendix F) illustrates how, if 10 different medications are presented in lecture and the working memory is capable of handling and processing only four, the other six are forgotten and not retrievable in the future because they were not encoded.

There are strategies to increase the efficiency of processing. One way is off-loading some of the processing in the working memory by combining verbal and visual input as in a multimedia presentation (Mayer & Moreno, 2003). This modality effect increases working memory capacity. Learning in this way enables some of the work of processing to be shared by the different mental processors or channels, minimizing the work of understanding and enhancing the ability to archive (Leahy & Sweller, 2016).

Another strategy to improve archiving is to allow time between learning episodes (class, study, etc.), so the items in working memory can be moved into long-term memory. This

spacing effect can be applied to learning the basic principles in class and then having students use the information in a future application exercise, also a form of scaffolding. Finally, an example of the segmentation effect is where students can view multimedia presentations at their convenience and multiple times (Mayer & Moreno, 2003). This format not only improves learning, but it is delivered in a manner today's students prefer.

PPP Methods

In designing the PPP, faculty intentionally provided students with multiple modalities for processing and retaining knowledge by converting points from traditional quizzes into a multimedia, multidimensional assignment. The multiphase assignment grade was weighted at 10 percent of the final grade so students would feel the effort expended was worth their time. Students in nursing pharmacology (n=71) were enrolled in their first semester of a baccalaureate nursing program in a public university in the southwest. Students met on the same day of the week for three hours in the afternoon throughout the semester with one instructor.

Students were assigned by the Blackboard® randomizer to a discussion group of no more than nine people per group. Each student self-selected a medication on which to base their case study, approved by the instructor to avoid duplication. The student created a case study that could be inspired by personal experience or fabricated. Students were instructed to create a video presenting their case study (e.g., YouTube®), which was posted on the discussion thread with the medication name as the title. Videos were less than five minutes in length. Minimum criteria included medication name, medication class, mechanism of action, top three adverse experiences, and contraindications/warnings (See Table A.1). As part of inputting, students were also required to respond to two other threads within their group, which required them to post more information about the medication, which could be presented in a different way. Students'

working memories were then engaged by asking them to describe either another indication for the medication or adding another medication appropriate for the condition with rationale. All 71 videos were visible to all students through the end of the semester, and students were encouraged to use them as a study tool for Exam 3, as well as the comprehensive HESI-A® and HESI-B®. Testing of the archived memory was verified by an increase in exam scores that followed the assignment (Unit Exam 3, HESI-A®, and HESI-B®).

Results and Recommendations

Traditional methods of overall course evaluations (scale: 0 to 5) showed improvement in student ratings of the course compared to the previous semester without the PPP. As a specific evaluation method, students were surveyed through a Qualtrics® link on the learning management system evaluating their perceived value of learning interventions used in this course (small-group unfolding case studies, class discussion case studies, lecture with PowerPoint®, guest speakers, supplemental instruction, i.e., tutoring, and the PPP).

Thirty-five of the 71 students voluntarily completed the survey and indicated that the PPP contributed to meaningful learning, ranking it fourth of six interventions offered in the course. The interventions that ranked higher were tutoring and class and unfolding case studies. An open-ended question gave students an opportunity to provide further information about how these interventions enhanced meaningful learning. Comments included: “The PPP was an interesting concept but needed more instruction around expectations” and “The project was great. It wasn’t a huge time commitment, and it really made me think about all the drugs we had covered. Plus, it was interesting to watch the other students’ videos.”

The PPP was administered during Unit 3, but this may have added to student stress as this was close to final exams. A better approach may be to have projects posted throughout the

semester when each medication is covered in class. These videos would potentially be powerful learning/studying tools for the entire class throughout the semester. It would also afford students the freedom to choose the time in the semester for their PPP to be due. The revised rubric should also incorporate a creativity component (~5 percent). Another recommendation would be to add peer evaluation for two videos per student on the discussion thread to encourage thoughtful and interesting submissions.

Limitations

Limitations of this program initiative include a potential lack of generalizability because of the small sample size and utilizing one state college of nursing. Students were admitted with a similar criterion adding to the homogeneity. The course was conducted live in one third of the students' classroom and live video-conferenced in two thirds of the students' classroom.

Summary

Nursing pharmacology is not an easy course, but it can be intentionally designed to be effective in engaging students and helping them retain meaningful information according to the principles of cognitive load theory. A potential additional benefit would be students feeling more confident and having less anxiety. Utilizing the tenets of cognitive load theory, educators can include assignments and activities that intentionally leverage multimodal learning and allow for effective mental processing. This prepares students to retain and retrieve knowledge, resulting in better patient outcomes. Teaching sound medication management principles may result in more confident, competent, and safe nurses in the future.

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Chapter 3: Bringing Clinical Context to the Classroom in Nursing Pharmacology: A Case Study

(Mauldin, B., (in press), as submitted to *Nursing Education Perspectives*)

Abstract

Patient safety is part and parcel of nursing care and is taught throughout nursing education, particularly in core pharmacology, first-semester courses. This timing does not allow for clinical application and fosters a theory-practice gap. Transformational learning theory explains how teachers can engage students in active learning and introduce clinical context into a didactic classroom. To that end, an innovative pharmacology assignment using a real-time nurse case-study, was a structured, in-class activity and post-class reflection focused on contextualizing learning for nursing students without clinical experience. Afterward, students reported transformed thinking regarding the importance of meaningful learning in nursing pharmacology.

Nurses are inculcated with the importance of patient safety from the first day of nursing school. First semester nursing students typically learn the theoretical rationales for safety measures, but not have the opportunity to apply that knowledge until the following semester in clinical courses. This theory-practice gap can be difficult to bridge once established, and innovative strategies are required to assist students in making connections between standards of care learned in an academic environment and the implications in the clinical setting. When nurses do not consistently and intentionally follow best practice guidelines, the results can be catastrophic for patients and nurses.

Nursing pharmacology is traditionally taught in the first semester of nursing school with successful completion as a pre-requisite for participation in clinical courses. Due to the nature of

creative nursing programs (accelerated, second-degree, hybrid, etc.), students bring a broad range of clinical context to their courses. For students who lack clinical context, this context needs to be created as an orienting stimulus for understanding the high stakes nature of medication management and core course competencies.

Background and Significance

Nursing students often approach pharmacology as a course to be endured rather than mastered. This can result in a lack of understanding of the import of basic, crucial competencies associated with safe and effective patient pharmacological care (Yazdan Parast et al., 2018). It is imperative for students to comprehend the reasons behind performing the three checks and clearly communicating the rights of medication administration every time a medication is given to a patient.

Because pharmacology is a didactic course administered prior to clinical experience, the clinical applications can be perceived as abstract and futuristic; therefore, bringing clinical significance into the classroom early in the semester and the nursing curriculum may be effective in bridging the existing theory-practice gap. Introducing clinical significance may also serve as a catalyst for a change in thinking from personal performance goals to mastery goals and from student learning outcomes to patient outcomes.

Theoretical Frameworks: Transformational Learning Theory and Swiss Cheese Model

Transformational learning theory (TLT) describes how adult learners modify their frames of reference, which include patterns of thinking, feeling, and behaving, as well as personal viewpoints (Slavich et al., 2012). Frames of reference can be altered by the process of problem-solving, discussing problems with others, and reflecting on assumptions upon which viewpoints are based (Slavich et al., 2012). TLT suggests that identifying and challenging assumptions is

done by engaging in active learning activities in which participation is encouraged and robust discourse is facilitated. Some of these learning activities are group projects, engaging with case studies, and simulation exercises (Slavich et al., 2012). Students' learning about how errors occur can further enhance context. Catastrophic errors are rarely committed in isolation by one individual; rather they are the result of multiple, smaller errors that are compounded by serious, underlying system errors operating in the background (Durstenfeld et al., 2019). The flaws are exposed when the individual and the system align bringing about bad outcomes. In the Swiss Cheese Model (SCM), the holes in Swiss cheese (the errors) line up with the holes within the system. The SCM not only explains how the negative outcomes occur, but assists those charged with root cause analysis to proffer solutions to shrink the holes and prevent the holes from lining up in the future (Durstenfeld et al., 2019). Distinguishing individual and system errors, the SCM labels active errors as those involving frontline personnel at the point of care and latent errors as those at an organizational design level that allows the active errors to occur (Naunton et al., 2016).

Complex, Real-Time Nurse Case Study: Presentation and Impact

In designing the complex, real-time nurse study assignment, faculty utilized the tenets of the TLT, in which students were presented with a current case study temporally unfolding. Students were asked to problem-solve, discuss perceived problems with peers, and submit a personal reflection regarding their thoughts about the exercise. Use of a case study to impact clinical context rather than course content is how this exercise was transformational in innovation and motivating student learning.

Students were presented with a PowerPoint® presentation regarding the role of a nurse as a professional and introduced the SCM as a method for understanding how errors, both human

and systemic, can align with catastrophic results. Students then viewed a video from a medical provider with the initial information about how a nurse was described as responsible for the agonizing death of a vulnerable patient by overriding system fail-safes, giving vecuronium instead of prescribed Versed® (Damania, 2018; Matheson, 2019). Following the video, the class engaged in a discussion regarding their thoughts, feelings, and points-of-view regarding the situation and the nurse's role in the death of this patient. Most students expressed horror at how the nurse could have acted so recklessly and committed so many consecutive errors.

The students were then shown a video from the same provider three months later including the name of the nurse being charged criminally with reckless homicide and abuse of an impaired adult (Damania, 2019). The discussion following this video was more sympathetic to the nurse, who was largely perceived as a scape goal for the larger systemic gaps, as well as a way to avoid profound penalties both financial, criminal, and reputationally to the organization. The discussion enabled a detailed delineation of the differences between negligence, malpractice, and criminality. At the time of the video, the nurse did not have her license in danger of being revoked. Rather, the governing body sent a letter to the nurse informing her that her license was not in jeopardy (Matheson, 2019).

The discussions were lively and respectful. Students were then instructed to write a reflection answering the following questions:

- Should the nurse be charged criminally for her actions/inactions? Why or why not?
- Should the nurse lose her license for her actions/inactions? Why or why not?
- If the nurse has her license suspended, do you think that she should have a pathway to have it reinstated? Why or why not?

- Did this case change your thinking about nursing pharmacology and patient safety? If so, how?

The reflection was due at midnight on the day of the discussion to facilitate a continuous flow of ideation. It was also designed to contextualize the clinical learning regarding pharmacology and safe medication management principles. Additionally, the learning assignment introduced the professional aspect of nursing and emphasized the direct line between the meticulous aspects of medication management (beyond administration) and patient outcomes. This reflection activity permits students to recognize the relevance of course materials to their chosen profession.

Students reported a variety of feelings, observations, and opinions. The consensus was that the series of errors committed by the nurse was disturbing and unsettling, especially since she had likely been engaging in workarounds over time and on this one day, the errors aligned with tragic consequences. Many students expressed their horror at this case-study nurse's seemingly cavalier attitude regarding patient safety as well as the systemic problems of the organization. They expressed that nurses should be held to higher standards than other professionals, and their concern that multiple mistakes can eventually progress to negligence. Most students felt that the nurse should have a hearing regarding retaining her licensure, but that criminality would have a negative and chilling effect on all healthcare professionals. Finally, many students expressed great sadness and compassion for the patient and her family.

Teaching Innovation Results and Recommendations

Traditional measures of nursing pharmacology success should be augmented by a clinically-contextual impetus to spark a transformation in thinking from pedagogical learning to patient-focused learning. A strategy to create relevance is presenting a real-life scenario and

fostering critical thinking around its outcomes through class discussion and personal reflection. This shift in context may result in an earnest alteration in the motivation and meaning early in the curriculum of what it is to be a safe nurse. Establishing a clinical context may alter students' trajectory in their nursing education and beyond.

This transformational learning shift from didactic memorization and regurgitation to a clinical framework of understanding may have utility beyond nursing education. It may also benefit pharmacy, medicine, and mid-level provider education. When clinical context is introduced early in the professional curriculum, it may have the effect of transforming students' motivation and momentum to learn and have a positive effect on future patient interactions and practice.

Summary

Nursing pharmacology is a didactic core course requiring successful completion prior to advancement to more clinically complex education. It requires both memorization of facts and understanding of applications to a clinical situation. Students present to nursing school with a broad range of clinical contexts. In order to bridge a potential theory-practice gap, educators may provide, by intentional design of assignments, a clinical context that students can use to transform frames of reference and personal viewpoints regarding the importance of mastering pharmacology principles, affecting motivation and attitude to learning. This may result in students more adequately prepared for the next level of education as well as provide a solid basis for safe and effective patient care in future practice. Pharmacology principles are used every day by every nurse; therefore, traditional learning can no longer be the standard for pharmacology education.

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Chapter 4: Impact of Theory-Based Interventions on Meaningfulness of Undergraduate Nursing Pharmacology Student Learning

Abstract

Background: Nursing students, nurse educators, and hiring nurse managers report that newly graduated nurses are inadequately prepared for the rigors of nursing practice, particularly in safe medication management. Because medication errors represent a significant proportion of patient harm and teaching pharmacology to nursing students in the traditional lecture-based format has not been effective, improving meaningful learning (ML) of pharmacological principles in nursing students is a priority.

Purpose: To evaluate the effectiveness of a two-pronged ML pharmacology intervention with baccalaureate nursing students.

Design: Quasi-experimental study.

Sample: Fifty-nine baccalaureate nursing students from one state university, with three geographically separate campuses: 1) the comparison group campus was suburban, 2) one of the two intervention campuses was community and 3) one was rural.

Methods: The two-pronged intervention included 1) The Pharmacology Phamily Project, based on cognitive load theory, designed to improve long-term memory of complex pharmacological information and 2) an unfolding real-time case study, based on transformational learning theory, designed to provide clinical context for learning pharmacology. Outcome variables included context for learning, ML, motivation for learning and academic performance.

Results: Significant correlations were found between context for learning, motivation to learn and meaningful learning. Context for learning pharmacology increased, although, due to sample size, did not meet statistical significance. Meaningful learning and academic performance were

higher in the intervention group compared to the comparison group, although not statistically significant.

Conclusions: Findings from this study offer educators an opportunity to consider the importance of context, meaningfulness and motivation as important predictors for learning pharmacology.

Key words: Pharmacology, nursing education, patient safety, meaningful learning, clinical context.

Background and Significance

Nurse educators are challenged with teaching an increasingly substantial amount of complex content to nursing students to produce safe and competent nurses. Despite successfully passing the licensure examination, newly graduated nurses report being unprepared for the rigors of patient care and responsibility that accompanies the professional role (Graf et al., 2020; Hyun et al., 2020; Odland et al., 2014; Xie, 2021). The contrast between the scaffolded learning in the educational environment and the stressful role of taking responsibility for multiple patients is stark; graduate nurses often cite this transition as a source of fear (Odland et al., 2014; Willman et al., 2021). The reduced number of clinical hours provided to nursing students due to the pandemic, shortages of nurses in the clinical setting, and the retirement of experienced nursing faculty and rapidly evolving healthcare environment contribute to this perceived deficit (Saifan et al., 2021).

One aspect of nursing care that graduate nurses report feeling unprepared for is pharmacological knowledge and acumen (East & Hutchinson, 2015; Khan & Hood, 2018; Sherman et al., 2012). As long as there have been pharmacotherapeutics, nurses have been at the forefront of medication management (Foster et al., 2017). This significant responsibility includes appropriate patient assessment and reassessment, safe medication administration, and patient teaching (Foster et al., 2017). Inherent to successful implementation of these duties is a thorough understanding of medications, in addition to how they affect anatomy, physiology, and pathophysiology, in order to promote the most beneficial patient outcomes possible (Foster et al., 2017).

Pharmacology, the study of medications, is a complex biomedical science that is foundational to multiple clinical disciplines, including medicine, pharmacy, and nursing. The

word pharmacology is derived from the Greek language literally meaning the study of poison (Pharmacology, 2020). Because medication can produce positive, desired clinical responses as well as adverse, undesired experiences that can range from annoying to life-threatening, nurses must be knowledgeable about pharmacotherapeutics and how they might affect – both positive and negative – their patients.

Due to the seriousness and implications of medication errors, some notable organizations (e.g., The Joint Commission, Institute of Medicine) have identified medication errors as a primary focus of quality improvement in healthcare (Preston et al., 2019). According to the United States Food and Drug Administration (FDA), medication errors are defined as errors that are preventable and cause harm when in the control of a licensed healthcare professional, a patient, or a patient advocate (FDA, 2019). These errors can occur at any point along a continuum of medication prescribing, access, disbursement, and administration (FDA, 2019). Nurses mainly operate in the administration phase and are often referred to as the last line of defense for the patient. This refers to the fact that prescribers may prescribe inappropriately, pharmacists may approve inappropriately, clinical conditions may be inappropriate for safe medication administration; it is nonetheless the nurse's responsibility to be cognizant of these circumstances and to advocate for the patient and their well-being.

Pharmacological advocacy requires a certain depth of knowledge of medications and how they may potentially affect patients. In this regard, nurses require an understanding of appropriate prescribing of medications as well as their appropriate usage in given clinical situations. Nurses, both new graduates and experienced nurses, have identified perceived inadequate preparation during nursing school education for the rigors of medication management in practice (Huston et al., 2018), although novice nurses tend to make more errors (Hickerson et

al., 2016; Huston et al., 2018). Though this is not a new phenomenon; the competing demands of nursing care often has resulted in a lack of successful and informed medication management for patients (Craft et al., 2016; Saifan et al., 2021).

A robust and thorough educational preparation enables nurses to be best at addressing these challenges. This educational preparation is achieved through a broad range of tactics for teaching future nurses pharmacological principles (Anderson et al., 2017; Smith & Davis, 2021) beginning with the typical stand-alone pharmacology course. The information delivered within this single course is supplemented by other medications taught in specialty courses (e.g., maternal nursing, pediatric nursing). The nursing pharmacology course is where nursing students learn the basics of administration, distribution, metabolism, and elimination, as well as learn the most commonly prescribed medications. Nursing students are expected to learn these basics through a primarily lecture format, which has been shown to be a hindrance to meaningful learning (ML) and long-term memory and recall (Anderson et al., 2017; Craft et al., 2017; Huston et al., 2018). Exploring innovative teaching and learning strategies in nursing pharmacology that can improve pharmacological competence in new nurses through knowledge acquisition and retention would be paramount for safe patient care (Foster et al., 2017). Addressing this academic-practice gap is a top priority for outcomes for nurses, patients, and clinical partners to be improved (Anderson et al., 2017). The purpose of this study was to address innovations in learning pharmacology that would enhance learner uptake and retention of basic pharmacology knowledge and skills.

Review of Literature

Examination of the current delivery methods for pharmacology in nursing education revealed that traditional lecture format is still widely practiced in nursing schools (Croteau et al.,

2011; Huston et al., 2018). This is likely the case since with content-heavy courses like pharmacology, lectures are an efficient (to the teacher) modality to communicate large amounts of information. However, efficiency for the teacher does not necessarily translate to effective learning by students (Craft et al., 2017; Croteau et al., 2011). Current research regarding innovative pedagogies in nursing pharmacology in which "innovative" denotes anything other than lecture-based delivery of content can inform about best practices for teaching pharmacology. Understanding the definition and implications of nursing student clinical context can frame these best practices. Researchers understanding of how best practice for teaching pharmacology influenced clinical context for applied knowledge, self-efficacy to learn pharmacology, student perceptions of their motivations to learn pharmacology, and unit examination scores (e.g., formative and summative) was central to study design and intervention development. This study was focused on how the variables context for learning (CL), motivation for learning (MoL), and ML interact with one another to foster academic performance (AP) in pharmacology.

Review of Innovative Pedagogies in Nursing Pharmacology

Nursing students today are faced with many challenges that could be characterized by a plethora of choices for learning resources (textbook, online access to content, internet, etc.) and, as a result, some students can become overwhelmed and lack focus (DiCarlo, 2009). For this reason, nursing students look to educators to guide and focus their learning with the goal of having the requisite knowledge to become a safe practicing nurse. Nursing educators who are teaching the next generation of nurses were themselves most likely taught in didactic, teacher-centered environments rather than a learning, student-focused environment (DiCarlo, 2009; Innovation in nursing education, 2004), perpetuating nursing pharmacology that is traditionally

and consistently taught with lecture format and rote memorization (Croteau et al., 2011). Yet, research has shown that lectures alone do not actively engage students in higher-order thinking nor equip them with the ability to think through situations that they have not encountered previously (Alton, 2016; Croteau et al., 2011; DiCarlo, 2009). A wide variety of active learning interventions have been studied in nursing pharmacology with the intent of improving student learning outcomes, including computer-based learning platforms, flipped classroom, simulation, and curriculum changes. The goal is for students to retain and use their knowledge to optimize patient outcomes.

Computer-based Learning Platforms

Most of the studies identified utilized computer-based interventions to improve student outcomes. Two of these studies utilized video vignettes. East and Hutchinson (2015) evaluated a videotaped simulated pharmacology scenario improved pharmacology learning compared to standard lecture in undergraduate nursing students according to students' self-reporting. Devi and colleagues (2013) compared the traditional live demonstration of medication administration with a video demonstration of the same exhibition. The students in the video (experimental) group preferred this method, because they were able to see the demonstration clearly and could watch it as many times as they wanted. This method relies on student motivation to view and review the available videos.

Electronic health record (EHR) usage is an integral part of current medication management. Vana and Silva (2014) evaluated the use of EHR simulation together with an online medication reference guide as resources for students navigating a pharmacology case study exercise. Dubovi and colleagues (2018) used a novel computer-based, interactive model to evaluate how well nursing students were able to learn the pharmacology of diabetes mellitus on

the molecular level. Of note, this model for learning was successfully used previously in a pathophysiology course to teach complex processes.

Escape rooms have gained wide popularity as entertainment that is mental, physical, and social. This innovation recently has been adapted as an interactive didactic tool (Gómez-Urquiza et al., 2019; Hermanns et al., 2018; Richter & Frenzel, 2021; Smith & Davis, 2021; Taraldsen et al., 2020). Hermanns and colleagues (2018) designed an escape room project to facilitate nursing students learning about cardiovascular medicines. The purpose was to actively engage students in an activity that is generally perceived as recreation with content that is generally perceived as difficult to produce better educational outcomes. Students were found to be more actively involved with the content; however, students reported frustration regarding the instructions and technical problems (Hermanns et al., 2018). Gomez-Urquiza and colleagues (2019) created an escape room exercise that was given to voluntary participants in an adult health 1 course. The authors reported a high degree of motivation and engagement, although some of these findings could be explained by participants volunteering for the assignment and their age (mean age = 19.5 years).

Most textbooks now come with online resources and several researchers have investigated ways to engage students with digital course material. Similar to the escape room rationale, most students are familiar with using Quick Response (QR) codes and associate their use with positive results. QR codes frequently are used in healthcare education to increase student motivation and engagement (Karia et al., 2019; Lin & Teng, 2018). Lin and Teng (2018) investigated the use of QR codes in a nursing pharmacology course to quickly link digital and physical resources. This process actively involved the student in the learning process and

allowed the teacher to become a facilitator of learning with mixed results. In this study, problems with technology resulted in frustration, as with previously reported studies.

Learning management systems (LMS), such as Blackboard® or Canvas® platforms, are widely used to manage course content and delivery, including courses that are primarily classroom-based (Croteau et al., 2011; Doggrell & Schaffer, 2016; Paskausky, 2017). These LMS platforms have transformed higher education, allowing teachers to use inherent features to foster student learning. For example, Croteau and colleagues (2011) used a hypothetical online community called "The Village" that is accessed through the Blackboard® LMS platform. Students enrolled in the course would read case studies about patients in the community and complete assignments housed in Blackboard® throughout the course. Although a small study, there was a significant difference between the intervention and comparison groups' standardized exam scores ($p < .001$). Doggrell and Schaffer (2016) used a website that provided additional resources (lectures and activities) and support throughout the course that pharmacology students accessed through Blackboard®. Students reported increased individual commitment to their own personal learning on post-semester evaluations, and the withdrawal rates from the course and the program were reduced.

The novel coronavirus disease 19 (COVID-19) pandemic has resulted in widespread and abrupt changes in the delivery of all levels of education, including nursing education. The chaos that ensued was compounded by a lack of knowledge of the novel virus itself and the daily changing environment of stay-at-home orders. Platforms such as Zoom® swiftly became popular as educators attempted to finish the semester successfully by converting classes to online versions. Virtual classrooms have direct and indirect advantages, such as containment of pathogens within households, convenience, and fewer expenses associated with commuting and

travel (Iwai, 2020). Some disadvantages have also emerged such as a lack of focus and attention, the loss of spontaneous creativity amongst students in the physical classroom, the distractions of background noises, videos, and the chat box, and inequities of internet connectivity (Almusharraf & Bailey, 2021; Fitzpatrick et al., 2020; Iwai, 2020). Didactic courses which are delivered via lecture format, such as nursing pharmacology, are simpler to convert to an online format than courses involving creative interaction or simulation (Iwai, 2020). When traditionally face-to-face classes are delivered exclusively digitally, the resulting familiarity may have a negative effect on motivation to learn (Iwai, 2020).

Flipped Classroom

The flipped classroom involves reshaping the classroom from teacher-centered to student-centered, an approach that has gained momentum as a teaching strategy in nursing education (Abeysekera & Dawson, 2015; Betihavas et al., 2016; El-Banna et al., 2017). This rearrangement also involves a shared responsibility for learning, with the goal of better preparing nursing students for transition to clinical practice (Betihavas et al., 2016; El-Banna et al., 2017). El Banna and colleagues (2017) implemented the flipped classroom to one pharmacology section and compared exam scores between the flipped and traditional classrooms. They then changed which sections were receiving the intervention and traditional instruction and compared exam scores on a second exam. Students in the flipped classroom had significantly higher scores on exam one, but there was no difference noted in exam two. Students also expressed concern about the preparation required in such a complex class to effectively participate in the flipped classroom (El-Banna et al., 2017). Geist and colleagues conducted a similar study of the flipped classroom in nursing pharmacology and compared exam scores to the traditional delivery of content. Scores in three unit exams were significantly higher in the intervention group, although

there was not a statistical difference in the comprehensive final exam scores. Bossaer and colleagues (2016) compared a flipped classroom with a traditional, lecture-based classroom to teach an oncology module for third year pharmacy students and compared exam scores between the groups. Students in the flipped classroom performed poorer than those in the traditional class delivery cohort. Although the flipped classroom has become popular recently as an innovative pedagogy, there is little agreement in the literature regarding the definition of flipped classroom (Abeysekera & Dawson, 2015; Betihavas et al., 2016). Consideration of the dose of the flipped classroom may help understand the disparity of findings across these studies.

Simulation

Simulation is a cornerstone for nursing education and, as such, has been implemented in many nursing courses with the notable exception of pharmacology. Simulation is a strategy designed to bridge the preparation-practice gap, improve patient safety, and improve students' confidence and competence (Sanko & Mckay, 2017). Sanko & Mckay (2017) evaluated the use of manikin-based simulation focusing on improving student self-reported confidence and competence in medication administration practices. Both the intervention and comparison groups increased in competence from time 1 to time 2, however, there was a statistically significant improvement in confidence in the intervention group only. In a similar study, Tinnon and Newton (2017) examined the effectiveness of replacing one lecture period in an undergraduate nursing pharmacology course with a simulation exercise. Comparing student satisfaction with learning and quiz grades between the simulation and non-simulation groups indicated no differences (Tinnon & Newton, 2017).

Curriculum Changes

Alterations to nursing school curricula can be complex and challenging to implement. Meechan, Mason, and Catling (2011) described using an integrated medications management curriculum, as a thread throughout the courses, during the first year of an undergraduate nursing program. While Meechan et al. (2011) substantively revamped the curriculum, Craft et al. (2017) offered supplemental education. An optional three-day workshop for pharmacology was offered prior to the third and final year of a Bachelor of Nursing degree with goal of improving the integration of pharmacological and bioscience principles with nursing practice. The students who participated reported an increase in knowledge and understanding, as well as a greater perception of clinical nursing practice.

Clinical Context

Context refers to a certain environment (physical, social, psychological, etc.); clinical means that the environment is relating to the care of a patient (Clinical context, n.d.). Nursing students may seek a degree in nursing because of their stated desire to help people; however, there may be an unrealistic understanding of what clinical context of nursing pharmacological practice actually means. Learning the clinical context of safe medication management early in the baccalaureate nursing curriculum may be helpful to socialize the student to the registered nurse role.

A review of the literature produced few studies exploring ML in a nursing pharmacology course. Furthermore, no studies were identified using cognitive learning theory (CLT) and transformational learning theory (TLT) to design teaching interventions for pharmacology. No studies were found that combined cognitively- and affectively-based interventions focused on producing ML in nursing pharmacology. This study addressed these gaps.

Theoretical Frameworks

Three theoretical frameworks were the basis for the learning interventions in this study: 1) meaningful learning theory (MLT), 2) CLT, and 3) TLT. This cumulative theoretical framework served to organize and conceptualize the study design and model (Mock et al., 2007). The theoretical framework was used to describe the relationships among the study variables and inform the methods (Matthew-Maich et al., 2009; Mock et al., 2007). Research questions were formulated using the tenets of the theoretical frameworks (Mock et al., 2007).

Meaningful Learning Theory

Meaningful learning is described by Ausubel as different from rote learning, in which students connect new knowledge to existing knowledge; it is in contrast to memorization devoid of relativity to other understanding (DiCarlo, 2009; Mcalpine, 2004; De Sousa et al., 2015). The differences between rote learning and ML can be visualized in Figure G.1 (Novak & Cañas, 2010). Meaningful learning occurs when students are intrinsically motivated and can cognitively make sense of new information by tagging it to existing information (Novak & Cañas, 2010; De Sousa et al., 2015). By deliberatively connecting new knowledge with residential understanding and context, the learner is challenged and benefitted with scaffolded learning, which are methods that offer a variety of learning opportunities designed to help students progressively move toward stronger understandings and independence in their learning process. (Sousa et al., 2015; Great Schools Partnership, 2015).

Additionally, there is an affective learning component to ML that serves also to connect new learning to existing learning (De Sousa et al., 2015). Meaningful learning requires active engagement of the learner. When meaningful learning occurs, students have been shown to not only remember, but remember in context with connections to the anchor of previous knowledge

and emotions (De Sousa et al., 2015). Meaningful learning is active (rather than passive) learning, has constructivist principles as a basis, and promotes long-lasting memory (Cadorin et al., 2014; "Meaningful learning," n.d.; De Sousa et al., 2015).

Ausubel's theory of ML consists of three phases: 1) advance organizer, 2) presentation of learner task, and 3) strengthening of cognitive organization (Hassard, n.d.). The first phase is teachers clearly identifying the aims of the lesson, the second phase is engaging students in ML activities, and the third phase is facilitating active learning that is associated with attaching the new learning to previous frameworks for processing (Hassard, n.d.).

Specific teaching and learning methodologies can be employed to increase the significance and meaning of learning, such as case studies, workshops, forums, and group discussions (De Sousa et al., 2015). Assessment of these interventions can include questionnaires, diaries, reflections, and discussion boards (De Sousa et al., 2015). Each learner brings a unique combination of motivation and context that can affect the resulting ML (Cadorin et al., 2014; DiCarlo, 2009; Novak & Cañas, 2010).

Cognitive Load Theory for Sustainable Learning

Initially described in the 1980s, CLT addressed human neurological physiology and provided guidance on how to craft learning interventions designed to leverage its principles (Chandler & Sweller, 1991; Van Merriënboer & Sweller, 2010). Based on Miller's work, which described a limited available working memory while learning new information, CLT proposed that overloading this holding tank of working memory is an impediment to learning (Abeysekera & Dawson, 2015).

According to CLT, there are three interfaces with information during learning: 1) sensory memory (input of information), 2) working memory (processing of information), and 3) long-

term memory (archiving of information). Humans can store vast amounts of data in their long-term memory (Leahy & Sweller, 2016). Conversely, working memory can hold a limited number of pieces of new information prior to archiving into long-term memory (Mayer & Moreno, 2003; Josephsen, 2015). In a pharmacology course, students are bombarded with large amounts of new information in lectures (i.e., *inputting*). This download subsequently can lead to a decrease in learning, as the working memory becomes overloaded, essentially clogging the processing and hindering the ability to archive important pharmacology information. Figure G.2 illustrates how if six different medications are presented in the traditional approach to pharmacology education, the working memory is capable of handling and processing only four, the other two are forgotten and not retrievable in the future, because they were not encoded into long-term memory. However, this is not the only mechanism for learning pharmacology.

There are strategies to increase the efficiency of processing. One strategy is to off-load some of the processing in the working memory by combining verbal and visual inputting, such as a multimedia presentation (Mayer & Moreno, 2003; Nilson, 2018). The purpose of using multiple modalities is to increase the ability of the brain to store information for later retrieval. Learning in this way has been shown to enable some of the work of processing to be shared by the different mental processors or channels, minimizing the work of understanding and enhancing the ability to archive (Leahy & Sweller, 2016).

Another strategy to improve archiving is to allow time between learning episodes (pacing class, study, etc.), so the items in working memory can be inputted into long-term memory (Nilson, 2018). This pacing-effect can be applied to learning the basic principles in class, which fosters a scaffolding structure for learning. Having students use the information in a subsequent application exercise offers the opportunity for educators to incrementally move learners towards

greater understanding and independence. This type of scaffolded learning enhances safe interactions between the expert (instructor) and the student learner to promote a deep learning for the student. An example of a pacing-effect could be offering students the opportunity to view multimedia presentations multiple times (as many as they perceive they need) at their convenience (Mayer & Moreno, 2003). This format may serve a two-fold purpose: 1) improve learning and 2) ensure delivery in a student-preferred fashion (DiCarlo, 2009).

Transformational Learning Theory for Contextual Learning

Transformational learning theory describes how adult learners modify their frames of reference, which include patterns of thinking, feeling, and behaving, as well as personal viewpoints as they learn (Matthew-Maich et al., 2009; Slavich & Zimbardo, 2012; see Figure G.3). Frames of reference can be altered by the process of problem-solving, discussing problems with others, and reflecting on assumptions upon which viewpoints are based (Matthew-Maich et al., 2009; Slavich & Zimbardo, 2012; Tweedlie & Vincent, 2019). Transformational learning theory suggests that identifying and challenging assumptions is accomplished by engaging in active learning activities in which participation is encouraged and robust discourse is facilitated. Some of these learning activities could be group projects, engaging with case studies, and simulation exercises (Slavich & Zimbardo, 2012). By effective processing of emotions, beliefs and attitudes are transformed, and future actions are better defined (Matthew-Maich et al., 2009), which are crucial to inspiring and motivating students to internalize the drive to learn the concepts of nursing pharmacology beyond memorization and into application of concepts into the nursing role (DiCarlo, 2009).

Nursing students bring a broad range of clinical context to their courses. For students who lack clinical context, it needs to be created as an orienting stimulus for understanding the

high stakes nature of medication management and core course competencies. In pharmacology, transformational learning theory enables teachers to engage processes by applying an affective tag to improve cognitive learning and application. Connecting the emotions of a learning experience to content may make the experience vivid, personal, and memorable (Brown, 2011; O'Malley, 2019). Integrating the affective learning domain for pharmacology students may enhance the motivation to engage and retain the content (Brown, 2011; Matthew-Maich et al., 2009).

Conceptual and Operational Definitions

The major concepts of MLT, CLT and TLT as they relate to this study are in Table B.1, including operational definitions for how each concept is measured.

Research Questions

Based on the tenets of MLT, two methodologies were selected as the basis for the two-pronged innovative intervention – a case study with reflection designed to provide context for learning pharmacology and a multi-media presentation with group discussion designed to provide various lenses for learning about medications and pharmacology principles. Transformational learning theory informed the design of the case study with reflection and CLT informed the design of the multi-media presentation/discussion. The study model guided the design and conduct of this study (see Figure G.4). Outcomes for these interventions are CL, MoL, ML and AP in pharmacology. The following research questions were posited for the study:

Research Question 1: Will participants in the intervention group (IG) have higher context for learning in pharmacology compared to participants in the comparison traditional learning group (CG) at baseline?

Research Question 2: Will participants in the IG have a change in context for learning in pharmacology measured at the beginning of the semester compared to course completion?

Research Question 3: Will participants in the IG have higher meaningful learning in pharmacology compared to participants in the CG?

Research Question 4: Will participants in the IG have higher motivation to learn pharmacology compared to participants in the CG?

Research Question 5: Will participants in the IG have higher AP scores compared to participants in the CG.

Research Question 6: What are the relationships among CL, MoL, ML, AP in pharmacology?

Research Design

This quasi-experimental study was conducted in one Bachelor of Science in Nursing (BSN) program within a single state university system that is offered on three different geographic campuses. The intervention was delivered in a community and a rural location and the comparison group was offered traditional education on a suburban campus.

Methods

Sample

A convenience sample of undergraduate nursing students enrolled in a BSN program in a state university in a large southwestern state was recruited by email through the LMS. The recruitment email instructed students to confirm they met the inclusion criteria and, upon doing so, were invited to participate in the study by clicking a link in the recruitment email. By clicking on the link, students provided implied consent to participate in the study. Inclusion criteria were students had to be least 18 years old and enrolled in one of the four sections of the

nursing pharmacology course. The Pharmacological Basis for Nursing course was offered in the first semester of the nursing school curriculum, which coincides with the fall semester of the junior year of a four-year BSN program. The populations of the three program locations were community - 81,631, rural - 18,544, and main campus - 106,985 (United States Census Bureau, 2019).

Protection of Human Subjects

Appropriate approval from the Institutional Review Board (IRB) of University of Texas at Tyler was obtained (see Form H.1). Consent information was included in the recruitment email and on the first page of the online study questionnaire. Both included a clear explanation of the study purpose, participation in data collection, study potential risk and benefits, protection under the participants' family educational rights and privacy act (FERPA), options for study withdrawal, the primary investigator's (PI) contact information for questions regarding the study, and IRB contact information for ethics and study participation questions (see Form H.2).

To provide continuity across study variable measures, student names were requested on the questionnaire pre and post. The PI used a list of student names within each course to create a corresponding case number for each student to ensure that all data kept confidential and to connect pre and post data as they were entered into the study datafile. This case list was housed in the principal investigator's password-protected laptop and was not accessible or shared with anyone. This mechanism for collecting data served to protect student/participant identity and allowed data to be connected across the semester for students who participated in the pre-test and the post-test surveys.

Instruments

All data were collected via the study questionnaire housed on the Qualtrics platform. Demographic and covariate information included age, gender, ethnic identification, campus location, professor name, time that class convened, internet reliability, and delivery of the instruction (i.e., remote, hybrid or face-to-face). The outcomes of the study were context of beliefs, meaningful learning, motivation to learn, and learning achievement in pharmacology. All reliability coefficients for this study for all measurement scales were > 0.80 (see Table B.3)

Context for learning pharmacology was measured by the Student Beliefs as Context for Learning Pharmacology scale (SBCLP; Appendix C), capturing students' degree of belief about their perceived role, confidence in learning ability, and delivering safe pharmacological care. These beliefs provide the context for learning the role and responsibilities of a nurse in safe medication management. The scale is comprised of 20 items with a 5-point Likert scale ranging from 1=strongly disagree to 5=strongly agree. There are two reverse-scored items, 15 and 17. Items were summed after items were reversed, with a potential range of scores from 20 to 100. Scores higher than or equal to 80 indicated an acceptable context for learning pharmacology. The original instrument was designed to measure student nurses' beliefs about and confidence in their ability to implement evidence-based practice (EBP) and has performed similarly across various settings (Cronbach's $\alpha > .80$; Fineout-Overholt, 2018).

Meaningful learning was measured by the Student Satisfaction and Self-Confidence in Learning scale (SSSL; see Appendix D), which was designed to capture perceived confidence in and satisfaction with learning. This scale was developed through a partnership between the National League for Nursing (NLN) and Laerdal ("Development of available instruments," n.d.). It is comprised of 13 items with 5-point Likert responses, ranging from 1 = none to 5 = very

much. In the original scale, there were two sub-scales: 1) student satisfaction and 2) self-confidence in learning; however, in this study, all items contributed to a meaningful learning score. Items were summed with a potential range of scores from 13 to 65. Scores higher than or equal to 52 indicated acceptable satisfaction with learning pharmacology. Each original sub-scale had an internal consistency coefficient of > .80 (.94 student satisfaction; .87 self-confidence in learning; "Development of available instruments," n.d.). The original scale was modified with permission (NLN, n.d.) to reflect student satisfaction and self-confidence in learning pharmacology.

Motivation to learn was measured the Health Professions Motivation to Learn Pharmacology scale (HPMLP; see Appendix E), which was derived from the Modified Archer Health Professions Motivation Survey (Perrot et al., 2001). In the original scale, there were three established subscales: 1) Goal Orientation (i.e., motivation), 2) Learning Strategies, and 3) Locus of Control. For the purposes of this study, the HPMLP scale was comprised solely of a modified version of the original goal orientation subscale. This 41-item scale had Likert responses of 1=strongly disagree to 5=strongly agree. The range of scores was from 41 to 205, with scores higher than or equal to 164 indicating acceptable motivation to learn pharmacology. This instrument was originally developed to measure motivation to learn in health professions college students (medical, nursing, pharmacy, etc.; Perrot et al., 2001; Cronbach's $\alpha > .80$). The researcher adapted the scale, with the author's permission (Perrot et al., 2001), to reflect student perceptions of their motivations to learn complex pharmacology content.

Academic Performance was measured by a composite mean of traditional indicators of learning achievement, four-unit exams and one final exam. This composite mean for each

participant was provided by the course faculty at the end of the semester. No data were provided for students who did not participate in the study.

To capture the impact of COVID-19 on learning, an open-ended comment box was offered at the end of the online questionnaire. Students could reflect on such issues as external learning stressors, extemporaneous distance learning, loss of connection with fellow students or other factors they felt affected their learning.

Two-Pronged Intervention

Students in the intervention and comparison groups were enrolled in nursing pharmacology within their first semester of a baccalaureate nursing program in a public university in the southwest. Students in both groups met on the same day of the week for three hours with one instructor throughout the semester. Pandemic accommodations included remote options for students and varied across time, which created opportunity for students to get confused regarding flow of information and expressed angst for lack of connection with educators and stability of learning.

Context: Case Study Exercise

The first prong of the intervention was an in-class unfolding case study exercise that was conducted in week three. In designing the complex, real-time nurse study assignment, faculty utilized the tenets of the TLT, in which students were presented with a current case study temporally unfolding. Students were asked to problem-solve, discuss perceived problems with peers, and submit a personal reflection regarding their thoughts about the exercise. Use of a current case study to impact clinical context rather than course content is how this exercise was transformational in innovation and motivating student learning.

Students in the IG were presented with a PowerPoint® presentation by the principal investigator (via Zoom®) in week three (early in the semester) regarding the role of a nurse as a professional and introduced the Swiss Cheese Model (SCM) as a method for understanding how errors, both human and systemic, can align with catastrophic results. Students then viewed a video from a medical provider with the initial information about how a nurse was described as responsible for the agonizing death of a vulnerable patient by the nurse overriding system fail-safes, giving vecuronium instead of prescribed Versed® (Damania, 2018; Matheson, 2019). Following the video, the class engaged in a discussion regarding their thoughts, feelings, and points-of-view regarding the situation and the nurse's role in the death of this patient. Most students expressed horror at how the nurse could have acted so recklessly and committed so many consecutive errors.

The students were then shown a video from the same provider three months later including the name of the nurse being charged criminally with reckless homicide and abuse of an impaired adult (Damania, 2019). The discussion following this video was more sympathetic to the nurse, who was largely perceived as a scape goat for the larger systemic gaps, as well as a way to avoid profound penalties both financial, criminal, and reputationally to the organization. The discussion enabled a detailed delineation of the differences between negligence, malpractice, and criminality. At the time of the video, the nurse did not have her license in danger of being revoked. Rather, the governing body sent a letter to the nurse informing her that her license was not in jeopardy (Matheson, 2019). This decision was ultimately reversed.

The discussions were lively and respectful. Students were then instructed to write a reflection answering the questions listed in Table B.2, by considering the case study and the in-class discussion as they shared their thoughts about the exercise. The individual reflection was

due at midnight on the day of the discussion to facilitate a continuous flow clinical reasoning and judgment. The experience was designed to contextualize the clinical learning regarding pharmacology and safe medication management principles. Additionally, the case study learning assignment introduced the professional role of nurses and emphasized the direct line between the meticulous nature of medication management (beyond administration) and patient outcomes. The individual reflective portion of the assignment permitted students an opportunity to recognize the relevance of course materials to their chosen profession, as well as the responsibility nurses have for safely caring for patients. The principal investigator graded the reflection assignments and the grades were forwarded to the corresponding faculty for entry into the LMS gradebook.

Meaningful Learning: Pharmacology Phamily Project

The Pharmacology Phamily Project (PPP) spanned the entire semester and was comprised of several student submissions. In the first week of the semester, a free website (Signup.com®) was used to manage sign-ups; students were instructed to choose a particular medication to base their case study on as they completed the assignment. The free website allowed students to choose a medication that was of personal interest and avoid duplication with other students. The medications were grouped by the exam in which the knowledge of the medication would be tested. This enabled students to opt for a due date early in the semester or later in the semester, whichever suited their preferences, and also fostered some autonomy in the assignment.

Each student created a case study that could be inspired by personal experience or could be completely fabricated. Students were instructed to create a multi-media presentation of their case study (e.g., YouTube®; audio/video required), which was posted on the discussion thread

with the medication name as the title. Videos were required to be less than five minutes in length. Minimum criteria included medication name, medication class, mechanism of action, top three adverse experiences, and contraindications/warnings (See Table A.1). As part of inputting (CLT), students were also required to respond to four other threads within their medication-exam group, which required them to post more information about the medication and, possibly, present it in a different way. Students' working memories (CLT) were then engaged by asking them to describe either another indication for the medication or to add a medication (with rationale) that may also be appropriate for the given condition in their case. Student videos from all groups were visible to all students throughout the semester. Students were encouraged to use the videos as study tools for exams throughout the semester, as well.

A PPP assignment rubric was posted on the LMS for students to review as they completed their assignment, and a discussion board was created for each of the five medication-exam units within the semester. Students posted their PPP video on the thread that corresponded to the medication-exam unit within which they were tested. The students were responsible for introducing the PPP video and responding to four of their peers' PPP video submissions. The principal investigator (PI) graded the PPP video projects and discussion board threads. The PPP assignment was weighted at 10 percent of the final grade so students would feel the effort to learn was worth the time invested. The PI submitted the PPP grades to the corresponding campus faculty for entry into the LMS gradebook. Although the PPP projects were graded throughout the semester, faculty did not release PPP grades until the end of the semester (week 13) when all PPP video projects were completed and graded.

The comparison group had a poster presentation that incorporated medication information; however, it was not multimedia and was not case based. Intentionally providing

students multiple modalities for processing and retaining knowledge enhanced the opportunity for long-term recall (CLT archiving), which traditional quizzes or single media options do not.

Data Collection

Data were collected on a single measure (context for learning) at Time 1 and on all four measures (all study variables) at Time 2. This enabled comparison of context for learning across the semester.

Pre-Intervention Data Collection: Context for Learning

Pre-intervention demographic and context for learning data were collected via a questionnaire on the Qualtrics® software platform at Time 1. Pre-intervention reminder announcements were posted via the LMS in all sections of the course on 1/11/21, 1/18/21, and 1/20/21. Data collection for the pre-test was halted after three weeks as planned. Out of a possible 179 students who could participate in the Time 1 data collection across both in IG and CG, 36 participants completed the pretest SBCLP scale (20% response rate), 34 had complete data. There were 21 in the IG and 15 in the CG. There was a total of three missing values within the dataset. To address these random missing data, the within person mean for the SBCLP scale was imputed for two missing values for one participant and one missing value for another participant.

Post-Intervention Data Collection: All Study Variables

An invitation to participate in post-intervention data collection on the Qualtrics® software platform was sent out to all sections of the pharmacology course via the LMS email. Out of a possible 179 students who could have participated in the post-intervention data collection, 22 students completed data for all study variables (12% response rate), with 16 from the IG and six participants from the CG. Across the IG and CG, there were eight participants whose data could be matched pre-intervention and post-intervention. One participant (IG) did

not answer any of the HPMLP scale and was listwise deleted from all analyses. Four participants had missing values that occurred at random. These missing values were across different scales and required a total of four replacements with the within person scale mean.

Analysis

Statistical analysis was conducted using IBM® SPSS® Statistics version 28. Data were reviewed for assumptions of parametric testing. Data were generally normally distributed with only one extreme outlier that was deleted for all analyses. Additionally, sample size across the data collection period was extremely small and may have affected analysis results. Descriptive statistics were calculated for each of the outcome variables (see Table B.3).

Procedures to Enhance Control

The study was conducted in three geographically separate state university campus locations in East Texas. The IG was comprised of two campuses, community and rural, with one section on each campus. The CG was comprised of only the main (larger) campus, with two course sections and two instructors. The PI was a Clinical Assistant Professor at another state university and had no teaching role at the state university and was not known to the students enrolled in the pharmacology course. The geographical distance of the campuses naturally facilitated physical separation of the study participants, possibly enhancing the intervention fidelity and generalizability of the results. Furthermore, a historical confounder was that this study was conducted during a global pandemic, which resulted in further physical separation of students within a given course and offered learning challenges because attendance was restricted at times to only virtual options.

The PI accessed the students in the IG with permission of the faculty so that the content and intervention assignments could be shared. Ideally, this would have been in-person; however,

with pandemic restrictions, PI-student access was limited to online only. The PI received permission for the CG faculty to invite the CG students through the LMS email. There was no person-to-person contact with CG faculty or online connection with students except through recruitment emails. This was somewhat intentional to avoid any contamination of the CG and risk affecting the fidelity of the intervention; however, it may have facilitated students ignoring study data collection, since there was no connection to the study or the PI. To protect the fidelity of the intervention, faculty within the IG were educated about the intervention and its delivery as well as grading and student data collection. These were completed by the PI; however, having faculty knowledgeable about the intervention (both prongs) was deemed a prudent research safeguard. The instructional meetings were completed via Zoom®.

The syllabus for all course sections was identical. Since the syllabus was generic, the interventions could be described via the LMS and not affect the syllabus used by students in either the IG or CG. The intervention prongs replaced closely related pre-existing assignments in the IG because the intent and theoretical approach made them uniquely different. Time and attention were accounted for in the CG by completing those pre-existing assignments as traditionally conceptualized and delivered.

Results

Sample

A total of 36 students responded to the study questionnaire at Time 1 and 23 students at Time 2. Across Time 1 and Time 2, there were 8 matched cases with both complete pre and post data. It is interesting that more students participated at the beginning of the semester than the end of the semester, which could have been a result of course workload overall or disconnect with the study in the CG. Four males and 32 females completed Time 1 with an age range of 19-47. At Time 1, there were 21 participants in the IG and 15 in the FCG. Within the Time 1

sample, 44% (16/36) of the students indicated they had previous healthcare experience, with 81% of these participants (13/16) in the IG. Four of the 16 were licensed vocational nurses (LVNs), seven were certified nursing assistants (CNA), one was a medical assistant, one was a rehab director technician, one was a respiratory therapist, one was a medical lab technician, and one was a sitter. Twenty-one Time 1 participants identified as White, seven as Black or African-American, three as Asian, three Hispanic, one as American Indian or Alaska Native, and one did not answer.

At Time 2, there were 19 females and 3 males, with one student indicating preferred not to answer. The age range of the 23 Time 2 students was from 19-42. There were 17 participants from the IG and six in the CG. More than half of the Time 2 participants (52%) had previous healthcare experience (12/23), and 92% of those were in the IG (11/12). Two were LVNs, three were patient care technicians (PCTs), and two were CNAs, one was a medical assistant, one was a registered dietitian, one was a paramedic, one was a pharmacy technician and one was a sitter. However, independent samples t-test showed that prior healthcare experience did not affect study outcomes. Fourteen participants identified as White, six as Black or African-American, one as Asian, and two as other. Note that during analysis, one case was listwise deleted because it was an outlier, leaving a total of 16 in the IG and a total of 22 in the Time 2 sample.

Answers to Research Questions

Research Question (RQ) 1: Will participants in the IG have significantly higher context for learning in pharmacology compared to participants in the CG at baseline?

RQ1 was answered no. A total of 36 participants completed the Time 1 pretest SBCLP scale at the beginning of the semester. An independent t-test was conducted to compare the IG

and the CG SBCLP means. The results indicated that there was no significant difference (t = .60, p = .55) between the groups' context for learning in pharmacology (i.e., SBCLP) at baseline.

Research Question 2: Will participants in the IG have a change in context for learning in pharmacology measured at the beginning of the semester compared to course completion?

RQ2 was answered yes. Eight participants with paired cases across Time 1 and Time 2 were analyzed. The SBCLP scale data across both Time 1 and Time 2 met assumptions for normal distribution, multi-collinearity, skewness and kurtosis. The dependent variable was defined as the change (Δ) in the Time 1 to Time 2 SBCLP scores. There was a 2-point increase across the eight paired cases in Time 2 SBCLP scores (i.e., context for learning pharmacology), indicating an increase in beliefs about their confidence in learning. A dependent t-test was conducted to compare Time 1 and Time 2 SBCLP scores, which showed that there was no statistically significant difference (t = -.712, p = .50). The 2-point delta did not achieve statistical significance, which was likely due to small sample size of eight participants; however, this delta may be educationally meaningful and can be explored further in future research.

Research Question 3: Will participants in the IG have higher meaningful learning in pharmacology compared to participants in the CG?

RQ3 was answered with a provisional yes. A total of 22 participants completed the post-intervention SSSL scale (i.e., meaningful learning). The16 participants in the IG has a mean of 52.25 (SD = 10.90) and the 6 participants in the CG has a mean of 42.16 (SD = 9.33). A t-test showed that the difference in ML between the two groups trended toward significance (t=2.00; p=.06) demonstrating that IG participants perceived their learning as meaningful.

Research Question 4: Will participants in the IG have higher motivation to learn pharmacology compared to participants in the CG?

RQ4 was answered no. The overall HPMLP scale (motivation to learn) differences were not statistically significant (t=-0.003, p=.99). However, the three subscales of the HPMLP scale were independently compared between IG and CG. The Mastery subscale reflects to goal is competence, the Performance subscale reflects the goal is a good grade, and the Alienation subscale reflects the goal is to pass the course. Of note, the Mastery subscale mean was 2.19 points higher and the Performance subscale mean was 2.77 points higher in the CG. The Alienation subscale mean was 5.6 points higher in the IG. These were not expected findings. The higher percentage of previous healthcare experience in the IG may have prompted a heightened need for passing the course, moving Alienation to the priority motivation slot. These differences offer opportunity to consider in future studies how experience may create even small differences in motivation to learn.

Research Question 5: Will participants in the IG have higher learning achievement compared to participants in the CG?

RQ5 was answered no. Though exam scores were 2.16 higher in the IG, an independent t-test indicated that there was no significant difference between the IG and CG ($t = .66$; $p = .52$). However, it is worth noting that two points on exam scores could be educationally meaningful in that those two points could represent moving to the next grade distinction within a grade ranking system. Future studies can help bear out this possibility.

Research Question 6: What are the relationships among context for learning (beliefs), meaningful learning, motivation to learn, and learning achievement (academic performance) in pharmacology?

To answer RQ6, a correlation matrix of Pearson Correlations was created of Time 2 combined data (n=22; IG and CG data were included; see Table B.4). Significant correlations

were found between context for learning (SBCLP) and AP (exam scores; $r = .44$, $p < .05$), between motivation to learn (HPMLP) and meaningful learning (SSSL; $r = .58$, $p < .01$), and context for learning (SBCLP) and motivation to learn (HPMLP; $r = .59$, $p < .01$). Given the small sample size, a Spearman Rho correlation matrix was also generated, which confirmed the above findings (see Table B.5).

Additional Findings

Most studies in pharmacology have AP as the dependent variable. However, given the correlations in this study, AP was not the reasonable dependent variable, particularly since CL is the only variable that is related to AP. From these findings, ML seems to be a more reasonable outcome variable. The more reasonable relationships prompted by the study findings in this small sample would be that CL influences MoL, which influences ML. AP could be a moderator of CL. A simple regression analysis showed that CL, MoL and AP collectively accounted for 34% of the variance in ML ($F(3)$ 2.934, $p = .063$); however, the regression coefficients showed the MoL was the primary contributor to ML ($\beta = 0.538$, $p < .05$; CL $\beta = .043$ & AP $\beta = .060$, $p > .05$). Future studies may further explore ML as an outcome for learning in pharmacology.

Findings from Intervention Delivery

Context for Learning: Students reported a variety of feelings, observations, and opinions. The consensus was that the series of errors committed by the nurse was disturbing and unsettling, especially since she had likely been engaging in workarounds over time and on this one day, the errors aligned with tragic consequences. Many students expressed their horror at this case-study nurse's seemingly cavalier attitude regarding patient safety as well as the systemic problems of the organization. They expressed that nurses should be held to higher standards than other professionals, and their concern that multiple mistakes can eventually progress to negligence.

Most students felt that the nurse should have a hearing regarding retaining her licensure, but that criminality would have a negative and chilling effect on all healthcare professionals. Finally, many students expressed great sadness and compassion for the patient and her family.

Discussion

This was the first known study combining three theories (i.e., CLT, TLT, and MLT) and their representative measures, the SBCLP scale, the HPMLP scale, and SSSL scale, to seek understanding of how pharmacology nursing students' context for learning and cognitive processing can affect their meaningful learning within a pharmacology course.

Of interest was that there were more participants in the IG who had prior experience in healthcare roles than the CG. It would be interesting to replicate this study with a sample of only those who were naïve to healthcare work. Previous healthcare experience may be a de facto contributor to CL. Additionally, clinical experience may attenuate participants' perceptions of CL since they may have a more realistic idea of what it requires to safely care for patients. Future studies may include focus groups to discuss this issue when prior experience with healthcare roles is a factor within the sample.

When comparing CL at the beginning of the semester and near the end of the semester in the IG, some notable changes were in item 14, *I am sure I know how to measure the outcomes of pharmaceutical care* and item 15, *I believe that implementing the three checks, the seven rights, and scanning medications takes too much time* (Δ of -1.1 and -1.81, respectively). For item 14, as the Case Study Intervention prong unfolded, IG students may have realized that they were not as knowledgeable about measuring the outcomes of pharmaceutical care, resulting in lower results at Time 2. Additionally, students in the IG at the beginning of the semester indicated they did not believe that doing three checks, seven rights, and scanning – every time, every

medication – would be time consuming. They indicated a change in their responses near the end of the semester that may reflect development of a deeper and more realistic understanding of the challenges of these important safety processes. These findings are from a small sample and inferences are not robust; however, these findings are notable when considering future studies.

The differences in MoL sub-scales (i.e., Mastery, Performance, & Alienation), could be a function of several factors, including geography location (community vs. rural vs. suburban), previous experience with education, outside employment, availability of resources, and/or personal factors (e.g., socio-economic, family resources and support). Future studies may want to include these demographics to better understand the differences in how groups prioritize their MoL. For example, the IG had higher AP than the CG; however, the MoL for the IG was primarily represented in the Alienation subscale. Educationally, for sustainable learning, MoL of Mastery would be the preferred priority. Studies exploring how to foster a shift from either Performance or Alienation to Mastery could inform both educators and students who study complex content like pharmacology.

With the current dose of ML interventions (i.e., 2-prong intervention, 1 one-day and 1 semester-long), the data collection challenges, and sample recruitment challenges, the traditional outcome of AP improved, albeit marginally. However, ML was 10-points higher in the IG and trended toward significance in this small sample, further supporting the consideration of it as the outcome metric for learning in complex content courses like pharmacology. With resolution of the data collection and sample recruitment challenges, further improvement may be increased in all study variables as a result of the intervention. Finally, in future studies, comparing different doses of ML interventions may improve the outcomes of AP and ML.

Strengths and Limitations

The strengths of this study include the quasi-experimental design, one state university BSN program, a consistent approach to the pharmacology course (i.e., a single syllabus), the use of a comparison group, geographic distance between three campuses, virtual distance, and the use of a two-pronged theory-based intervention to impact ML for nursing pharmacology students. All students in this study were first semester BSN students at the same state university. A study design of this type has not been found in the literature regarding nursing pharmacology. This study could fill a gap in the literature and result in enhancing effective teaching and learning strategies in nursing pharmacology in the future.

Limitations of this study include potential threats to internal and external validity. Threats to internal validity include the presence of confounding variables, diffusion, instrumentation, and testing. Confounding variables include frequent adaptations to teaching content throughout the semester as compliance with federal and state regulations changed due to the pandemic, as well as the impact on individual students facing changing family dynamics (e.g., needing to remain home with school-age children), health concerns, and unforeseen stressors. Diffusion between study groups was possible, although not likely to be a significant factor due to the geographic, virtual, and social distancing during this time frame. Faculty in the comparison groups were provided no specific information about the intervention, thereby reducing the threat of diffusion, although students in the IG were aware the principal investigator implemented the interventions. Instrumentation may potentially be a threat in that surveys were modified from the originals. All efforts were made to ensure that the original intent of the measures were preserved, and as few words as possible were changed. Testing may have been a threat to internal validity since the researcher had no influence over the types of questions within

the exams; some students may have been better test-takers. The small number of participants limits generalizability.

Due to IRB guidelines regarding recruitment, the importance of study participation may have been attenuated in the large comparison group. These potential participants did not have a compelling reason to participate in the study other than intellectual curiosity. The high number of participants in the IG vis-à-vis comparison group may have skewed the data. Limitations to recruitment may have had a significant effect on the participation rates, especially in the comparison group. These students had no relationship with the principal researcher (because of no interaction with the interventions) which may have affected motivation to participate. The changing guidelines of course delivery (due to COVID-19 restrictions) presented an unusual educational environment which inserted and magnified stressors not typically experienced in the pharmacology course, which are difficult to quantify. Additionally, since a high percentage of the participants were already members of the healthcare community, this may have dampened their change (Δ) in context since they were already in possession of realistic clinical context. Furthermore, this may have led to an increased motivation to participate in the study.

Summary

Nursing pharmacology is a persistent and increasing factor in safe and effective patient care resulting in positive patient outcomes. Medication management has evolved beyond medication administration and now includes patient assessment/reassessment, medication reconciliation, clinical judgement, patient teaching, and interprofessional collaboration. Learning these complex aspects of pharmacological care increases in complexity every year, and nursing students struggle to retain large amounts of information and applying it to individual

patients. Learning information (rote memorization) as opposed to ML (using a memory tag) is an outdated method for teaching and learning nursing pharmacology.

Utilizing theoretical bases for designing learning interventions, this study utilized a two-pronged intervention to increase learning outcomes for student nurses as well as influence the positive outcomes of future patients. By storing information in long-term memory rather than the superficial learning of rote memorization, nursing students may be better prepared for the complexities of medication management and ultimately improve patient outcomes.

Designing assignments using the cognitive load theory (CLT) may be utile in increasing the long-term memory of pharmacological principles in nursing students. Introducing a transforming real-time case study may provide a reason to nursing students as to why learning pharmacological principles is crucial to safe patient care.

Meaningful learning in nursing pharmacology must transcend perfunctory memorization and evolve to clinical judgement integration of clinical data, assessment information, and patient preferences to produce a unique and tailored patient care plan. Teaching nursing students how to treat each patient as a unique and special individual and leverage the information they learned in nursing school, may result in improved outcomes.

Applying the lessons learned may have application beyond nursing pharmacology; using the tenets of the CLT, TLT, and MLT in courses other than nursing pharmacology may produce improved outcomes in other courses and disciplines. Intentional design of assignments using theoretical underpinnings may have significant effects on patient outcomes.

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Chapter 5: Summary and Conclusion

Synthesis

Nursing pharmacology has historically been a source of frustration for nursing students and nursing faculty, yet the implications of sustained learning or lack thereof have a profound impact on safe and effective patient outcomes (Alton, 2016). Sustained learning is challenging given the amount of pharmacology content as well as its complexity. Pharmacology has a language which is unfamiliar to many student learners, introducing another hurdle to understanding, processing, and retaining critical information necessary for the best patient outcomes in the future.

Graduate nurses, as well as experienced nurses, report feeling inadequate to effectively carry out the many responsibilities of medication management (Factor et al., 2017; Foster et al., 2017; Graf et al., 2020; Huston et al., 2018; Maben et al., 2006; Odetola, 2018; Saifan et al., 2021). Nursing confidence in preventing medication errors has its foundation in a thorough understanding of the appropriateness of a drug, dose, route, etc., which has been ordered. The incidence of inappropriate use of medications increases with patient age, the occurrence of comorbidities, and the number of medications prescribed (Perez-Jover et al., 2018), and nurses are considered the last line of defense against all these potential medication errors regardless of the medical professional committing the error. Medication management/administration is one of the riskiest tasks that a nurse will carry out, for themselves and for the patient (Croteau et al., 2011). The nurse may put their license and freedom at risk, as well as the patient who has their very life at risk (Damania, 2019; Matheson, 2019).

In order to protect patients, nurses must possess a vast working knowledge of medications and the appropriate and inappropriate uses of them. For this to happen, nurses must

have an internal, permanent database of information, supplemented by resources at hand and the ability to recall and apply this data to the current patient scenario. This is in stark contrast to the rote carrying out of medication orders without critical thinking of the appropriateness of the order. Nurses must be willing to take the time (a valuable resource) to confirm the validity of the medication order(s) and to determine whether or not it is safe and appropriate to administer them.

Most nursing pharmacology is still taught in didactic format in order to cover the vast amount of material without consideration of how effectively student nurses will be able to process and retain the knowledge in the long term. If patient safety is truly at the crux of safe medication management, then nursing pharmacology faculty should fashion teaching strategies to maximize understanding, processing, and long-term storage of nursing pharmacology information (Foster et al., 2017). This also serves to protect future nurses from adverse experiences for themselves as well as their patients (Damania, 2018; Damania, 2019).

First semester nursing students in a baccalaureate (BSN) program often lack the clinical language fluency associated with adept learning of clinical concepts, but also the clinical context for learning that information. Since nursing pharmacology is typically taught prior to nursing students entering their clinical courses (and often a pre-requisite for such courses), it becomes incumbent upon nursing pharmacology faculty to teach the language of pharmacology, as well as the clinical context, so that nursing students understand medication management practices as they relate to patient safety (Foster et al., 2017).

To that end, faculty can intentionally design learning activities in nursing pharmacology to facilitate understanding, processing, and storage of difficult, complex information for long-term storage and efficient recall of information during future clinical situations. This study shows that this is a multi-factorial process. Using the tenets of the cognitive load theory, faculty

can intentionally design a learning activity to assist student learning which promotes learning, processing, and encrypting into long-term memory the key aspects of medications commonly used in the clinical setting (Josephsen, 2015). This process describes the "how to learn".

Students present with a broad range of clinical context, which affect the learning/processing of information, from no clinical context to extensive clinical context. Transformational experiences come in various scenarios. Some students have experience within the healthcare realm, and some present with only an idea of what it means to be a nurse. In order to enhance clinical context in a didactic course for all students, an exercise can be designed to propel the nursing student into a real-time, unfolding clinical case study where they have the opportunity to insert themselves into the role of the nurse and submit a personal reflection regarding recommendations for the nurse in question, and what their thought processes were in formulating the recommendation without judgement. This exercise provides students an opportunity, early in the semester, to understand the "why to learn" this complex and difficult material; it has effects on future patients' outcomes. Early intervention in the semester may have effects throughout the semester and beyond.

Combining the TLT (why to learn) and the CLT (how to learn) intentionally in designing nursing pharmacology interventions, nursing students may approach the gravity of learning nursing pharmacology through a different lens. By introducing the TLT exercise early in the semester (week 3), it may have an impact on the motivation to learn throughout the remaining weeks of the semester in nursing pharmacology as well as other foundational courses. The CLT exercise (throughout the semester) provides the mechanisms for students to input, process, and retain critical information for retrieval in the short and long-term. When implemented in toto, meaningful learning (MLT) can be achieved.

Next Steps

There are several avenues of future research pursuits. Longitudinal analysis of the study participants when they take the standardized exam for pharmacology, two semesters in the future, comparing the exam results between intervention and control groups may provide information regarding the sustainability of learning. Additionally, investigating the relationship between mastery and performance may prove insightful; while there may be an overlap between these two variables, it is unclear whether mastery has a significant influence on performance, or whether performance has a significant influence on mastery.

Investigating the effect of similarly crafted interventions (using CLT and TLT) in other complex courses may be instructive. Also, researching whether a transformational learning exercise similar to the one described in this study improve clinical context in other healthcare disciplines.

Future studies also include comparing different doses of meaningful learning interventions and evaluating the impact on academic performance. Additionally, investigating how motivation to learn and context for learning may influence meaningful learning measured with different scales.

Finally, expanding understanding of the constructs of this study with a relationship focus, rather than a variable focus, may provide insight to the interactions between them. A model for prediction of pharmacological and, ultimately, practice success is a future goal.

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Appendix A: Chapter 2 Table

Table A.1

Pharmacology Phamily Project Rubric

Criteria	Excellent	Good	Fair	Poor	Not demonstrated
Initial Video Post **60 points**	**45 to 60 points** All 5 required elements are addressed. 1. Patient case described. 2. Medication name and class described. 3. Mechanism of Action (MOA) described. 4. Contraindications/Warnings discussed. 5. Top 3 adverse effects described.	**31 to 44 points** Only 3 required elements are concisely addressed.	**16 to 30 points** Only 2 required elements are concisely addressed.	**1 to 15 points** Only 1 required elements are concisely addressed.	**0 points** Does not post at all or post is late.
Response (typed) Posts **30 points**	**21 to 30 points** Responds to two other posters adding either another indication for the medication described OR another medication appropriate for the described patient and why appropriate. Expands on original post.	**0 points** NA	**1 to 20 points** Minimal evidence of integration between this post and the original student's post.	**0 points** NA	**0 points** No response(s) posted or posting is late.
Etiquette and Writing Mechanics **10 points**	**10 points** Comments are organized, easy to understand, and free of grammatical, spelling, or punctuation errors.	**7 points** Posts have less than 5 grammatical, spelling, or punctuation errors.	**4 points** Posts have less than 7 grammatical, spelling, or punctuation errors.	**2 points** Posts reflect 7 or more grammatical, spelling, or punctuation errors.	**0 points** Does not post on Discussion Board.

Appendix B: Chapter 4 Tables

Table B.1.

Conceptual and Operational Definitions

Study Intervention				
MLT Theoretical Construct	**Iterative TLT & CLT Intervention**	**Intervention Mechanism**	**Intervention Method**	**Operational Protocol for Intervention**
Context	TLT construct - Patient safety in medication management	Context-rich Case Study and Reflection	• Engage relevant, ethically challenging case study (real-life preferred) • Immerse participants in the context of nurses' roles and responsibilities in safe medication management • Interject in future discussions to strengthen context	**Week 3 (one class period)** • Engage PowerPoint® presentation (PI delivered) o Profession of nursing context o Swiss Cheese Model of errors alignment resulting in harm to patients. • Viewed video (PI delivered) o Medical provider shares facts about the case of a nurse implicated in the death of a patient following medication errors (https://www.youtube.com/watch?v=FIeYsJywO00) • Discussed (PI led) the scenario, the nurse, safety violations, the patient, the errors, etc. o PI guided discussion of feelings about the case, including perspectives on what should happen to the nurse involved. • Viewed second video (PI delivered) o Same provider o Recorded three months following the first one o More details revealed about: ▪ the nurse

				▪ institution ▪ criminal charges filed against the nurse ▪ Board of Nursing stance ▪ just culture (https://www.youtube.com/watch?v=ZrpzNVBgTT8) • Discussed (PI led) o Have views on the case changed o Impact of second video. • Wrote reflection (independent) focused on specific open-ended questions (Appendix G) & submit by midnight.
Emotional Connection	CLT construct - Information processing using input, throughput, and output. Designed to reduce the amount of cognitive load input for the working memory and, thereby, increase processing to long-term memory	Pharma-cology Phamily Project	• Multi-modal, multi-phased engagement of pharmacology material • Create a case scenario video about a unique medication. • Share video with fellow learners to enhance the intervention effect • Peer review is part of the enhanced learning • Lasts 14 weeks	**Week 1 through Week 14 (one class session & work outside of class)** **First Week** • PI created list of potential medications and posted on LMS • Medications divided into five groups to coincide with five unit exams. • Students identified and signed-up for a medication on which to base the individual projects • PI confirmed medication assignment with each student before work commenced • Rubric posted for PPP assignment on LMS • Exemplar posted for PPP assignment on LMS. **Weeks Two-14** • Students who chose medications in a given week created PPP presentation to share with course mates and posted on designated LMS

				discussion board within the course. Presentation included a patient case and: o Medication Name o Medication Class o Mechanism of Action o Indication for Patient Case o Top three Adverse Experiences o Contraindications and Warnings • All students reviewed PPP presentations posted each week and responded to four creators of the presentation with the following: o Two posts providing another indication for the presented medication or another medication for the condition o Two posts critiquing the presentation, including one positive and one potential improvement • Expectations were that students would: o Use what they have learned from creating the PPP presentation (input) o Share in a multi-media case study information to aid in the efficiency of processing (throughput) and o Store (output) the new information for use in their careers. Students had access to ALL PPP presentations from the time they were initially posted until the end of the semester.
Study Outcomes				
MLT Theoretical Construct	**Study Variable**		**Conceptual definition**	**Operational definition**

Context	Context for Learning in Pharmacology	Beliefs about role, confidence in ability, & perception of pharmacological learning	Student Beliefs as Context for Learning Pharmacology scale (SBCLP; Appendix C)
Emotional Connection	Meaningful Learning in Pharmacology	Self-confidence/ individual belief in ability to learn pharmacology	The Student Satisfaction and Self-Confidence in Learning (SSSC; Appendix D).
Motivation to Learn	Motivation to Learn Pharmacology	Core impetus to invest time and effort into learning complex pharmacological information	Health Professions Motivation to Learn Pharmacology scale (HPMLP; Appendix E)
Archived Knowledge Retention	Learning Achievement	Performance on traditional standardized exams	Mean of unit exams as provided by faculty of record in the course

Table B.2.

Questions Guiding Reflective Assignment in the Case Study

Q1.	Should the nurse be charged criminally for her actions/inactions? Why or why not?
Q2.	Should the nurse lose her license for her actions/inactions? Why or why not?
Q3.	If the nurse has her license suspended, do you think that she should have a pathway to have it reinstated? Why or why not?
Q4.	Did this case change your thinking about nursing pharmacology and patient safety? If so, how?

Table B.3

Study Variables Descriptives & Reliability Coefficients

Variable Measure	Number of Items	N	Min	Max	Mean	Std. Deviation	Cronbach Alpha
Context for Learning (Beliefs) Time 1	20	36	72	90	80.38	6.99	.83
Context for Learning (Beliefs) Time 2	20	22	71	95	82.45	8.03	.87
Motivation for Learning (Goal Orientation Scale)	41	22	93	167	139.42	19.60	.89
Motivation for Learning – Performance Subscale	15	22	35	65	52.01	9.10	.79
Motivation for Learning – Achievement Subscale	10	22	13	40	21.81	6.56	.70
Motivation for Learning-Mastery Subscale	16	22	45	78	65.61	9.82	.91
Meaningful Learning (Satisfaction and Self Confidence in Learning)	13	22	27	60	49.5	11.24	.95
Learning Achievement (Academic Performance)	N/A	22	65	95	84.24	6.77	N/A

Table B.4

Correlation Matrix for Study Variables (n=22)

Study Variable	Statistic/Significance	Academic Performance	Context for Learning	Meaningful Learning	Motivation to Learn
Academic Performance	Pearson Correlation	1	.444*	.313	.399
	Sig. (2-tailed)		.038	.157	.073
	N	22	22	22	22
Context for Learning (Time 2)	Pearson Correlation	.444*	1	.392	.608**
	Sig. (2-tailed)	.038		.071	.003
	N	22	22	22	22
Meaningful Learning	Pearson Correlation	.313	.392	1	.588**
	Sig. (2-tailed)	.157	.071		.005
	N	22	22	22	22
Motivation to Learn	Pearson Correlation	.399	.608**	.588**	1
	Sig. (2-tailed)	.073	.003	.005	
	N	22	22	22	22

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table B.5

Spearman Rho Correlation Matrix for Study Variables

			Academic Performance	Context for Learning	Meaningful Learning	Motivation to Learn
Spearman's rho	Academic Performance	Correlation Coefficient	1.000	.514*	.378	.421
		Sig. (2-tailed)	.	.014	.083	.058
		N	22	22	22	22
	Context for Learning	Correlation Coefficient	.514*	1.000	.399	.594**
		Sig. (2-tailed)	.014	.	.066	.005
		N	22	22	22	22
	Meaningful Learning	Correlation Coefficient	.378	.399	1.000	.623**
		Sig. (2-tailed)	.083	.066	.	.003
		N	22	22	22	22
	Motivation to Learn	Correlation Coefficient	.421	.594**	.623**	1.000
		Sig. (2-tailed)	.058	.005	.003	.
		N	22	22	22	22

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Appendix C

Student Beliefs as Context for Learning Pharmacology Scale

Mauldin & Fineout-Overholt, Copyright, 2020

Below are 20 statements about pharmacology and learning. Please circle the number that best describes your agreement or disagreement with each statement. There are no right or wrong answers. (This contains both the original and scale questions).

Modified Pharmacology Question	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
1. I believe that pharmacology knowledge results in the best clinical care for patients.	1	2	3	4	5
2. I am clear about the steps of articulating seven rights of medication management.	1	2	3	4	5
3. I am sure that I can implement safe medication management principles.	1	2	3	4	5
4. I believe that asking questions about rationales for giving each medication to a patient is best practice for nursing.	1	2	3	4	5
5. I understand that the role of pharmacology expertise in ensuring best practice and reliable outcomes for healthcare.	1	2	3	4	5
6. I know how to describe a pharmacological issue using data generated from practice (assessment).	1	2	3	4	5
7. I believe that I can systematically search for the best evidence to answer clinical questions regarding drugs in a time efficient way.	1	2	3	4	5
8. I understand the language of pharmacology (e.g., MOA, adverse effects, metabolism, etc.)	1	2	3	4	5
9. I believe that learning how to apply pharmacology principles in the clinical setting is an important part of providing nursing care.	1	2	3	4	5
10. I believe that I can identify and overcome barriers to implementing safe medication management.	1	2	3	4	5
11. I am sure that medication management guidelines can improve clinical care	1	2	3	4	5
12. I am sure that I can implement principles of safe medication management in a time efficient way.	1	2	3	4	5
13. I am sure that implementing safe medication management principles will	1	2	3	4	5

improve the care that I deliver to my patients.					
14. I am sure I know how to measure the outcomes of my pharmaceutical care.	1	2	3	4	5
15. I believe that implementing the three checks, the seven rights, and scanning medications takes too much time.	1	2	3	4	5
16. I am sure that I can access the best resources in order to implement safe medication management.	1	2	3	4	5
17. I believe pharmacology is difficult.	1	2	3	4	5
18. I know how to implement safe medication management sufficiently enough to initiate necessary patient-centered changes.	1	2	3	4	5
19. I am confident about my ability to implement safe medication management within my future clinical settings.	1	2	3	4	5
19. I am confident about my ability to implement safe pharmacology principles within my future clinical settings.	1	2	3	4	5
20. I believe the care that I currently deliver in simulation is consistent with safe medication management principles.	1	2	3	4	5

Appendix D

Student Satisfaction and Self-Confidence in Learning

Modified with Permission, Mauldin, 2020

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

1 = NONE AT ALL
2 = NOT MUCH
3 = UNDECIDED – you aren't sure
4 = SOMEWHAT
5 = VERY MUCH

Satisfaction with Current Learning	None	Not Much	Undecided	Somewhat	Very Much
1. To what extent do you believe that the teaching methods used in this course were helpful and effective.					
2. To what extent do you believe that the instructor(s) provided me with a variety of learning materials and activities to promote my learning of pharmacology.					
3. To what extent do you believe that you enjoyed how my instructor taught the course.					
4. To what extent do you believe that the teaching materials used in the course were motivating and helped me learn the content.					
5. To what extent do you believe that the way my instructor(s) presented the content was suitable to the way I learn.					
Self-confidence in Learning					
6. To what extent are you confident that you are mastering the content that my instructors presented to me.					
7. To what extent are you confident that this course covered critical content necessary for the mastery of future clinical placements.					
8. To what extent are you confident that you are obtaining the required knowledge from this course necessary for use in the clinical setting.					
9. To what extent are your instructors using helpful resources to teach the course.					

10. To what extent is it your responsibility as the student to learn what you need to know from this course.					
11. To what extent do you know how to get help if you do not understand the concepts covered in the course.					
12. To what extent do you know how to use course resources to learn critical aspects of the content.					
13. To what extent is it the instructor's responsibility to tell me what you need to learn of the course content.					

Appendix E

Health Professions Motivation to Learn Pharmacology Scale

(Modified from Perrot LJ, Deloney LA, Hastings JK, Savell S, Savidge M. (2001) *Measuring student motivation in health professions' colleges*. Advances in Health Sciences Education: Theory and Practice 6:193-203)

Think back over your last semester. In general, when did you feel most successful?			
	Item	Subscale	Focus
1	When I showed nursing students I was good at using what I learned in pharmacology.	GO	P
2	When a lecture or tutorial made me think about using what I learned in pharmacology.	GO	M
3	When I did almost no work and got away with it.	GO	A
4	When I got a higher grade than other students.	GO	P
5	When I learned something interesting in pharmacology.	GO	M
6	When I showed people that I was smart.	GO	P
7	When something I learned made me want to find out how to use it in pharmacology.	GO	M
8	When I didn't have to work too hard.	GO	A
9	When I was the only one who could answer the lecturer's question.	GO	P
10	When all the tasks and assignments were easy.	GO	A
11	Learned something new about pharmacology.	GO	M
12	Did better than other students in the class.	GO	P
13	Found the work easy.	GO	A
14	Realized you were getting through the course without having to work hard.	GO	A
15	Read something interesting in pharmacology.	GO	M
16	Worked hard in pharmacology.	GO	M
17	Realized you didn't have to prepare for tutorials.	GO	A
18	Worked on a challenging task or assignment in pharmacology.	GO	M
19	Saw improvement in your work in pharmacology.	GO	M
20	Got one of the highest grades in pharmacology.	GO	P
21	Did well without having to work hard in pharmacology.	GO	A
In general, how much do you agree with these statements?			
22	The more challenging the task in pharmacology, the harder I work.	GO	M
v23	If someone is evaluating me, I tend to expect the worst.	GO	P
24	I like to be the best person in my group.	GO	P
25	I am usually worried about what impression I make.	GO	P
26	I'm always thinking of ways to improve how I do things in learning pharmacology.	GO	M
27	Good grades are important to me.	GO	P
28	As long as I pass the course, I don't care about the grade I get.	GO	A
29	I put in long hours of work in pharmacology just to do a good job.	GO	M
30	I feel very upset when I commit some sort of error in pharmacology.	GO	M
31	I like to compete against myself.	GO	M
32	The opinions that important people have of me regarding pharmacology cause me little concern.	GO	M
33	I get anxious when I don't know how I'm doing.	GO	P

34	Lecturers should not expect students to study material that they won't be tested on.	GO	P
35	I am often afraid that I look ridiculous or make a fool of myself.	GO	P
36	As long as you do enough work to pass, it doesn't matter whether or not you learn anything.	GO	A
When you feel greatly satisfied or positive about yourself, was it because you…			
37	Accomplished something that others in your class could not do?	GO	P
38	Understood something in pharmacology for the first time?	GO	M
39	Were involved totally in learning pharmacology?	GO	M
40	Received recognition or prestige?	GO	P
41	Enhanced your status in the group?	GO	P

GO=Goal Orientation Subscale: Focus: P=Performance; M=Mastery; A=Alienation

Appendix F. Chapter 2 Figure

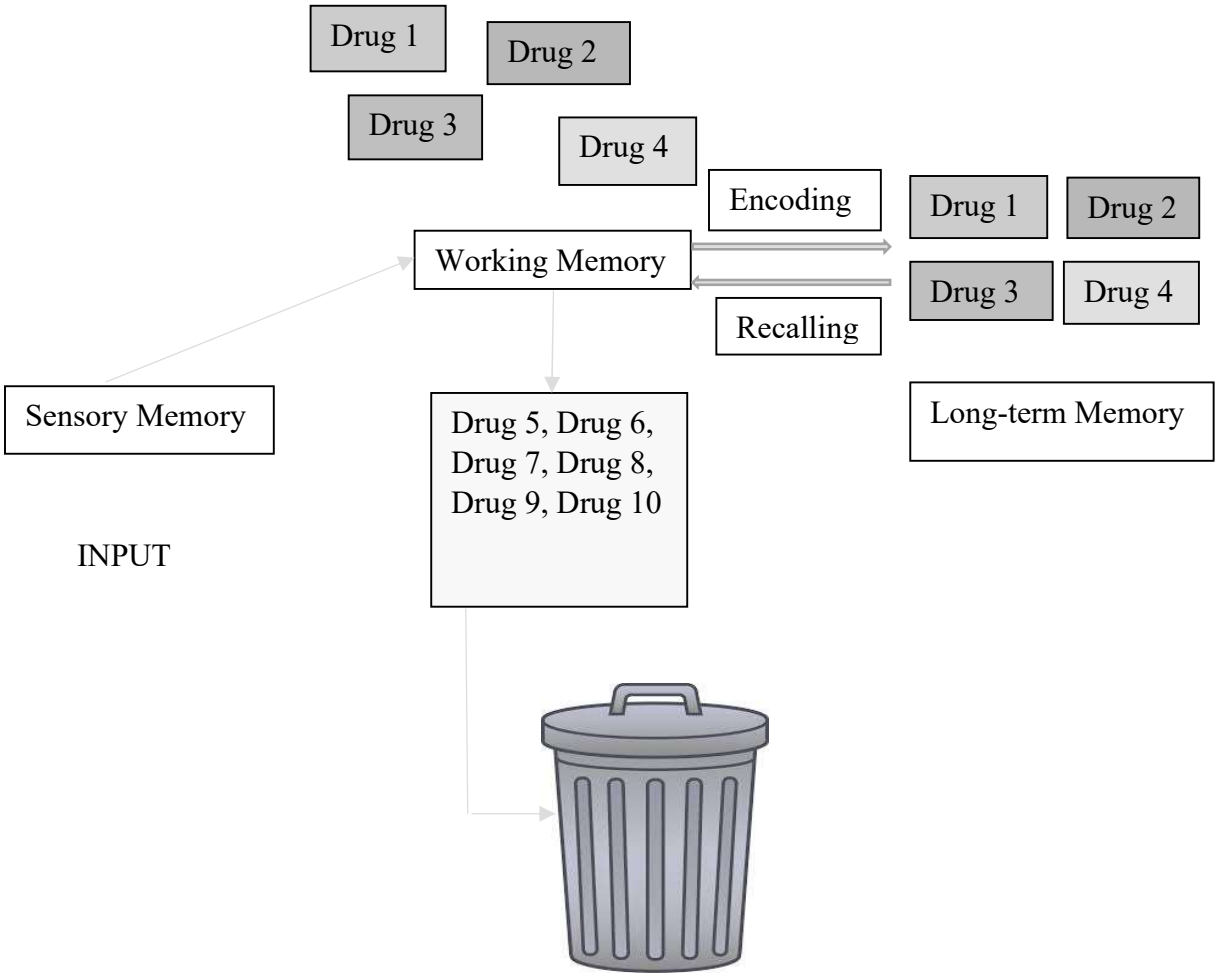

Figure F.1. Cognitive Load Theory in Pharmacology Education

Appendix G. Chapter 4 Figures

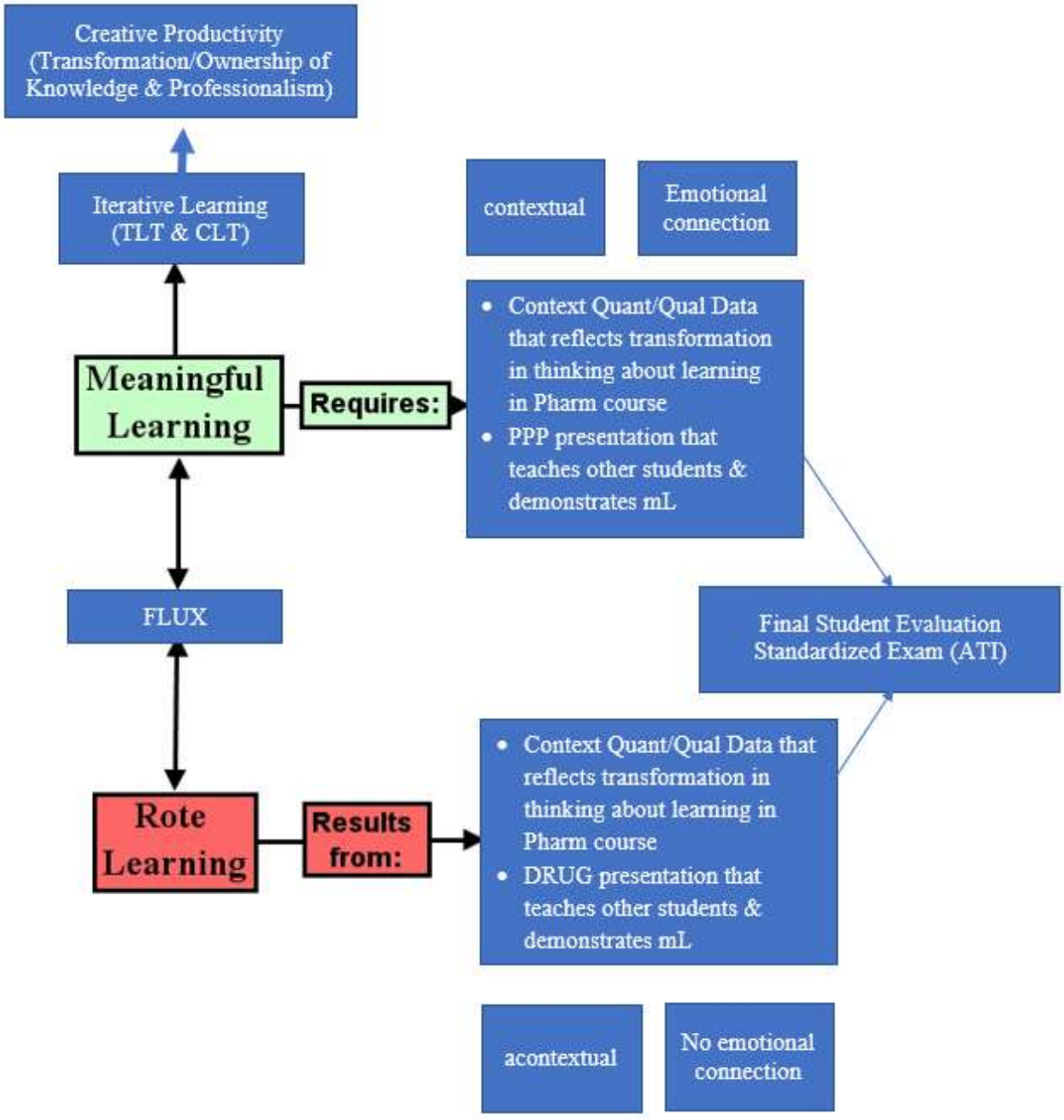

Figure G.1. Meaningful Learning Theory (Modified)

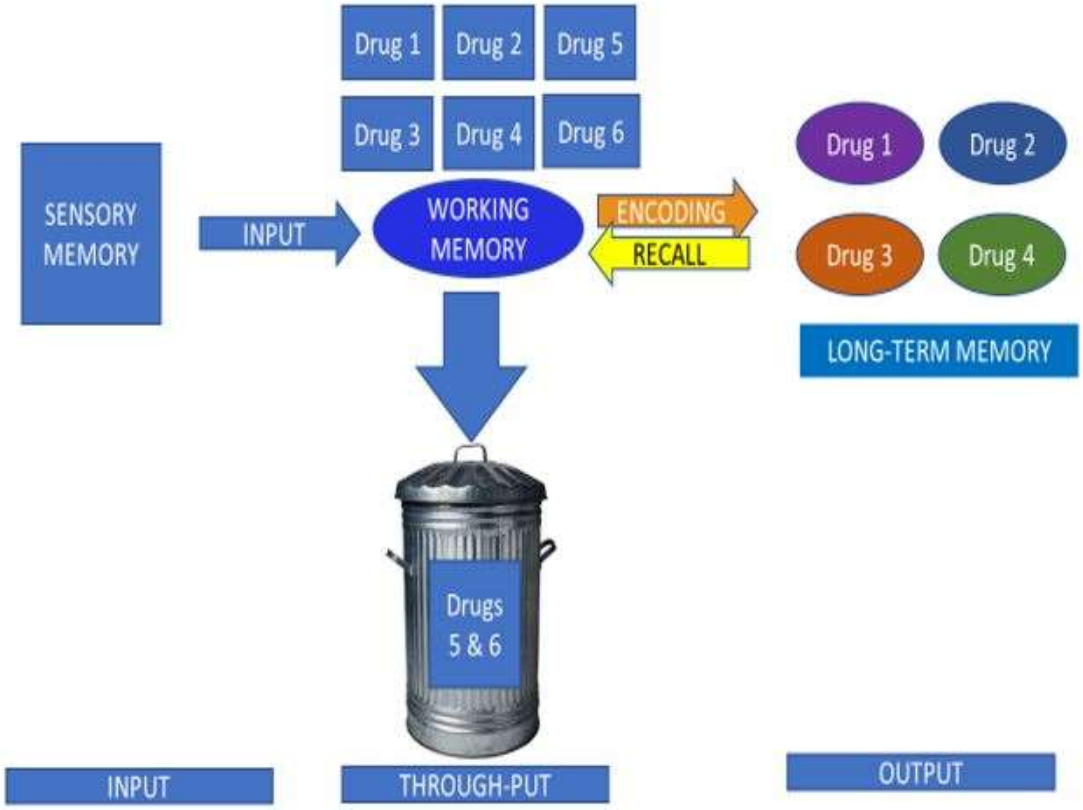

Figure G.2. Cognitive Load Theory

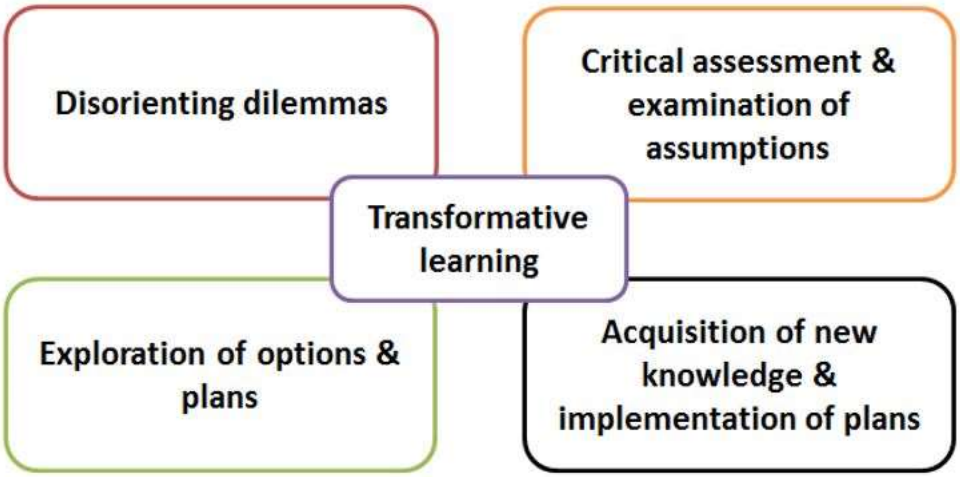

Figure G.3. Transformational Learning Theory

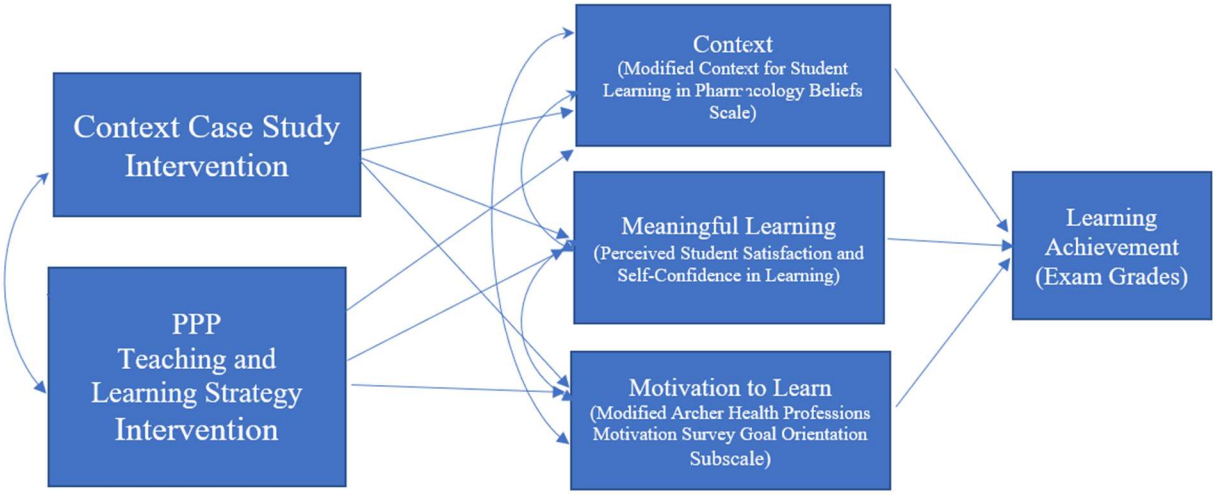

Figure G.4 Model to Guide Study

Appendix H

Approvals & Documents

Form H.1

UT-Tyler Institutional Review Board Approval for Study

The University of Texas at TYLER
Office of Research and Scholarship

INSTITUTIONAL REVIEW BOARD
uttyler.edu/research • 903-565-5858

Dec 16, 2020 5:08:15 PM CST

Dear Betsy Mauldin,

Your request to conduct the study: Impact of theory-based intervention on meaninfulness of undergraduate nursing pharmacology student learning, IRB-FY2021-67 has been approved by The University of Texas at Tyler Institutional Review Board as a study exempt from further IRB review subject to Category 3.(i)(B). Research involving benign behavioral interventions in conjunction with the collection of information from an adult subject through verbal or written responses (including data entry) or audiovisual recording if the subject prospectively agrees to the intervention and information collection.
Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.
. While this approval includes a waiver of signed, written informed consent, please ensure prospective informed consent is provided, if applicable, unless special circumstances are indicated in the approval email. In addition, please ensure that any research assistants are knowledgeable about research ethics and confidentiality, and any co-investigators have completed human protection training within the past three years, and have forwarded their certificates to the Office of Research and Scholarship (research@uttyler.edu).

Please review the UT Tyler IRB Principal Investigator Responsibilities, and acknowledge your understanding of these responsibilities and the following through return of this email to the IRB Chair within one week after receipt of this approval letter:

- Prompt reporting to the UT Tyler IRB of any proposed changes to this research activity.
- **Prompt reporting to the UT Tyler IRB and academic department administration will be done of any unanticipated problems involving risks to subjects or others.**
- Suspension or termination of approval may be done if there is evidence of any serious or continuing noncompliance with Federal Regulations or any aberrations in original proposal.
- Any change in proposal procedures must be promptly reported to the IRB prior to implementing any changes except when necessary to eliminate apparent immediate hazards to the subject.
- Submit Progress Report when study is concluded.

Best of luck in your research and do not hesitate to contact the Office of Research and Scholarship if you need any further assistance.

Sincerely,
University of Texas at Tyler Institutional Review Board

Form H.2

Recruitment Email

Hello! I am a PhD student at the University of Texas at Tyler School of Nursing. I am conducting a study to explore the importance of meaningful learning in nursing pharmacology in the Bachelor of Science in Nursing program. Because you are enrolled in N3307 Pharmacology, I am inviting you to participate in this important pilot study.

Participation in this study will involving engaging in some specific activities related to learning in pharmacology and completion of several online surveys spaced throughout the semester, which should take 5-10 minutes to complete.

There are no anticipated risks for taking part in this study, other than the time to engage the learning activities and to complete the study questionnaire. The surveys will be completed online using surveying software call Qualtrics®. The data submitted to the survey will be password protected and only be accessible to the researcher – faculty will not have access. Only aggregate data will be presented. Once the data are analyzed, the survey data will be purged. No one other than the primary researcher (me) will know if you completed the survey. Your choice to participate in this study or not participate will in no way affect your standing with the University of Texas at Tyler nor your grade.

A potential benefit may be exercising your autonomy and taking an active role in potentially improving nursing pharmacology for future students. Knowledge gained from this study may enhance the ability of nursing faculty to improve the delivery of pharmacology.

If you agree to participate, please click on the "I agree to participate" link below to be taken to the online questionnaire. The questionnaire will take approximately 10 minutes to complete. Once you complete the survey and select SUBMIT, your participation in the study is

verified. Once data are submitted, they cannot be removed. By completing the survey (submitting it), you are consenting to participate in the survey.

[URL was inserted].

Contact information:

If you have concerns or questions about this research study, you can call Betsy Mauldin, principal investigator for the study at 512.422.4407.

If you have questions about your rights as a research subject, you can call the UT Tyler Institutional Review Board at 903.565.5858, or email at research@uttyler.edu.

Thank you!

Appendix I

Biographical Sketch

BIOGRAPHICAL SKETCH

NAME: Betsy Mauldin, MSN, MBS, RN, CMSRN, PhD (c)

eRA COMMONS USER NAME: N/A

POSITION TITLE: Clinical Assistant Professor

EDUCATION/TRAINING

INSTITUTION AND LOCATION		DEGREE	Completion Date	FIELD OF STUDY
Oral Roberts University	Tulsa, OK	BS	5/1982	Biology/Chemistry
Oral Roberts University	Tulsa, OK	MBS	5/1984	Biomedical Science
Texas Tech University	Lubbock, TX	BSN	12/2015	Nursing
Angelo State University	San Angelo, TX	MSN	8/2018	Nursing
University of Texas at Tyler	Tyler, TX	PhD(c)	Exp. 11/2021	Nursing

A. Personal Statement

I am a Clinical Assistant Professor in the College of Nursing at Texas A&M University, and my current research is focused on innovative teaching and learning strategies in nursing education. I have a broad background in the basic sciences with extensive training and expertise in pharmacology. My doctoral research examined factors contributing to meaningful learning in nursing pharmacology. Interventions were designed using the cognitive load theory, transformational learning theory, and meaningful learning theory. Students' beliefs about pharmacological care, satisfaction and self-confidence in learning, and motivation to learn were quantified and analyzed. Post-doctoral research plans include examining variables generically (e.g., not in pharmacology) and further describing their relationships in a research model, as well as following the study participants one year hence to determine whether pharmacology knowledge persisted into long-term memory as purported in the dissertation study.

B. Positions and Honors

Positions

2018 – present	Clinical Assistant Professor, Texas A&M College of Nursing
2016 – 2019	Staff Nurse, Baylor Scott & White Medical Center, Round Rock
2010 – 2015	Pharmaceutical Sales Specialist, AstraZeneca, Austin, TX
2005 – 2010	Professional Sales Specialist, Schering-Plough, Austin, TX
2002 – 2005	Business Manager, Bristol-Myers Squibb, Austin, TX
2002 – 2010	Faculty, LeTourneau University, Austin, TX
1988 – 2002	District Manager, Merck & Co., Inc., Austin, TX
1986 – 1988	Territory Manager, Fujisawa SmithKline, Tulsa, OK
1984 – 1986	Research Technologist, Children's Medical Center, Tulsa, OK

Honors

2020	Outstanding Graduate Poster Presentation, UT-Tyler Lyceum
2018	Outstanding Graduate Student/Nurse Educator, ASU
2015	Excellence in Nursing Award, Texas Tech University

C. Contributions to Science

1. My earliest contribution to scientific research involved describing conditions for maximum enflagellation in *Naegleria fowleri*, the ameba which causes primary amebic meningoencephalitis; this infection is nearly always fatal. While the pathogen is ubiquitous in freshwater sources, it is rarely infective so conditions for pathogenicity need to be described. It is postulated that the flagellate form of the ameba is the infectious stage and therefore understanding conditions resulting in this form may be instructive to preventing infection.
    a. Cable, B. & John, D. (1986). Conditions for maximum enflagellation in *Naegleria fowleri*. *Journal of Protozoology, 33*, 467-472.

2. In nursing pharmacology education, I crafted an assignment utilizing the tenets of the cognitive load theory in order to promote effective mental processing and storage into long-term memory. In the Pharmacology Phamily Project, students were challenged with creating a case study utilizing a multi-media presentation which was viewed and critiqued by peers in order to create a lasting memory of the medication and its utility.
    a. Mauldin, B. (2021). A novel teaching strategy in nursing pharmacology: Learning using cognitive load theory. *Nursing Education Perspectives*. Advance online publication. https://doi.org/10.1097/01.NEP.000000000000814

3. Nursing students present with a variety of experiences within the healthcare milieu which shape their context of their nursing education. Some have a great deal of experience (e.g., licensed vocational nurses, paramedics, respiratory therapists, patient care technicians), and some have only an idealized notion of what it is to be a nurse. This context can impact how a nursing student approaches their education. In order to interject a practical context for pharmacology nursing students (typically taken prior to clinical classes), an unfolding case study was introduced early in the semester of a nursing pharmacology course to introduce the "why" do I need to know this complex information.
    a. Mauldin, B. (in press). Bringing clinical context to the classroom in nursing pharmacology: A case study. *Nursing Education Perspectives*.

D. Additional Information: Research Support and/or Scholastic Performance

Nursing GPA (pre-requisites, BSN, MSN, PhD): 4.0/4.0