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# Effect of Delivery Method on Nursing Students' Math Competency and Learning Perceptions

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Abstract

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MSN, University of Phoenix, 2005

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

The delivery method of a math course may affect the math scores of nursing students, which relates to rates of medication errors that could be fatal. The purpose of this study was to discover the relative effectiveness of a delivery method of a math course. Benner's novice-to-expert theory guided the study. A sequential explanatory, mixed-methods, nonexperimental pre-/posttest alternative treatment design was used. Phase 1 answered which delivery methods—online self-directed, face-to-face, or a mix of online self-directed with instructor lead—were associated with the best Medication Administration Competency exam results. Phase 2 included students' assessment of each learning method. The sample size was 148 students who were admitted to 1 nursing school between 2011 and 2013. The data were collected from 4 sources: (a) archival standardized entrance exam math scores, (b) archival standardized exit exam math scores, (c) a qualitative survey regarding student perceptions of the delivery method, and (d) a qualitative section of the same survey with math questions. The ANCOVA analysis showed no statistically significant difference in the delivery method used. Students with lower pretest exam scores took the posttest exam more times and also had lower posttest grades. The content analysis showed that students from all 3 groups did not see an advantage in the delivery method, but in certain teaching strategies that support learning. Therefore, the nursing school should continue to allow students to select their preferred delivery method, or offer fewer methods as they were equivalent. Positive change could come from using teaching strategies that students valued, improving their ability to provide correct dosages and increasing patient safety in the healthcare environment.

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Section 1: Introduction to the Study

## Introduction

Medication errors are a national concern in the United States (Department of Health, 2004, 2012; McMullan, Jones, & Lea, 2011; Potter, Perry, Stockert, & Hall, 2013; Ridling, Christensen, Harder, Gove, & Gore, 2015; Wright, 2007). Over a 1-year period, "9.7% of the 1,378 allegations against nurses concerned drug errors second only to the 12.3% of complaints relating to patient or client abuse" (Snow, 2007, p. 12). The numbers are overwhelming: Every year, injuries by medical errors affect 1.5 million people in the United States and cost $3.5 million (Department of Health, 2004, 2012; Kim & Bates, 2013). The National Coordinating Council for Medication Error and Reporting and Prevention (2012) estimated 98,000 people die each year from medical errors and 44% of those errors were medication errors. According to Tzeng, Yin, and Schneider (2013), medications potentially cause harm and account for 15% of the errors in hospitals. A potentially fatal reaction can occur from a misplaced decimal point, incorrect calculation, and a tenfold dosing error (Coben & Weeks, 2014; Tzeng et al., 2013). All of these disabling injuries and deaths are preventable.

Accurate medication dosage calculation is a skill that must be demonstrated by the student nurse in order to safely and effectively administer drugs. A student nurse's lack of math skills could be lethal (Kim & Bates, 2013; Mackie & Bruce, 2016; Potter, Perry, Stockert, & Hall, 2013; Polifroni, McNulty, & Allchin, 2003; Revell & McCurry, 2013). Even when calculators have been used to see if this would decrease errors (Brown,

2006), some nursing students were unable to pass the medication competency exam. Computation is not the problem, since calculator use did not help students obtain the correct answer. Revell and McCurry (2013) found similar results that there were no significant differences in nursing students' math scores with the use of computers/online learning. Sulosaari et al. (2015), using 328 nursing students, found a mean score of 72% for correct answers on a knowledge exam, even with the use of calculators. Maag (2004) studied a 1-hour multimedia presentation with nursing students learning medication math and found the presentation did not offer any significant improvement. Revell and McCurry (2013) felt the results found in the literature were mixed regarding the various strategies used with nursing students learning math. According to Townsend (1991), nursing students using computer-assisted instruction received higher scores than those who used the traditional lecture math course.

The delivery method may be affecting nursing students' processing style, and, according to Kelly and Colby (2003), could make a difference in the retention of math skills. Three delivery methods were examined: online self-directed (distance learning), face to face (traditional learning), or a mix of online self-directed with instructor lead class (hybrid learning).

In Section 1, I will discuss in more detail the problem of mathematical skills of nursing students, research questions, and the nature and purpose of the study. I will review the theoretical perspective, define terms, and state the assumptions, limitations,

scope, and delimitations of the study. The significance of the study and a summary will conclude the section.

## Problem Statement

There is great concern among health care agencies to validate the mathematical skills of nursing students for medication administration. Polifroni et al. (2003), Granados (2013), and Mackie and Bruce (2016) recommended setting the standard at or near 100% accuracy in math exams for the administration of medications. This standard could decrease the number of errors nursing students make now and later as professional licensed nurses. Several researchers examined medication errors and stated large drug calculation errors due to poor drug math skills are a part of the medication errors (Granados, 2013; McMullan et al., 2010, 2011; Revell & McCurry, 2013; Wilson, 2003). Additional reports also indicate errors in calculation of the medication dosages, which is still a problem existing today in the United States and is an international problem in the nursing profession (McMullan et al., 2010, 2011; Revell & McCurry, 2013; Tzeng et al., 2013).

According to Brown (2006), nursing students using calculators were unable to pass a medication competency exam with an 85% score and the main error was calculation, which is preventable. Brown also found that, as long as nursing students were dealing with addition, subtraction, multiplication, and division of whole numbers, the students were able to calculate correctly. The author reported, when working with fractions, decimals, and percentages, the students' average range of correct answers was

38% to 97%, with more than half of the nursing students scoring below the 70% score mark. Sulosaari et al. (2015) found 72% of students could not pass the first math exam and as many as 74% of nursing students were unable to pass the Medication Administration Competency (MAC) exam. The authors reported 64% of the students had failed a MAC at least once with 20% of them using additional math courses. Ashby (1997) found 56.4% ($N = 100$) of medical surgical nurses could not solve 90% of the competency math problems. Therefore, computation is not the problem; there must be something else causing nursing student errors in math. The question remains, if the exam scores would be affected by the delivery method of the course.

There may be a connection between performance on the MAC exams and the delivery method used in the math classes taken by the students. According to Kelly and Colby (2003), the delivery method used may make a difference for students' knowledge to be retained because the delivery method may be a barrier to a student's processing style. Kelly and Colby asserted if students follow step-by-step instructions in a traditional learning setting and they come to the correct solution, it does not mean the student truly understands the process or concept. Many nursing students believe they understand this process until the medication administration exam is administered and they fail. Kelly and Colby indicated the problem may be more than just the delivery method used, the process and concepts may be a problem as well. Wells and Dellinger (2011) stated, even with the increased use of online learning, hybrids, or distance learning, studies conducted thus far are mixed in regard to the effectiveness of the traditional classroom instruction format.

Billings and Halstead (2012) agreed study results regarding effective delivery methods remain mixed and may not influence student learning.

Mackie and Bruce (2016) agreed with Brown (2006) calculation is still one of the main problems with nursing students' math skills, but felt that the use of online learning may change the outcome of that learning. Timpke and Janney (1981) found positive outcomes with the use of computer-assisted instruction (CAI). Thirty-two nursing students used the CAI method, and all 32 passed the mastery of the medication administration exam on the first attempt. The control group of 28 students used traditional means of learning and only 17 passed the medication exam on the first attempt. Mayer and Sims (1994) studied a multimedia-type presentation, which included animations and narrations, and found math exams were more successful, with than without the multimedia presentations. Revell and McCurry (2013) found there were no differences in the learning and test results. . Tariq and Durrani's (2011) examined students' perceptions of their math competence, less than half felt competent and 75% failed the exam.

Maag (2004) used 56 nursing students and 56 non-nursing students in the study. The algebraic test used had a reliability of $r = .82$, it is significate in that the exam is reliable to test what it is suppose test and did so each time. According to Maag only 18% of the nursing student passed the exam; passing was seen as 70% or higher. The differences between the nursing and non-nursing student's exam results were insignificant. According to Maag (2004), the students agreed personal knowledge level

and ability to perform the medication math had increased with the use of CAI. Maag's evidence after administering a treatment of 1-hour multimedia presentation about math to nursing students did not support any significant improvement; which indicates a 1-hour intervention is not the answer.

Granados (2013) found similar results. The Author's, the attempt to compare Internet-based learning with other modes of delivery also reported outcome of a lack of significant difference in math scores. Granados (2013) found that there is no difference in the math scores as they related to the use of multimedia or textbooks. According to Timpke and Janney (1981), as well as Boling, Huogh, Saleem, and Stevens, (2012) additional research may be needed regarding a multimodal online learning format over longer periods of time. The use of an online program for math material could be used to obtain the same pass rate or cognitive outcomes as a traditional classroom (Boling et al., 2012). Boling et al. (2012) also found students preferred online tutorials for delivery of math content, but stated future research may need to include student perceptions through surveys and focus groups or interviews in order to determine which instruction delivery method is best for the math course for a given nursing curriculum. Agreeing with the authors was Revell and McCurry (2013) who stated there is no difference with the delivery method used for nursing students in the cognitive outcome regarding a math course. Simon, Jackson, and Maxwell (2013) found 97% of students felt comfortable using computers and technology but that 33% reported not being as familiar with the use of online tools in a learning management system. Many of these students, about 52%,

preferred that online technology not be used, even if used to develop a hybrid course. Nursing educators need to examine the teaching strategy trends, the complexity of delivery methods for courses, and admission skills of new students to meet educational demands (Billings & Halstead, 2012; Billings & Phillips, 2007; Mancuso-Murphy, 2007; Ni, 2013; Revell &: McCurry, 2013).

One scrutinized skill is the math ability of student nurses and the need to be proficient in math. Math skills are essential to providing safe and effective patient care in medication administration; however, the math skills of nursing students vary in ability, as indicated in some of the research literature (Mackie & Bruce, 2016; Granados, 2013; Wright, 2007). Brown (2006) and Polifroni et al. (2003) indicated nurse educators should not assume a nursing student's math ability and medication administrating skills are adequate, even if transcripts indicate math was taken in high school. Mackie and Bruce (2016) agreed. A student nurse's lack of math skills could lead to unsafe healthcare environments: Math skills and critical thinking are used to administer medications; many of these medications could be lethal to the healthcare consumer if the calculations are inaccurate (Mackie & Bruce, 2016; Polifoni et al., 2003).

Currently, published research "offering substantive solutions for the mathematical under-prepared nursing student" is limited (Brown, 2006, p. 99), although numerous researchers have implemented various strategies to address the math skill deficit (Billings & Halstead, 2009, 2012; Revell & McCurry, 2013; Wilson, 2003). Many of the research studies regarding teaching methods and student outcomes are quantitative studies or

qualitative studies only (Billings, 2005, 2007; Billings & Halstead, 2012; Billings & Kowalski, 2005; Brown, 2006; Heise & Himes, 2010; Newton, Harris, Pittilgio, & Moore, 2009; Phillips & Billings, 2007; Revell & McCurry, 2013; Walsh, 2006; Wright, 2007). Billings and Kowalski (2004, 2005) found, in order to address the many learning styles and cultures, nurse educators need to use technologies to support the learning process and assist nursing students in meeting the competencies and learning outcomes. Billings and Halstead (2012), as well as Phillips and Billings (2007), found webcasts were another option for potential use in an online mobile environment. Webcasts have a potential in the traditional classroom, and may also meet the online learning needs and desired learning outcomes of students. These studies were qualitative research designs and used surveys to understand students' perceptions. Creedy et al.'s (2007) findings were consistent with other studies, as a significant number of nursing students (60%) had no or very little informational technology (IT) ability; thus, the students were not satisfied that the delivery method met learning needs. Creedy et al. concluded the online delivery method was not the best choice. However, by the time students completed nursing school, 61% of students reported feeling comfortable with computer usage in an online environment (Creedy et al., 2007).

## Research Questions

The problem I addressed in this study was that it is unknown which of three delivery methods (online, traditional, and hybrid) used to deliver the clinical math course

for pre-license nursing students brings about the best MAC exam results. The research questions that I used to answer this problem are as follows:

1. Is there a significant difference among the three delivery methods as associated with the passing grade for MAC?
2. Is there a significant difference among the three delivery methods as far as the number of times the MAC exam is taken?
3. How do the nursing students assess the value of each delivery method?

The need exists to understand the relationship between the teaching delivery method used and the students' perceptions of the teaching delivery methods. Phase 1, using quantitative analysis answered Question 1 and 2. Phase 2, using qualitative analysis, answered Question 3.

## Nature of the Study

In this study, I explained the relationships and comparisons of delivery methods used to convey math skills and the perception of nursing students. I was seeking the best practice delivery method for clinical medication math skills education. This sequential explanatory, mixed-methods, nonexperimental pre-/posttest alternative treatment research study assisted in understanding the effect that a math delivery method had on nursing students abilities to pass math competencies and decrease medication errors. Furthermore, I evaluated three delivery methods (traditional, online, and hybrid) used to teach student nurses math skills. Students' perceptions of the math course, to meet the

learning needs and to pass the MAC exam were evaluated. Additional detail about the study methodology appears in Section 3.

## Purpose of the Study

The purpose of this sequential explanatory, mixed-methods, nonexperimental, pre-/posttest, alternative treatment design was to discover which of three delivery methods (online, traditional, or hybrid) of math instruction for pre-license nursing students elicited the best outcome. The first phase, quantitative research, addressed the MAC exam scores relationships and comparisons to the three delivery methods to examine which delivery method resulted in the best outcome of passing scores. The data for the first phase were kept in the Midwestern school of nursing's archived database.

The second, qualitative, phase employed an open-question survey in SurveyMonkey, deployed to nine individual students; three from each of the three delivery methods: traditional, online, and hybrid. The questionnaire's purpose was to explore the participants' views regarding learning needs being met, barriers affecting test performance, and the delivery method used. The intent of using participants' perceptions is to support the quantitative data results, explain any differences between the three delivery methods, and to find any similarities or differences between quantitative and qualitative data results. I also sought to find any differences or similarities between the perceptions of the students and the quantitative results. The results of the study may have an effect on how math programs are instituted within schools of nursing.

## Theoretical Perspective

In this study, I used the novice to expert theory (Benner, 1984) as a foundation. Benner (1984) espoused skill acquisition needs to be founded in experience and sound education. Hubert and Dreyfus's (1980) theory of skill acquisition proposes a learner goes through five different phases of learning proficiency: novice, advanced beginner, competent, proficient, and expert. Benner used Hubert and Dreyfus's theory of skill acquisition to apply learning of skills in the nursing field. According to Benner, learners gain skills over time with practice and experience, moving from dependent, novice learner (pedagogy) to experienced learner (andragogy); to which meeting both types of learner needs is possible via the hybrid course delivery method.

Another theoretical support for this study came from the concepts of pedagogy and andragogy theories. Many theorists (Bruner, 1960; Dewey, 1916; Merriam, Caffarella, & Baumgartner, 2007; Vygotsky, 1962) developed the concept of pedagogy; whereas, Knowles (1973, 1978, 1984, 1990; Merriam et al., 2007) developed the concept of andragogy. According to Knowles, Holton, and Swanson (1998), pedagogy was developed in monastic schools preparing boys and men for the priesthood in the seventh century. Andragogy has a similar beginning when a German grammar school instructor, Alexander Kapp, used the term to explain Plato's teaching method to students (as cited in Ozuah, 2005). Later, according to Ozuah (2005), Eduard C. Lindeman further developed the andragogy theory and Malcolm Knowles contributed to this theory with the development of adult learner theories (Knowles et al., 1998).

The pedagogical model is a teacher-centered model because it states that the learner is dependent upon the instructor (Heise, & Himes, 2010; Knowles et al., 1998; Merriam, et al., 2007). This structure is similar to the novice learner needs stated in Benner's (1984) theory, where the novice may not know their own learning needs and the material learned in a subject format such as math, history, or reading (Knowles et al., 1998). The pedagogical model also posits the learner may be motivated to learn by external incentives such as prizes, grades, and punitive measures (Knowles et al., 1998). Knowles (1990) also made the assumption that the pedagogical learner does not have many prior experiences, did not play a part in the learning process, and thus, needed the teacher-lead type format; this is similar to Benner's (1984) novice. Thus, the teacher develops the what, how, and when of a concept, and determines the degree of learned content after the instruction occurred.

Andragogy, put forth by Knowles et al. (1998) and Heise and Himes (2010), is a more student-centered model. Andragogy assumes the adult learner needs to know how and why the information is important for him or her to learn and the instructor's responsibility is to divulge that information (Knowles et al., 1998; Ozuah, 2005). Ozuah (2005) and Knowles et al. share the opinion, the learner wants control of when and how information is learned. This concept gave rise to the idea of self-directed learning, such as online-distance-type classes (Billings & Halstead, 2012; Bower & Hollister, 1967; Erikson, 1964). ). Knowles et al. assumed adult learners come with prior experiences in learning information, such as Benner's (1984) expert learner, and may know their own

learning style needs. Thus, there is a need for the instructor to use live or real experiential learning such as simulation, internships, on-site clinicals, and case studies. Increasing problem-life-centered tasks to meet the adult learners' need to know assumption and the need to be able to deal with those life events from what is learned is appropriate. According to Ozuah and Knowles et al., the adult learner is pushed to learn due to internalized motivations with the need to complete a goal and/or elevate their self-esteem.

Ozuah (2005) and Knowles et al. (1998) found that pedagogy may be appropriate in some learning situations where the student is a dependent learner and may have no prior experiences on which to base their new knowledge. On the other hand, the student may gradually move from dependent learning to adult learning and, thus, increase autonomy and self-direction (Benner, 1984; Merriam et al., 2007; Ozuah, 2005). The idea of a student transitioning from a dependent learner to an independent learner (pedagogy to andragogy) is similar to Benner's (1984) novice to expert theory of the stages the learner moves through in the nursing field. Benner and also Knowles (1989) discussed various learners at different stages and the needs of each learner. The instructor working with learners from each stage in the same course may find that the hybrid delivery method may be best to use for the clinical math course in order to meet the needs of each learner.

The novice learner (Stage 1) in the nursing field would be a student nurse, one who has very little experience or exposure in understanding the skills needed for safe performance. Nursing students in this phase are striving to gain some experience and

work on principles or rules that guide the learning. Student nurses performing clinical math calculation at this phase find the need to follow a step-by-step procedure or sometimes referenced as a formula/procedure used to calculate (Benner, 1984). Thus, a more concrete or teacher directed learning such as the pedagogical theory (Heise & Himes, 2010) would be appropriate. In this situation, the learner is dependent on the instructor to guide the learning (Billings & Halstead, 2012; Merriam et al., 2007).

The advanced beginner (Stage 2) in this phase has gained a marginal amount of experience and can see there are more aspects to a situation (Benner, 1984). A nursing student in this phase can see more than one method is available to set up a math problem and/or perform short cuts. The student in this phase only uses one method and is not sure as to how to use the other methods or does not have any experience in using the other methods. Thus, this student is still a concrete learner of a teacher directed learning experience as in the pedagogical theory (Heise & Himes, 2010; Merriam et al., 2007). The learner is still dependent on the instructor to guide the learning but may be starting to transition to a more adult learning style (Billings & Halstead, 2012; Knowles et al., 1998; Merriam et al., 2007; Ozuah, 2005).

In the competence phase (Stage3), the student nurse has an increased level of understanding due to experience in the same situation. In the competence phase, students examine the problem's characteristics and deliberately choose a plan to solve the problem. The student also learns which parts are needed to best solve the problem and which ones can be ignored (Benner, 1984; Billings & Halstead, 2012; Merriam et al.,

2007). Nursing students in this case are able to set up the math problem, choose which information is important, and choose the method needed to solve the problem. According to Benner (1984), the student has increased their problem solving ability, gained insight, and increased their level of performance and proficiency. Thus, this learner is transitioning from a teacher directed learning style, as in the pedagogical theory (Billings & Halstead, 2012; Heise & Himes, 2010; Merriam et al., 2007) toward andragogical learning, such as student directed (Billings & Halstead, 2012; Knowles et al., 1998; Merriam et al., 2007 Ozuah, 2005).

The proficient (Stage 4) is where the student nurse now learns from past experiences and anticipates what to expect when a given situation arises. The student then modifies the plan as needed to solve the medication math issue as a response to the event and views the event as a whole situation (Benner, 1984; Billings & Halstead, 2012; Merriam et al., 2007). This new understanding as a whole improves the student nurse's decision making process and making the decision as to which system to use to solve the math problem less difficult. Thus, this learner has transitioned to the andragogical learner (adult learner; Billings & Halstead, 2012; Knowles et al., 1998; Merriam et al., 2007; Ozuah, 2005). Understanding student progression could fit very well in designing a course to meet the various stages in which the learner progresses.

Today's students have diverse learning needs to consider when determining how a course is delivered (Billings & Halstead, 2012; Merriam et al., 2007). Determining student learning needs and the best delivery method (traditional, online, or hybrid) to

meet those student needs within a course is appropriate for the nurse educator to contemplate.

According to Livingston and Condie (2010), student's preferred using e-learning, no matter if they in the classroom or using distance learning. Students selected e-learning due to wanting control of learning at their pace and in their own choice of environments; thus, e-learning enabled personalization of the learning to meet their needs. Further, e-learning is a move to self-regulated learning with the use of self-assessments to meet goals. Therefore, this student becomes more of an adult learner as Ozuah (2005) and Knowles et al. (1998) described. The hybrid course delivery method is a blended format using textbooks, e-learning (online), and traditional in the classroom options that may fit all learning styles. The hybrid course delivery method would work for what was termed as the transitional student who is moving from pedagogy to andragogy learning (Billings & Halstead, 2012; Heise & Himes, 2010; Merriam et al., 2007) who needs the classroom structure but still wants to make some choices to how the learning takes place. Some students need a more structured learning environment where they are face-to-face in a classroom with an instructor leading the learning, such as in pedagogy learning (Heise & Himes, 2010; Billings & Halstead, 2012; Merriam et al., 2007). This method best fits the student who does not have as much experience in learning or has encountered a new subject. The novice learner could conceivably move from pedagogy to andragogy and back depending upon the subject, the experience with the subject, and the learners' needs (Billings & Halstead, 2012; Heise, & Himes, 2010; Merriam et al., 2007). Therefore, the

traditional classroom may meet the pedagogy learners' needs and the online classroom may meet the adult learner's needs. The hybrid classroom would meet transitioning students' needs**;** but, also may assist in skill acquisitions for all learner types (Billings & Halstead, 2012; Heise, & Himes, 2010; Merriam et al., 2007).

Benner's (1980, 1981) model of skill acquisition, adapted from Hubert and Dreyfus's (1980) theory, was selected as the theoretical background for this study because student nurses need to progress through different stages of learning and clinical medication calculation skills need to be accurate and learned over time (Billings & Halstead, 2012; Merriam et al., 2007). The student needs room to grow and change from one stage to the next. The delivery method used for the course needs to match each of these stages to assist in promoting learner growth (Billings & Halstead, 2012; Merriam et al., 2007).

The novice to expert theory with pedagogy and andragogy components could, when applied to this study, mean the independent variables of traditional classroom, online classroom, and hybrid classroom will explain dependent variable results of the MAC and the student nurse's learning perception. Then Benner's (1980, 1981) theory would mean the traditional delivery method of a math course is more of a pedagogical format for the novice student. The online delivery method is more of an andragogical format for the expert student with experience, and the hybrid delivery method could be applied or used for all learner styles, including the transitional learner (Benner, 1984; Merriam et al., 2007; Ozuah, 2005).

## Definition of Terms

*Clinical medication math*: Nursing clinical medication math uses metric, apothecary, and household systems of measure with basic math skills to calculate medication dosages. These skills involve converting Roman and Arabic numerals, multiplying, dividing fractions and decimals, and using "six methods for calculating drug dosages: basic formula, ratio-proportion, fractional equation, dimensional analysis, body weight and body surface area" (Kee, Marshall, Woods, & Forrester, 2017, p. vii) to decide medication dosages. The nurse must have knowledge of these and conversions within and between the three systems of measurement to accurately calculate prescribed medication dosages (Kee & Marshall, 2009, 2013; Potter & Perry, 2009; Potter, Perry, Stockert, & Hall, 2013).

*Conceptual skills*: The ability to form understanding and the setting up of the problem to be solved and to understand the process underlying the solution (Kelly & Colby, 2003; Stes, Coertjens, & Van Petegem, 2010).

*Critical thinking in nursing field*: Critical thinking is a disciplined, intellectual process of applying clinical knowledge. Nursing professionals understand critical thinking as a judgment and the capability to think in organized, methodical, and consistent manner. Critical thinking is used to create a safe environment for healthcare consumers. The nursing professional follows a standard and is required to be proficient in applying quality care that comes from using critical thinking (Potter & Perry, 2009; Potter et al., 2013).

*Dimensional analysis*: A calculation method referenced as the factor-label method, unit factor method, or units and conversions (Kee & Marshall, 2009, 2013). A technique used to process units, manipulate units, to eliminate or cancel unwanted units. Dimensional analysis is a common-sense approach eliminating a need to memorize a formula. Advantages include the decreased number of steps required to calculate a drug dosage and ease of equation set up (Kee & Marshall, 2009, 2013).

*Drug*: Any substance used to modify body functions, which may or may not be therapeutic (Kee & Marshall, 2009, 2013; Potter et al., 2013).

*Health Education Systems, Inc. (HESI) exam*: The HESI exam is a testing system used by nursing programs to determine incoming student competences. . The HESI exams are standardized tests used by schools to compare results with other like or non-like schools across the United States (HESI, 2012).

*Hybrid teaching delivery*: Hybrid teaching is a combination of the traditional and online teaching methods. The students and instructor would meet in a traditional classroom for some activities and use online assignments to facilitate the learning of concepts. The students would have received feedback on assignments before coming to the classroom to clarify or solve misunderstandings of concepts (Billings & Halstead, 2009, 2012).

*Medication*: Any drug or substance used for its therapeutic effect in the human body (Kee & Marshall, 2009, 2013; Potter & Perry, 2009; Potter et al., 2013).

*Medication Administration Competency (MAC) exam*: Passing this exam is a requirement for all nursing students. Each MAC is developed by the school and administered to the student. It contains minimum requirements and a knowledge base of clinical calculations, (i.e., nonparenteral, parenteral, and topical medications) for the undergrad nursing student. Each school sets its own passing score. Comprehension of the math skills is the goal in teaching medication administration and, thus, is defined as the understanding of the skills and their use in medication administration, as a part of required nursing courses (Kee & Marshall, 2009, 2013).

*Medication errors*: According to National Coordinating Council for Medication Error and Reporting and Prevention [NCCMERP] (2008) any medication mistake that is preventable can be interpreted as wrongful medication use or causes a patient injury while administered by a healthcare professional, patient, or consumer is called a medication error. The error may be associated with any of the following nursing function areas of "professional practice, healthcare products, procedures and systems, prescribing, communication, labeling, packaging and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use" (National Coordinating Council for Medication Error and Reporting and Prevention [NCCMERP], 2008).

*Nonparenteral*: Medication that is administered via alimentary canal, topically, mucosal/buccal, and into the ear or eye, and or nose. Medication that is not delivered intravenous, subcutaneous, or intramuscular is nonparenteral medication (Kee & Marshall, 2009, 2013; Potter & Perry, 2009; Potter et al., 2013).

*Online teaching delivery:* Online teaching can be considered a type of formal learning, where students and instructor, via the use of technology (e.g., a computer), use chat rooms and emails to exchange knowledge and do not meet in person. Some online classrooms use a learning management system that creates online learning materials, classrooms, whiteboards, chat rooms, discussion boards, and drop boxes for assignments. Students can attend synchronously or asynchronously with other students and instructors within the online classroom (Billings & Halstead, 2009, 2012; Merriam et al., 2007).

*Outcome/Goal*: Any result or consequence in response, i.e., tests results, which may or may not be favorable (Kee & Marshall, 2009, 2013; Potter & Perry, 2009; Potter, et al., 2013).

*Parenteral*: Medication administered via intravenous, subcutaneous, and intramuscular routes (Kee & Marshall, 2009, 2013; Potter & Perry, 2009; Potter et al., 2013).

*Traditional teaching delivery*: Traditional teaching sometimes referred as formal education (face to face): takes place in a classroom with students and educators present (Billings & Halstead, 2009, 2012).

## Assumptions, Limitations, Scope, and Delimitations

### Assumptions

I identified three assumptions for this study. The first assumption, confidentiality and anonymity of the participants, was upheld and participants were provided an explanation of their rights; therefore, I assumed that the participants would answer all

questions on the survey honestly. The second assumption of the study was that the sample would be representative of all undergraduate nursing students in the United States. The sample of nursing student participants should range from 18 years of age to 45 years of age and should be predominately female. Each individual could be a new graduate from high school or could have been out of school for some unknown amount of time. The third assumption was that the MAC exam is developed by each nursing school. The MAC developed by each school may contain different questions, but achieve the same goal to test the nursing students' medication math competency level; thus, the MAC exam was assumed typical to MAC exams at other schools of nursing in the United States.

**Limitations**

This study has seven identified limitations. A convenience sample was obtained from a school of nursing located in the Midwest and may limit generalization of the study to a larger population. The math program and materials used may not match other nursing programs, thus limiting the ability to generalize the study results. Many nursing students may not be considered "traditional" students; meaning enrollment did not occur upon graduation from high school. Many nursing students may be returning to school after an extensive amount of time away from formal educational and do not remember basic math skills. The next limitation encompasses those students of all three-delivery methods in each term who finished the math course at the same time, but the span of time after learning the content until the MAC exam is taken may be different and unequal.

Perceivably, a student could wait to take the test later than another student; thus, the span of time differs from the end of class to the time testing for the MAC exam.

Another limitation was the use of participants still in the school. Their archived data for semesters in the years of 2011 to 2013 for the quantitative part of this study, could have been as old as two years, which could affect the qualitative survey. The participating students in the qualitative phase were the same students who participated in the quantitative phase, but it may be one to two years after the math course in which the open-response survey is answered. Thus, some of the students had to reflect back in time to the course instead of being able reflect immediately after taking the course. Use of participants still in the school and their archived quantitative data for semesters in the years of 2011 to 2013 could be up to two years old; the time delay could have affected the qualitative survey. Participating students in the qualitative section are the same students who participated in the quantitative section, but there may be a one to two year delay in obtaining the qualitative data from an open-response survey after the math course. Thus, some of the students may have had a one to two year gap to reflect upon the course instead of obtaining responses immediately after completing the course.

Another limitation, the time span between each semester group and within each semester group, might have been different as to when the MAC is administered based on school year and calendar events. The time span differences could limit the ability to generalize the study's results. The final limitation of the study was the students who

performed well on the MAC exam could have chosen to answer the open-response survey questions in a more positive way than those students who marginally passed the exam.

**Delimitations**

The first delimitation of the study was the use of participants still in the school; their archived data for the quantitative part, for semesters in the year of 2011 to 2012, 2012 to 2013 and 2013 to 2014 could be as old as two years; which could affect the qualitative survey open-question responses. The participating students in the qualitative section were the same students who participated in the quantitative section, but may be responding to the open-response survey one to two years after the math course. Thus, some of the students had a longer reflection span to the course than others who were surveyed directly upon completion of the course.

Another delimitation was that a Midwestern school of nursing was chosen due to convenience, cost, and time. I sent an open-response survey to all participating nursing students instead of one-on-one interviews due to time constraints and cost. Time restraints required survey delivery after MAC exam completion. After completion of the math course, students had 3 weeks to complete a maximum of five attempts to pass the MAC exam. Additionally, the literature regarding delivery methods only used one methodology of either a quantitative or qualitative research design in determining if one of delivery methods was best practice. I used a mix-methods research design to obtain a deeper understanding and assistance in finding the best practice for nursing students to

retain math skills and reduce medication errors, thus assisting in filling a gap in the literature.

Finally, this study examined three course delivery methods: traditional, online, and hybrid. There are many more possible delivery methods for a course, such as web-cast synchronized, computer-based training, blended, and web-enhanced, partially distance learning, and technology enhanced.

## Significance of the Study

There is a limited amount of research regarding information about the relationship of delivery methods used and the MAC exam results. The development of a more complete understanding of the relationships between medication administration competencies pass rate, the delivery method used, and the student's perception may support the use of a specific delivery method. Nursing instructors using effective teaching strategies/delivery methods for a math course could increase student competency skills and provide a more complete education for nursing students. Then, in turn, the specific delivery method could assist in strengthening the nursing student's proficiency and retention of the math concepts; thus, decreasing potentially fatal medication errors affecting healthcare consumers. The retention of the math concepts could assist hospitals hiring reliable nurses to pass medications and again, creating a decrease in errors potentially fatal to the hospitalized client.

Schools of nursing may use the evidence from this study to determine which math course delivery method is most appropriate in meeting the learning needs of their nursing

students. Integration of the evidence obtained from this study supports the need to advocate for consumers and the communities those facilities serve. The community, subjected to potentially fatal medication errors, can be assured medication administration skills obtained from a math course designed to assist all nursing students in obtaining a successful, error free, evidence-based practice is safe. Integration of a course delivery method beneficial to all nursing student learning needs will enhance student progression through the curriculum in a timely manner and decreases costs associated with repeating a class.

Analysis of standardized nursing entrance exam math scores, learning-style preferences, and course delivery methods enables student advisors to recommend the best delivery method for the individual student learning needs. The advisor could also use the evidence to coordinate math tutoring and remediation as necessary, while using the delivery method most suitable for the student to be successful. The effective delivery method will then increase students' proficiency in math, which will decrease medication errors and improve patient safety.

The use of the study evidence by the schools of nursing could enhance the nursing students' program completion rate. Finding the success rate and student perceptions of their learning needs brings about possibilities for increased graduation rate and an increase in National Council Licensure Examination (NCLEX) licensing exam success rate. This study will add to the knowledge base of research to fill in gaps regarding the delivery methods and math competency.

## Summary

Nursing instructors are struggling to determine which course delivery method is most effective toward improving retention of math skills. This study examined which of three delivery methods (traditional, online, and hybrid) used to teach a clinical math course for pre-license nursing students has the best outcome; the effects of the delivery method on MAC exam scores, the number of MAC exam attempts to pass, and students' perceptions. This, in turn, may have an effect delivery of math programs within schools of nursing.

Section 2 covers the review of literature. The section is broken into several subsections: adult learning, learning math, delivery methods, student nurses' lacking math skills, and medication competency. Section 3 includes the chosen research method and is divided into to several subsections. The subsections in Section 3 are delivery method descriptions, research design and approach, setting and sampling, instrumentation materials, data analysis, and protection of participant's rights. Section 4 provides the results, which includes the subsections of findings, quantitative Phase 1 and qualitative Phase 2. Section 5 contains the discussion, conclusions and recommendations with subsections of interpretation of findings, practical implications, recommendations for action, recommendations for future research, and implications for social change.

Section 2: Literature Review

## Introduction

The problem I sought to explore with this study was the low level of math skills of nursing students. Section 2 includes references covering a set of years to show history from new to older references ranging 1926 to 2016. Some of the references seminal works, such a Knowles adult learning concept, and Benner's theory of novice to expert in skills acquisition. Section 2 includes the review of literature related to the following areas: (a) adult learning, (b) learning math, (c) the delivery methods, (d) the student nurses' lack of math skills and, (e) medication competency exam (MAC). I used several bibliographic databases, such as Medical Literature On-line (Medline) and Cumulative Index to Nursing and Allied Health Literature (CINAHL), to search for studies. Key words and phrases used were *course delivery*, *math instruction, medication errors*, *learning math*, *adult learning*, *traditional delivery method*, *online delivery method*, *hybrid delivery method*, and *nursing students' medication errors.*

## Critical Review of Literature

### Adults Learning

According to Knowles et al. (2005), adults have different learning needs than children. These learning needs should guide the design and delivery of a course for adults. Knowles et al. (2005) first assumption is that adults will learn what they feel they need to know and the delivery design of the course needs to be considered by nursing instructors (Billings & Halstead, 2012; Gregson & Struko, 2007). Students are interested

in knowing the specific requirements to pass the class. According to Gregson and Sturko (2007), adult learners need to be aware of what that need is and its purpose of learning the content in a course. Therefore, instructors need to consider the delivery method of the math course; that the delivery method includes the purpose for learning the content.

Knowles et al. (2005) second assumption was that adults need to be in control of their lives and are responsible for their own personal learning. Thus, self-directed learning would be the teaching strategy of choice. According to Terry (2006), self-directed learning is a part of what it is to be an adult-like learner and defines or is a part of the development of learners. Adult students, therefore, need to be active in participating within the learning context for it to have meaning in their life (Jameson & Fusco, 2014; Rodrigues, 2012). Adults, according to Terry (2006), take responsibility for their learning as a part of self-monitoring. Therefore, self-directed learning is a more autonomous type of learning (Terry, 2006). When designing a delivery method of a course, these considerations need to be included.

The third assumption was that the experience of an adult learner is an important part of the learning process (Knowles et al., 2005). Adults have a diverse set of experiences to be considered by nursing instructors when deciding on what teaching strategies are to be used in a course (Billings & Halstead, 2012; Gregson & Sturko, 2007). An adult learner can have many different backgrounds, learning styles, and motivational needs that are to be taken into consideration in developing the course design (Jameson & Fusco, 2014; Rodrigues, 2012). The facilitator needs to create an

environment that allows for discussion, collaboration, and meeting the learning style of adults (Billings & Halstead, 2012; Gregson & Sturko, 2007). In order for the facilitator to meet diverse types of learners, such as the hands-on learner, auditor learner, and visual learner, the course delivery method may need to include more than one delivery style to meet all the diverse learning types. A hybrid method of course delivery may be necessary. The hybrid delivery method includes traditional face-to-face classroom and an online classroom, which would meet all of the different learning styles (Billings & Halstead, 2012).

The fourth assumption of Knowles et al. (2005) was that the adult learner must be ready to learn the content. Thus, the development of the course needs to take that into consideration and make ready for adults to be able to commit to the learning process. The placement order of the math course among other courses makes a difference in maximizing an adult's readiness to learn (Billings & Halstead, 2012). An adult, according to McDevitt (2001), will learn math content when the meaning of its use is explained with examples, and if he or she can apply it directly. Many adults have problems understanding the relevance of the course and how to apply it in life. Thus, the delivery method and timing of the course need to coincide with learning needs. McDevitt (2001) also discussed the need for the adult learner to "hang" what he or she has learned to other math concepts they have learned in the past. The adult learner comes to a classroom with diverse experiences and the course delivery needs to take this into account for learning to take place (Billings & Halstead, 2012).

According to Rodrigues (2012), the fifth assumption is that the adult learner is problem oriented, meaning that when an adult comes upon a problem he or she draws on past experiences and looks for new learning to find solutions. Adults become motivated to learn new content and to apply this content to problem solving (Jameson & Fusco, 2014; Rodrigues, 2012). To be effective, the instructor needs to assist the learner about when to use the skill and how to transfer what they have just learned to a life situation through that learner's style of learning (McDevitt, 2001). Examples and applications of real life situations, developed by the nursing instructor, expressed in terms of the student's learning style, and the type of delivery method used to meet that learning need can make a difference in the retention content (Billings & Halstead, 2012).

The last and sixth assumption is that adults have external and internal motivations, but internal motivations are stronger (Knowles et al., 2005). External motivators in an adult's past experiences can be the knowledge of a salary increase leading to a better job and credit toward a degree (Jameson & Fusco, 2014). The internal motivators can range from an increase in self-esteem to changes in quality of life, to which some of the external motivators contribute (Jameson & Fusco, 2014; Rodrigues, 2012). According to Knowles et al. (2005), some of the barriers that adult learners encounter deal with time constraints or the delivery of the program that does not take into consideration adult learner styles and may block the motivation to learn the content. According to Rodrigues (2012), a learner may be moving from dependent learning to independent learning and would need a learning environment that would allow for that

growth, such as a hybrid delivery method. Some students need a highly self-directed environment, while others still need a more pedagogical learning environment due to the content being new and the student being unable to "hang" the new information on past experiences (Billings & Halsted, 2012). Ozuah (2005) agreed with Knowles (1998) that the pedagogical delivery style of a course is appropriate in some adult learning situations when there is little or no experiential base, while other learners are transitioning into adult learners. The adult learner, then, has a larger experiential base on which to "hang" new content and has an increased sense of autonomy and self-direction (Billings & Halstead, 2012; Jameson & Fusco, 2014; Merriam et al., 2007). A learner can conceivably transition from adult learning styles to a more pedagogical format to learn new content and then with experience return to the adult learning format. To meet the learning needs of adults and their learning styles, and to be effective as a facilitator, the delivery method and teaching strategies need to match the adults' styles of learning from pedagogical to the use of adult learning principles (Billings & Halstead, 2012; Merriam et al., 2007).

## Learning Math

**Introduction.** Adults learn in different ways than children and have unique needs when it comes to learning (Knowles, 1980). In the learning math section, I will discuss issues in adult learning with regard to the environment/barriers, roles/learning style, experiences and obligations, delayed education, conceptual knowledge, and procedural knowledge.

**Environment/barriers.** The learning environment is not necessarily a physical place but a combination of conditions that, together, affect a learner's development and or growth (Billings & Halstead, 2012; Galbraith, 1990; Merriam & Caffarella, 1999; Merriam et al., 2007). Poor student learning environments do not take into consideration the needs of the learner and the barriers to learning medication math (Ohio Literacy Resource Center, 2014). The adult learning environment needs to be supportive and safe (Falasca, 2011). Revell and McCurry (2013) indicated that the challenges students have in learning math stem from poor math preparation, math and or test anxiety, as well as lack of conceptual and procedural knowledge. The instructor needs to use listening skills, observations, inductive approaches, and use open questions to encourage adults to participate in a positive learning environment (Vella, 2002). Galbraith (1990) stated that a positive learning environment would involve the learner in the planning, invite the adult to assess his or her personal learning needs, and encourage the learner to develop learning objectives, identify resources, and devise ways to use those resources to reach their goal. According to O'Tool and Essex (2012), the adult learning environment lacks the status and resources that are used in grade school, middle school, and high school.

In an adult learning environment, the instructor will be more of a facilitator in assisting the learner to implement learning plans and will be involved in the evaluation of the learning (Galbraith, 1990). The facilitator will also control the learning environment to match the material at hand and its importance as well as the degree of difficulty needed to challenge the learner but not frustrate and overwhelm the learner with information. The

learning environment should also contain an open, friendly atmosphere that encourages learners to participate in the positive and a meaningful experience of an educational environment (Falasca, 2011). Feedback must also be specific to the individual learner, and the learner must be able to visualize the benefit and reward of the education (Billings & Halstead, 2012; Galbraith, 1990). Falasca (2011) stated that instructors should see themselves as equals with learners in producing an environment where learning can take place.

According to Merriam and Caffarella (1990), barriers to adult learning fall under two categories: external or internal. An external barrier is beyond an individual's direct control (Falasca, 2011). Some examples of external barriers are vision or hearing changes and loss, health problems such as pain or fatigue from chronic illnesses, and changes in family roles (birth or death). According to Falasca (2011), internal barriers are within a person and under that person's control. Some examples of internal barriers are staying focused on the task at hand, anxiety, fear of not succeeding, and relying on old information to make sense of new information (Falasca, 2011). According to Raychaudhuri (2013) a significant learning barrier can be the students' internal learning preference and whether they have the ability to adapt to assimilate new knowledge.

Understanding that adults have very different learning needs, expectations, and barriers, and knowing how and when learning will take place improves adult learning (O'Toole & Essex, 2012). Instructors will need to structure the learning environment to engage all learners, break down barriers, and kindle personal growth and learning.

**Learning preferences/roles of adults.** Adults typically have more demands on their time besides learning math. Jameson and Fusco (2014) stated that in U.S. colleges as many as 73% of the undergraduate students are nontraditional. A nontraditional student is one who did not enter college right after high school but works full time, may have a family, is financially independent, may not have a high school diploma, and/or may be a single parent (Jameson & Fusco, 2014). The traditional school model is based in the use of 180 days to teach math with a learner without much demand on his or her time; whereas the nontraditional student cannot commit the time needed due to other obligations (Billings & Halstead, 2012; McDevitt, 2001).

The traditional lecture model used in the brick and mortar classroom is fine if the student is an auditory learner, but, according to Dunn (1994), only 30% of the adult population learns using the auditory method, and many adults, especially those who were underachievers in grade school, learn math best by kinesthetic methods. McDevitt (2001) suggested using more hands-on learning and the use of group work for adults to understand the content of math. Raycinhaudhuri (2013) stated that learners are in control of learning preference and that the learner is continually relearning how to learn. The learner may experience a conflict if their learning preference does not match the teaching strategy (Raycinhaudhuri, 2013). When such a conflict occurs, the learner tries to reorganize how to learn the content in a way that matches the teaching strategy, sometimes with and sometimes without success.

Wright (2012) stated that there are many different ways in which adults learn math. Some examples Wright used suggested that it is not the delivery method or the strategy chosen to teach the content, but the student's learning preference. Some students prefer online practice to hands on skill sessions, while others learn best with a practical approach or a little of both. Blais and Bath's (1992) study demonstrated that there may be a close relationship between a student's learning preference and his or her ability to do well on a medication competency exam. Wright (2012) also stated that learning preferences of nursing students may influence the ability of calculation skills learning which may not match the teaching strategy used.

Therefore, the learning of math skills may not be influenced by delivery method but by the teaching strategy used within the delivery method. Ridling et al. (2016) conducted a study which indicated that the adult learning preference needs to be considered. Wright (2012) stated that there are many factors that influence a nurse's math skill ability. Ohio Literacy Resource Center (OLRC, 2014) discussed that instructors need to prepare the delivery of the math content in more than one method to reach all learners.

McDevitt (2001) also suggested that as a facilitator teaching math to adults should pose a question to each student: Why do you want to learn (medication) math? In this manner, the question of learning math is rephrased in such a way to acknowledge a student's goals and need of math learning. Wright (2012) indicated that in order for nursing students to learn and retain math skills, time and resources are needed. The use of

a flexible environment so the student can work at their own pace that addresses their individual learning needs would be the best environment for learning math.

**Past experiences and obligations**. Knowles' (1980) third assumption includes the fact that adults have vast experiences that can be important in the process of learning material, such as with math. According to McDevitt (2001), in teaching math to adults, other skills may be needed, such as how to transfer the information learned into real-life situations and to understand when to use it and why, and OLRC (2014) agreed. The other skills will assist in the retention of the medication math as well as the understanding of its concepts (OLRC, 2014).

According to Rodrigues (2012), in regards to Knowles's fifth assumption, the adult learner is problem-oriented; therefore, when teaching an adult math, it is best to use a problem-oriented method. Then the use of a problem-oriented method will encourage understanding of the math but also enable the adult to figure out what is not known and to search and learn how to find the answer (Rodrigues, 2012). Sheryn and Ell (2014) conducted a study using group work to see how undergraduate students learned math. The authors asked three questions: the purpose of learning, method used in learning new material, and if they felt they were mathematician. Three students of the 10 used in the study stated their purpose was memorization and method of learning was reading the course items, rote learning, and practice. The other seven stated their purpose was to understand and the method of learning was stated to be the same (Sheryn & Ell, 2014). Sheryn and Ell felt that the students' attitude towards group work influenced how the

learning takes place. According to Sheryn and Ell students have past experiences and learning preferences that are very different from one another. One delivery method or teaching strategy is not going to work for all, it is not a one size fits all.

Knowles (2005) stated that learners come from many backgrounds, learning styles, different motivational needs, and life events; therefore, the instructor needs to provide different ways to learn the material. Reynolds and Greiner (2006) agreed and stated that more than one type of instructional strategy should be used such as lectures, PowerPoint presentations, discussion forums, and self-paced activities, as well as simulations to reach all learners. Reynolds and Greiner also stated that the delivery method such as blended learning (hybrid) as a flexible way to deliver a course could also reach all learners in using the various strategies where learning may be synchronous or asynchronous (Billings & Halstead, 2012). Rodrigues (2012) agreed and stated, for example, that lectures can be used for the auditory learner, power points for the visual learner, and real-life simulations set up for the kinesthetic or tactile learner.

**Delayed education.** According to Rittle-Johnson, Siegler, and Alibali (2001), the development of conceptual knowledge and procedural knowledge should be the main goal of education with strategies used to gain this process. If this process has not occurred early on in the education process, the adult will find math difficult and make many errors. Many times, education is delayed due to factors of personal or family-related events, disability, homelessness, financial, low self-esteem, and starting a family (Billings & Halstead, 2012; Jameson & Fusco, 2014; Zyngier, 2008).

Sheldon and Epstein (2005) conducted a study looking at the involvement of family with the students learning math skills and found that students did not comprehend the information initially. Sheldon and Epstein also found that during the 1997–1998 school year, over 23% of the students in elementary and secondary schools failed the math course. Also found was that 68% of elementary schools met or exceeded satisfactory competency levels, whereas only 31% of secondary schools met or exceeded satisfactory levels. In their review of literature, Sulosaari et al. (2015) found that math skills require a higher level of learning and that the grades in math courses do predict the success on the medication calculation exam. Somewhere along the line, the students are not retaining the information and not comprehending the information to use in the next set of grade levels. According to Sheldon and Epstein (2005), the students tend to forget over time the skills learned and struggle to achieve satisfactory levels (OLRC, 2014). This may also be a problem for the adult learner going back to school. Jameson and Fusco (2014) found that students tend to forget over time the skills needed for math and this may be the cause for some of the high anxiety over the traditional student right out of high school. The amount of time between learning the skills in grade school and using them later may, over time, cause a loss in retaining the information. Sheldon and Epstein (2005) stated that instructors need to conduct an analysis and determine what teaching method or activities improve the math proficiency of a student to retain the skills (Billings & Halstead, 2012. According to Mulhern and Wylie (2004), between 1992 and 2002, the numeracy levels among high school students have declined over time. The

math skills in calculation, algebraic reasoning, ratio-proportion, and estimation are a concern in higher education, and it has been noted that numeracy and mathematical skills among students entering college are of low standards (Hutton, 1998). Somehow, the students are not retaining math skills needed, possibly due the strategies used to teach, family involvement, and time span between learning the skill and its use.

**Conceptual knowledge definition.** Reigeluth (1979) termed conceptual orientation to be a concept that represents a set of items that have mutual features. Reigeluth described knowing the concept is to recognize or identify the item. Blais and Bath (1992) defined conceptual knowledge as pulling out of a problem the information needed and recognizing the pattern to know what to use to set up the problem to be solved. Akgun et al. (2012) understood conceptual knowledge to be more than recognizing a concept, understanding the definition and the name but being able to understand relationships between and among the different concepts. Akgun et al. stated that the conceptual knowledge is more of a network where concepts and ideas come together to assist in solving a problem. According to Wright (2007), conceptual meaning is the person's ability to recognize the correct information or pattern of concepts needed in order to set the problem up to be solved.

**Recognizing elements/concepts to be used.** According to Wright (2007), medication errors occur due to the inability of the person to do basic math and to pull together the correct information needed to set up (conceptual knowledge) the basic math calculation (procedural knowledge) to solve the problem. Lack of conceptual knowledge

is a big problem, not just basic fact knowledge. Blais and Bath (1992) examined nursing student errors and found that 66% of the errors are conceptual errors. Segatore et al. (1993) stated that the errors were 91% due to conceptual errors. Shockley et al. (1989) examined nursing students' use of calculators and found that calculators may have reduced arithmetic errors but may also increase the number of conceptual errors in pulling out the correct information in order to set up the problem. The calculators do not assist in telling the nursing student what data to use to input and how to interpret those results (McMullan, Jones, & Lea, 2009). McMullan et al. recommended that the learning be reinforced by use of regular practice but does not state if a delivery method would make the difference.

**Recognizing patterns and procedures matching.** Rittle-Johnson et al. (2001) proposed that conceptual knowledge and procedural knowledge lead into one another as each is gained: When conceptual understanding increases so does the procedural understanding and vice versa. According to Rittle-Johnson et al., competence in math depends on the development and the ability to link concepts and procedures to solve problems. Students are not understanding or recognizing the patterns of a concept and the procedure that matches to assist in solving the problem.

**Procedural knowledge definition.** Akgun et al. (2012) defined procedural knowledge as having two sections. The first section deals with the knowledge of symbols as the language used in math such as 2 x 2 means to multiply the numbers to get a sum. The second section covers relationships/rules of procedures to solve a problem. Rittle-

Johnson and Siegler (2001) understood procedural knowledge as the person's ability to understand sequencing; thus, the rule of order for a procedure to calculate correctly. Reigeluth (1997) stated that procedural knowledge is the understanding of a set of procedures/actions to be used to solve a problem. This could be seen as math skills, the knowing of a relationship, and understanding how it changes through the use of a procedure and how to work that procedure.

**Comprehension/retention.** According to Brown (2006), the nursing student's problem is working with fractions, decimals, and percent. The average range of correct answers was around 38% with more than half of the nursing students' scores below 70%. In Ashby's (1997) study of medical surgical nurses the researcher found that 56.4% ($N$ = 100) were unable to solve 90% of the problems in a medication calculation exam. Ashby (1997) and Maag (2004) agree that steps to do calculations to solve problems are one of the main problems causing student nurses math errors. According to Kelly and Colby (2003), even though students practice using a procedure, many never reach the competence level. Kelly and Colby suggest to teach procedural knowledge; however encouraging concept acquisition first and then procedural instruction. An example is to allow the student to use a conversion sheet during a math practice and exams. The student then is able to focus on the conceptual knowledge and then slowly introduce the conversion for medication math and the memorization needed.

**Implementation and correct calculation**. To gain procedural knowledge, Kelly and Colby (2003) suggest interactive processes that can be used to solve medication

problems. An example is to present music CDs, each costing $5, and instruct the student that there is $23. The student is asked, how many CDs can be purchased? Then have the student transfer the knowledge of that process to a medication problem. Kelly and Colby (2003) stated that the delivery method of a course may also be the barrier causing the student to not learn and retain the procedural knowledge needed for medication math.

**Summary.** According to the literature, medication errors occur due to the inability of the person to do basic math and to pull together the correct information needed to set up (conceptual knowledge) the basic math calculation (procedural knowledge) to solve the problem. According to Kelly and Colby (2003), even though students practice, they may never reach the competence level of conceptual and procedural knowledge. According to Rittle-Johnson et al. (2001), competence in math depends on developing the ability to link concepts and procedures.

Kelly and Colby (2003) stated that the delivery method of a course may also be the barrier causing the student to not learn and retain the procedural knowledge needed for medication math. The next step is to address whether the delivery method of the course causes a barrier or enhances the comprehension and retention of concepts and procedures.

## Delivery Methods

**Introduction.** Nursing researchers are studying the numerous delivery methods used in education, i.e., web-based courses, web-enhanced courses, web-hybrid instructional courses, and web-cast courses (Billings & Halstead, 2012; Billings &

Phillips, 2007; Creedy et al., 2007; Mancuso-Murphy, 2007). The investigation and the becoming aware of different delivery methods, students learning needs, and their perceptions of the math course will assist in choosing an appropriate delivery method for a math course, thus increasing the nursing students' math skills and decreasing medication errors.

Merrill (2006) suggested "implementing new teaching methodologies (delivery methods) that incorporate both technology and face-to-face teaching as a means of assisting the student to retain learning" (p. 107). Billings and Halstead (2012) proposed using several methods to reach the student (e.g., "long-distance learning through web-casts, videoconferencing, learning management systems, online threaded discussions, along with appropriate pedagogies" (p. 247). The instructor can accommodate different learners by "using various methods in one course" (Billings & Phillips, 2007, p. 153). Worrell and Hodson (1989) felt that there are inconsistencies in the methods chosen to educate nursing students in math. Three delivery methods are discussed in this study: traditional, online, and hybrid. Currently, there is no one standard definition for each of the delivery methods used by all nursing schools.

**Traditional delivery method.** Traditional teaching, sometimes referred as formal education (face to face), takes place in a classroom with students and educators (Billings & Halstead, 2012). Gruendemann (2011) stated that technologies could be used in the traditional setting as tools to enhance the education inside to classroom and that students typically value face-to-face approaches. Gruendeamann continued that the meaning of

face-to-face is a physical presence and contends that, in using online learning, you can no longer read the faces as a clue to learning taking place and be able to change the breadth and depth of the content at that moment. Face-to-face communication contains nonverbal cues that could contribute to the learning of complex skills of math. Gruendeamann conducted a qualitative study to ascertain the lived experiences and meaning of a face-to-face traditional classroom. The samples used were nursing students in a bachelor's degree program who had experience in traditional (face-to-face) classroom and online classes for nursing courses. The students gave feedback that concluded with the idea that being in the classroom, seeing each person and their reactions to information and received feedback, improves the understanding of the material. The students felt that meanings of content learned in the traditional classroom were obtained from the body language, expressions, tone of voice, and the caring from the instructor, and this cannot be obtained in an online environment (Gruendeamann, 2011). Simon, Jackson, and Mazwell (2013) conducted a study where a classroom course was delivered in an online environment as compared to other of sections of the course remaining face-to-face. According to Simon et al., the traditional classroom is a synchronous learning experience where online may be asynchronous. The students are required to be in the classroom to obtain motivation and instructions from an instructor but could also receive help from other students on the spot. Face-to-face delivery method allows for the sharing of one's own ideas. The student then is able to respond to nonverbal reactions, which could deepen the understanding of a concept but also improve critical thinking (Simon et al., 2013). Jaffe (1997) conducted a

study and found that the students may have a positive response to the online course but articulated that they had difficulty learning the material when it is not a traditional classroom. Spiceland and Haskins (2002) also agreed that instructors felt that face-to-face interaction is needed for learning to take place.

Lim, Morris, and Kupritz (2006) conducted a comparison study of classroom versus online with an information systems course. According to the results of 69 students, the online group did not have any significant difference from traditional learners or blended learners. The results could be due to using small groups and IT courses, where IT students have experienced different delivery methods as a part of that degree and may not be able to be generalized to other type courses. When student perceptions were included in the study, the results showed that blended (hybrid) courses provided the needed support and face-to-face interaction with the online component.

Larson and Sung (2009) used three delivery methods in a study to compare success rates among students. The principal instruction strategy used was the same textbook, lectures, and assignments with the same instructor teaching all the courses and delivery methods. The course used was an IT course with 168 students, with 22 students in online course, 83 students in the blended, and 63 in the face-to-face classroom format. The data used were from the three courses comparing exam scores, final course grades, and student perceptions. According to Larson and Sung (2009), no matter which delivery method was evaluated, the course received a positive satisfaction rating. The students

believed that the online or blended (hybrid) course demanded critical thinking more than the traditional face-to-face learning (Larson & Sung, 2009).

While other studies showed, there is no difference in the delivery method effectiveness on learning, Dobbs, Waid, and Del Carmen (2009) did a qualitative study to gain insight to the student experiences with face-to-face and online learning. The face-to-face course had 100 students, and the online had 180 student participants. The students reported that the traditional classroom was easier than an online course and that the students' GPAs were higher than those of the totally online student (Forman, 2011).

The research results are incomplete in that some studies showed there is no difference in the learning as associated with a course delivery method of traditional versus online when dealing with an IT course. Whereas other studies presented that the traditional classroom is the best practice due to the nonverbal language assisting in deepening understanding. Again, these studies were using IT courses where experience in different delivery methods are part of the degree and may not be able to be generalized to a nursing medication math course. The delivery modes chosen for a course could indicate that newer methods of course delivery may be as effective as those of traditional learning.

**Hybrid/blended delivery method.** Hybrid teaching is a combination of traditional and online teaching methods. The students and instructor would meet in a traditional classroom for some activities and use online assignments to facilitate the learning of concepts (Graham, 2006). The students would have received feedback on

assignments before coming to the classroom to clarify or solve misunderstandings of concepts (Billings & Halstead, 2012). According to Simon et al. (2013), the hybrid or blended delivery method provides a more flexible learning style. The student who has issues with in communication in a traditional classroom may find that an electronic hybrid delivery method for a course is an easier learning environment.

Lim, Morris, and Kupritz (2006) conducted a comparison study of classroom versus online blended with an information systems course. According to the results of 69 students, the online group did not have any significant difference from traditional learners or blended learners. The results could be due to using a small group. When student perceptions were included in the study, the results showed that blended (hybrid) courses provided the needed support and face-to-face interaction with the online component (Lim, et al., 2006). The perception is that the student feels he or she is more a part of the learning experience than in a total online course environment and appears to be in line with other findings (Lane, 2003; Lim et al., 2006; Reeves, Baxter, & Jordan, 2002; Willis & Cifuentes, 2005). According to Allen and Seaman (2004), half or more of post-secondary education rate the online blended courses as essential for lifelong learning, and the program is valued to be equal or superior to on-campus programs. The blended delivery method offers a wide range of time broken down between the sites with some ranging from 30%–79% (Allen & Seaman, 2004). Reynolds and Greiner (2006) see blended learning as a flexible way to deliver a course in which learning may be synchronous or asynchronous. The authors suggest that more than one type of

instructional strategy be used such as lectures, power points, discussion forums, and self-paced activities as well as simulations to reach all learners. The real question is how effective is the hybrid/blended classroom delivery method?

Nielsen (2008) conducted a review of research to examine the effectiveness of a blended course delivery method. The author, using two research questions, found that many students felt that blended/hybrid courses offered interaction between students and student instructors. According to Garnham and Kaleta (2002), students who did not contribute in the onsite campus classes did contribute in the online sections of the class. Kumrow (2007) agreed and stated that the students in a blended course delivery method managed their time, resources, and efforts to learn and used support appropriately when needed. Hall (2006) conducted a study using a survey to obtain data from three delivery methods. The author found that two thirds of participates preferred the blended delivery method and that it was more effective than compared with the onsite campus class with only 13% of participates deciding to use online course exclusively.

Ireland et al. (2009) conducted a mixed-methods longitudinal cohort study to examine the effects of the blended delivery method on learning. The researchers used 198 students in a treatment of blended learning and the other traditional classroom as the control. According to Ireland et al., the intervention group had significant increased knowledge of a research course tested per a 10-question true or false exam. The mean score was 57.6%, with 75% of the precipitants answering the 10 questions correctly. The mean score could well be due to some difficulties that students had in using technology to

learn the content of research as undergrad nursing students (Ax & Kincaid, 2001; Ireland et al., 2009; Owens & Kelly, 1998). Ireland et al. (2009) reported that the use of a hybrid delivery method for a course such as research for undergrad nursing students may improve the learning experience and address the varied abilities in learning styles noted in nursing education.

Blended/hybrid learning results are mixed with some researchers agreeing there is no difference in learning as associated with the delivery of a course. Other researchers reported that there was significant difference in knowledge learned within a hybrid delivered course versus an onsite campus class. The difference could be due to the fact that a hybrid course requires detailed matching to course content with the use of pedagogical strategies to encourage learning for life-long professional development (Murray, Perez, Geist, & Hedrick, 2013).

**Online delivery method.** Online teaching can be considered a type of formal learning, where students and instructor via the use of technology (e.g., a computer) use chat rooms and emails to exchange knowledge and do not meet in person. Some online classrooms use a learning management system that creates online learning materials, classrooms, whiteboards, chat rooms, discussion boards, and drop boxes for assignments. Students can attend synchronously or asynchronously with other students and instructors within the online classroom (Billings & Halstead, 2012; Merriam et al., 2007).

Interactions with technology provide learners with a way to be actively involved in the learning within a classroom or at home as distance learning. The use of technology

assists the student in developing critical thinking skills (Billings & Halstead, 2012; Livingston & Condie, 2010). The information technology is designed in such a way that it can support learning as a group or individual and can be tailored to fit a student's learning needs and style, according to Livingston and Condie (2010). The authors conducted a qualitative study to examine the students' perception of effectiveness of online learning. Students (56%) reported that blended learning, which was the use of printed textbooks and online materials, was preferred but used the online materials 87% of the time to learn the content. According to Citera (1988), an online discussion board can encourage the student to participate and critically think about an answer before posting versus in the classroom, which does not allow the amount of time needed for a through answer.

McLaren (2004) conducted a study using undergraduate statistics course comparing online and onsite course. The results showed that the final grade the student obtains is not connected to the delivery method. Whereas Thirunarayanan and Perez-Prad (2001) found that the online group scored higher than the traditional classroom group but was found to be statistically not significant. Harrington (1999) study of master's level students suggested that the online learning group and traditional classroom group are both successful in learning the content. The results may be attributed to the fact that many online or distance learning students are older with obligations. Also, the results may be due to the student truly knowing his or her learning style and choosing the correct delivery method that matches (Billings & Halstead, 2012).

Ni (2013) conducted a quantitative study comparing three online and three classroom groups of student's performance and all taught by the same instructors and design. The students did not have any experience in online classes and self-selected the delivery method for a course. The result showed the statistic value of (*p*-value .32) and (*p*-value .37) after those students who received a failure for the course were removed, thus indicating there was no differences in the group's learning effectiveness, thereby accepting the null hypothesis. Ni also noted that the online courses had a higher dropout rate (10% versus 4%), which was contributed to students discontinuing the class but also noted that it could be the type of course (a research course) that may not work well for online learning. Ni noted that other in courses, such as a theory-and practice-type classes, the failing rate is 8% for the online classes and 10% in the face-to-face classes. In the public course of management, financial management, and policy analysis, the failing rates are close with 5% for online and 4% for classroom (Ni, 2013). The demographics for many of the studies showed that the online students were older and more likely to have employment and other family obligations, which could contribute to the higher fail rate in the online programs (Harrington, 1999).

**Summary.** There are many studies in literature regarding online learning, hybrid learning, and traditional classroom, but the results are mixed with some researchers agreeing there is no difference in the learning as associated with delivery of a course. Other researchers reported that there was a slight to significant difference in knowledge learned in an online course. Other studies state that the only difference noted was the

failure rate, which could be due to demographics. These studies showed that the online students were older and more likely to have employment and other family obligations, which could contribute to the higher fail rate in the online programs (Harrington, 1999). Again, the research results appear to be incomplete in that some studies show there is no difference in the learning as associated with a course delivery method. The difference could be due to the fact that a course requires detailed matching of course content to the delivery method (Murray, et al., 2013). Then, if this is the case, determining which delivery method is appropriate for a clinical medication math course for undergraduate nursing students is important.

**Student Nurses' Lacking in Math Skills**

The need to be proficient in math is a nursing function used in medication administration. Math skills are an essential quality for providing safe and effective patient care. According to the NCCMERP (1999), 106,000 people have fatal events due to medication errors, and 2.2 million are inured every year (as cited in Greenfield, 2007). According to World Health Organization (2010), about 1.9 million errors with about 11% of the older population hospitalized are due to adverse drug reactions costing $2 billion yearly. However, the math skills of nursing students vary in ability as indicated in some of the research literature (Coyne et al., 2013; Newton et al., 2009; Wright, 2007).

Polifroni et al. (2003) conducted a nationwide study using proportional sampling methods, with schools randomly selected and then stratifying the sample by region. The authors found that 70% of the schools require algebra, 30% required algebra II and or

geometry, and 15% did not require any high school math courses for nursing school admissions. Coyne et al. (2013) stated that students entering schools of nursing varied in math education. Researchers Brown (2006) and Polifroni et al. indicated that nurse educators should not assume a nursing student's math ability and medication administrating skills are adequate, even if the transcripts show math was taken in high school. Kapborg (1995) concluded that the educational background of a student can influence the level of math proficiency. According to Tenhunen et al. (2014) and the IOM (2006), there are five methods to be worked on to decrease medication errors, one of which is the education of nurses and provider staff medication administration skills and math. When reviewing the databases, the literature does not confirm any complete best practice as to what constitutes a student's nurses' medication competency (Pape, 2001).

According to Coyne et al. (2013) and Sneck et al. (2016), the nurses need math skills but also conceptual skills to accurately calculate medication dosages as other researchers have stated in the past (Bliss-Holtz, 1994; Weeks et al., 2000). Cummings (2011) agreed with the past researchers (Bliss-Holtz, 1994; Weeks et al., 2000), that many nursing students were unable to conceptualize numbers, put them in a formula, or manipulate numbers with or without the use of a calculator. Many of the studies focus on the method of delivery or strategy such as the use of a computer, calculator, or personal digital assistant (PDA) with mixed success possible due to differing learning styles (Coyne et al., 2013; Cummings, 2011; Greenfield, 2007; Sneck et al., 2016; Weeks et al., 2000; Wright, 2005) but not on a whole course delivery method such as hybrid or online

(distance) and how that may affect the learning. Perlstein, Callison, White, Barnes, and Edwards (1979) evaluated 11 pediatric doctors, five pharmacists, with 27 registered nurses found that calculations by nurses may be off as much as 10 times the amount, more or less than what is prescribed by the doctor in about 56% of the medication errors. Cummings (2011) study showed that 58% of the nursing students could not complete basic math problems. Thus, over half of the medication errors were due to missed calculations from poor math skills. The nurse's math skills and critical thinking are used to administer medications, and many of these medications could be lethal if the calculations are inaccurate (Coyne et al., 2013; Polifroni et al., 2003; Preston, 2004; Sneck et al., 2016).

Wright (2006) conducted a quantitative study to exam the math skills of nurses. Wright stated that the main barrier for nurses is the lack of fundamental mathematical knowledge of principles needed to calculate drug dosages. Wright used a math test and questionnaire to determine the level of math skill but did not ask the nurses their perceptions. Scores ranged from 7 to 29 out of 30 possible with the mean score of 16.5. According to Wright (2006), the main difficulties in the math showed that mean test scores of 1.5 for multiplying fractions, 2.25 for interpreting information, 2.5 for ratios, 3.25 for place values, 3.75 for fractions, and 4.0 for percentages indicated that math skill is week and multiplying fractions is the top skill the nurses have problems working and Sneck et al. (2016) agreed and found similar results. The results in Wright's (2006) study showed that 37% of the nurses ($n$ = 26) were not able to complete or correctly solve 50%

of the questions. Another 96% of the nurses ($n$ = 68) did not complete correctly 75% of the questions correctly with in the math exam, thus supporting Wright's hunch that nurses lack basic math skills. Coyne et al. (2013) found in their study that 48% of the student nurses answered math questions incorrectly. The formula used by 25% of the students was incorrect, 8% incorrect math, and 5% math and formula used was incorrect. According to Wright (2006), the main problem is not always the math skill but maybe the contextualizing of the numbers, meaning that the numbers are plugged into a formula without significance. The numbers need to have the unit of measure included in the problem or formula used for solving. The context then makes the formula understandable and more easily solved (Weeks et al., 2000; Wright, 2007a).

Sredl (2006) felt there were three major areas causing confusion for student nurses: the number and diversity of mathematical formulas used in medication administration, the inability to correctly choose a formula to solve the math problem, and the mathematical language. Sredl conducted a study to examine if a triangle technique where the problem is looked at from three different ways to be solved, made a difference in the nursing student's ability to do computations. The study was conducted in a traditional classroom setting using a purposive sample of 30 senior nursing students. A pretest/post-test design was used with both exams being given on the same day. The results showed in the pretest that nearly all scores were not passing, but, in the post-test after the triangulation instruction, there was significant improvement as indicated by the Pearson's correlation (r∧sup2∧=0.84).

Greenfield et al. (2007) conducted a study using dimensional analysis, a format of how a problem is set up resembling a football field's end posts and is sometimes called the "football" method, which decreases the number of steps required to solve the problem, as the treatment to reduce medication error. The study was a nonrandomized quasi-experimental pilot. The sample was a convenience sample of ($n$ = 39) attending New York University nursing school. The authors found ($p$ = 0.05) that the control group scores showed mean = 86.92 with $SD$ = 14.5 (meaning that the group scores were spread out and were not as cohesive as the experimental group), 16 of the 26 students (61.5%) passed using the traditional formula methods. The experimental group scores mean = 92.12 with $SD$ = 6.2 (meaning that the groups scores were closer together and more cohesive and did better on the exam), with 33 of the 39 students (84.6%) passing the exam. The experimental group showed greater accuracy on the medication calculation exam, as compared with the traditional formula group. Neither Greenfield et al. (2007) nor Sredl (2006) applied the teaching strategy to a delivery method for a whole course; it can only be assumed that the delivery method was via traditional classroom.

Brown (2006) and Wright (2007) administered mathematics exams to establish nursing students' math skills. They agreed that one half or more of the incoming nursing students were deficient in basic math concepts, i.e., multiplication, fractions, division, decimals, and percentages (Brown, 2006; Cummings, 2011; Polifroni et al., 2003; Wright, 2007). Ptaszynski and Silver (1981) ascertained, after testing 73 nursing students, that none received a score above 80% and most scored 70%. Bindler and Bayne (1984)

used a much larger group of 700 or more over a five-year time period and discovered that as much as 38 percent of the students failed math proficiency exams, which are used for testing junior high proficiency in math. Blais and Bath (1992) studied nursing students' medication dosage calculation skills and determined that 89% of the 66 nursing students they tested did not pass the exam with the required 90%. Chenger, Conklin, Hirst, Reimer, and Watson (1989) in Canada found results comparable with that of previous studies mentioned.

Worrell and Hodson (1989) conducted a survey study of nursing schools in the United States of the 223 accredited schools of nursing, in which about 82% had reported deficiencies in math skills in their students. Polifroni, McNulty, and Allchin, (2003) also conducted a study across the United States to validate nursing students' math skills and found that new graduate nursing students did not possess basic math skills. Brown's (2002) study identified that only a mean score of 75% of more than 850 nursing students as having some basic math skills and agreed with Brown (2006) and Polifroni et al. (2003) that the areas of deficiency are fractions, decimals, percentages, and basic mathematical competencies to calculate medication dosages. Wright (2007) found similar results and substantiated the finding.

Blais and Bath (1992) and Bliss-Holtz (1994) identified conceptual errors and form errors, which made up 68 % of all nursing student math errors. Errors in computation, according these studies, comprise about 19 %, and the conversional errors were about 13 %. Math calculations are only a part of the medication administration

process in dosage calculations, which have an effect on the healthcare consumer, thus causing injury or even death (Kim & Bates, 2013).

Pozehl (1996) felt that nursing students had a higher deficiency rating in math skills than non-nursing students. The results showed that, upon comparing non-nursing groups with nursing groups, 17.9% in the nursing groups passed an algebra exam and the non-nursing groups 71.4% passed with 70 % or greater scores. Pozehl and Hodge's (1999) studies revealed more than just nursing students' lack of math skills but also additional factors that have an effect on the students' comprehension/proficiency (i.e., test anxiety, mathematics anxiety, mathematics self-efficacy, beliefs in myths about math, and previous mathematics achievement experience) are seen as barriers to learning. Deficient math skills have been linked through various studies to test anxiety, mathematics anxiety, and myths about math (College Board, 2005). Medication administration continues to prove to be a complex system with math skills that nursing students are expected to preform several times a day without error (Cooper, 2014).

**Summary.** Nurses need to be proficient in math to administer medications. Math skills are a must-have quality for safe delivery of care. Some of the studies focus on one particular strategy to increase comprehension and improve math skills (Coyne et al., 2013; Greenfield, 2007; Kim & Bates, 2013; Weeks et al., 2000; Wright 2005), while other studies focused on what the barriers are and what is it about math that nursing students do not understand (Wright, 2006; Sredl, 2006). Conceptual teaching is helpful however, there is no recommendation about a specific delivery method for math course.

## Medication Competency Exam

The medication administration competency exam is used at the end of the math course for beginning students. Once the student has completed the math course, each nursing class the student registers for in this Midwestern school of nursing will require another MAC exam before he or she is allowed to administer medication on the clinical floor. The exam becomes more difficult as the student progresses through each nursing course. Typical problems contained within the MAC for the beginning student include conversion problems, which are conversions between three different systems: metric, apothecary, and household. Types of problems seen in the exam include calculations for oral medications in tablet, capsule, liquid formats, topical medication, intra-muscular injections, subcutaneous injections, and intravenous. Also, a mixing of medications and calculation/titration of medication per body weight or surface area and reading the medication label are included. These different formats are then applied to adults as well as children. An example can be found in Appendix A.

## Summary

The literature indicates that math skills in calculating medication dosages has been an issue for a long period of time. What I found in the research was that the nursing student is lacking in concepts of math, the ability to use appropriate procedures to solve the problem, and estimation skills. The MAC exam requires the student nurse to use math concepts, procedures, and estimation for problem solving. Many methods/strategies in teaching have been used with very little change in the student's math ability; but the

literature does support that the only successful treatments were conceptual teaching. Also, discussed in the research, is that adults learn math in an environment that is different from grade school days.

What was not found in the literature was the use of quantitative and qualitative methods in the same study, in finding a delivery method that has the best outcomes. The literature review indicated in the research that most compared two delivery methods using quantitative analysis. This study used the same book and teaching strategies with only the delivery method being different. The purpose of this study was to conduct a mixed-methods study on three delivery methods—traditional classroom, hybrid classroom, and online classroom—for a nursing math course to find a delivery method with the best outcome.

# Section 3: Research Method

## Introduction

In this section, I discuss the research design. I describe the delivery methods, Phase 1 quantitative method, Phase 2 qualitative method, population, sample size, instrumentation and materials, data collection, and analysis of data. In this study, I examined the relationship between Medication Administration Competency (MAC) exam results and the three educational delivery methods used to teach a clinical math course: online self-directed (distance learning), face to face (traditional), and a mix of online self-directed learning and instructor lead class (hybrid).

## Delivery Method Descriptions

The purpose of this study was to discover which of three delivery methods (online, traditional, or hybrid) used to teach the clinical math course for pre-license nursing students brought about the best outcome as associated with MAC exam results. The MAC results were obtained from the school's archive database. Prior to comparison of delivery methods, each delivery method needs to be explained to assure each uses the same contents, teaching method, and processes with only difference between the three being the delivery method. First, I discuss the textbook used in all three of the delivery methods.

### Course Textbook

The textbook used in all three delivery methods was, *Clinical Calculations with Applications to General and Specialty Areas* (6th edition) by Kee and Marshall, published

by Saunders in 2009. The textbook structure and format provided all three of the delivery methods while using the same contents and processes to teach the clinical calculations course. The textbook and the online web companion to the text contain six different calculating methods to calculate dosages of medications and divides each method into five parts or sections.

Part 1 covers a basic math review, Roman numerals, fractions, decimals, percentages, ratios, and proportion math skills. Part 2 presents metric, apothecary, and household systems to calculate drug dosages. This section also includes the conversion of units within and between systems, how to read drug labels, drug orders, and abbreviations. The six methods included in Part 2 are how to perform basic formula, ratio and proportion, fractional equation, dimensional analysis, body weight, and body surface area calculations (Kee, & Marshall, 2013).Part 3 presents the oral, injectable (intramuscular, subcutaneous), and intravenous administration calculations. Part 4 includes the specialty areas such as labor and delivery, intensive care units for adults, critical care units for pediatrics, and community drug and dosage calculations. Part 5 contains posttests used for each section to determine competency and mastery in each area. There are also test banks available to the instructor to use to develop additional competency exams as needed. All three of these delivery methods—online self-directed, face to face, and a mix of online self-directed with instructor lead class—used this book and the same exams to teach the nursing students clinical calculations as well as test for competency.

**Traditional Face-to-Face Delivery Method**

Face-to-face instruction, which is sometimes interchangeable with the traditional classroom, used the text with the instructor-led course. The instructor explained the calculation process through lectures, assigning homework, quizzes, in-class work, and work done in large or small groups on the white board. In this setting, the student asks questions for further explanation of a process, and receives feedback for in-class work in real time. The traditional classroom was instructor directed and established a structured environment built on the concepts of pedagogical teaching.

Each of the five divisions in the text has several chapters. The traditional classroom does not use the web online companion, only the text. Each chapter begins with a list of objectives to be accomplished in that section. Below the objectives is an outline of the chapter for quick reference of content. The histories of the processes are explained in the next section. For example, the histories of Arabic and Roman number systems, as well as conversion of those systems. Each mathematical system includes examples of use to calculate units, the relationship of the units, and application of the information in a math problem are included. The student gains experience by completing practice problems individually, or in small or large groups, and making of flash cards as well as using a white board to show the work of the calculation processes. The end of each chapter features a post-test quiz for use in class or use as homework for feedback on mastery of that skill section. The instructor also has a CD-ROM with additional homework and quiz questions for each chapter available for printing and distribution as a

handout for student homework. Student progresses through each section, chapter, and part, until content completion and then the student is ready for the MAC exam.

**Online Self-directed Delivery Method**

The online, self-directed student attends a virtual classroom as the learning environment and uses the course textbook. Self-directed learning refers to distance learning or online learning many times. Ramsey and Clark (2009) defined online learning or distance learning as "students receiving instruction in a location other than that of the faculty" (p. 351). The online environment is student directed and controlled, with the instructor acting as a resource and facilitator. The student does the same homework and practice pieces as performed in the face-to-face classroom; but completes the work online and submits to an associated online grading program. The instructor uses a white board to go over questions from students, for students to use in work groups, or for students to individually work and receive feedback in real time from the instructor. This synchronized online classroom is where course work occurs at a certain time in which all students have to be available online. Homework, other class work, and tests submitted for feedback is via electronical submissions. The student is self-directed, as in andragogical models of learning, as he or she starts the reading and working online at their own pace. However, the student may need to meet with the online instructor and class at certain points of time, as directed by the instructional material. The self-directed online program is andragogical in nature, student centered, and student controlled. The online program has an automated white board that appears when each practice problem is completed,

giving feedback to the student upon submission. If the student has an incorrect answer, the white board pops up a step-by-step process explaining how to solve the problem and obtain the correct answer. If the student were in a traditional classroom, this process occurs with the instructor present. The processes for learning the content is the same for homework, exams, class work, group work, flash cards, and in-class board work as in the traditional classroom; only the work is in an online electronic format.

**Hybrid Delivery Method**

A hybrid delivery method uses the best features or best practices of both face-to-face and online learning. A hybrid course integrates face-to-face and online activities that reinforce, complement, and elaborate upon one another (Billings & Halstead, 2012). Today's nursing student is more accustomed to the use of technology in the classroom setting and expects its use do to past experiences in elementary and secondary education (Halstead & Billings, 2012). Thus, the student in a hybrid class uses the textbook, the online companion, and face-to-face instructor to learn the math content. The instructor can, in this case, present lecture on the math content in a traditional classroom style and or place the lecture online. The instructor may also act as resource and facilitator in traditional classroom or online, answering questions per traditional classroom face to face or may use whiteboard online. The math content is also online for the student to read and work through problems by themselves as well. The student homework, exams, and class work may be submitted online or in the traditional classroom. Hybrid courses use both the traditional and the online environment to reach students with different learning needs.

The same math content, teaching strategies, test questions, homework, exams, and other class work applied to both delivery methods used by the instructor to meet student-learning needs.

**Summary**

There was no one standard definition for what constituted a specific delivery method. However, some key points of agreement included: (a) traditional delivery requires "in-seat-time" or face-to-face time with an instructor in the classroom as a pedagogical interaction; (b) an online delivery method is conducted entirely online via a course management system via the Internet in an andragogical design; (c) hybrid delivery, sometimes called blended or mix mode, has web-based learning activities introduced to complement face-to-face components of the design to interact pedagogically or andragogical (Billings & Halstead, 2012). Comparison of the three delivery methods (tradition, online, and hybrid) the MAC exam is administered in the same setting.

The MAC exam is always in a proctored setting. The students have five attempts to pass the MAC exam within a 3-week period directly after the initial math course is completed. If the student is unable to pass the exam within the five attempts, the student does not pass the math course and must retake the complete course in another semester, and try again, with five attempts, to pass the MAC exam. Enrollment for the clinical math course occurs each semester, and there are three semesters in one year. Dismissal of the

student from the school of nursing occurs if unable to pass on the second attempt of the math course

## Research Design and Approach

### Phase 1: Quantitative Quasi-Experimental Research Design

In the first phase, which was the quantitative section of this study, I hypothesized that there would be differences between the delivery methods and nursing students' MAC scores on the exam. The first phase included analysis of the archived data from HESI standardized tests as the pretest from the student's admission into the school, then treatment of one of the three delivery methods, and then a posttest: the MAC. The alternative treatment, nonequivalent pre-/posttest group design approach is as follows:

Group A O1_____X1_____02 03
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Group B O1_____X2_____02 03
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Group C O1_____X3_____02 03
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Definition of terms:

Group A: X1: Delivery Method: Traditional (Face to Face)

Group B: X2: Delivery Method: Online instruction

Group C: X3: Delivery Method: Half in the classroom, half online (Hybrid)

Group A, B, C:

O1 nursing students HESI Math standard per test

O2: Post-test: the measurement recorded on the medication administration competency exam.

O3 Number of times test was taken

The pre- and posttest exam performance were compared upon completion of the medication administration competency exam. The data were obtained from the schools' archived data from 2012 to 2014 as well as the number of times the students needed to take the MAC exam before passing. The HEIS pretest exam was compared to the MAC exam results in each of the three delivery methods to try to find differences between those three. Next, the HEIS pretest exam was compared with the number of times the MAC exam was taken to pass by each student in each delivery method.

Table 1

*MAC and HESI Test Dates and Course Dates*

| Item | Term 11-1 | Term 11-2 | Term 11-3 | Term 12-1 | Term 12-2 | Term 12-3 | Term 13-1 | Term 13-2 | Term 13-3 |
|---|---|---|---|---|---|---|---|---|---|
| | JUNE / 2010-JLY/ 2011. | JUNE / 2010-JULY/ 2011 | JUNE / 2010-JULY/ 2011 | JUNE / 2011-JULY/ 2012 | JUNE/ 2011-JULY/ 2012 | JUNE / 2011-JULY/ 2012 | JUNE / 2011-JULY/ 2012 | JUNE / 2011-JULY/ 2012 | JUNE / 2011-JULY/ 2012 |
| **Course Range Dates** | Aug -Dec 2011 | Jan-May 2012 | May-Aug 2012 | Aug –Dec 2012 | Jan-May 2013 | May-Aug 2013 | Aug –Dec 2013 | Jan-May 2014 | May -Aug 2014 |
| **TREATMENT** | **96 students registered** | **62 students registered** | **20 students registered** | **98 students registered** | **65 students registered** | **15 students registered** | **92 students registered** | **70 students registered** | **18 students registered** |
| **MAC Range Dates POST-TEST** | October 2011 | March 2012 | June 2012 | October 2011 | March 2012 | June 2012 | October 2011 | March 2012 | June 2012 |

## Phase 2: Qualitative Research Design

In the qualitative research section, I explored the in-depth perceptions of nursing students' perceptions of learning medication math. I invited a sample of the nursing students from the quantitative Phase 1 section to complete open-response survey questions with the use of SurveyMonkey. The open-response survey questions provided

student participant's the opportunity to indicate their perceptions of learning needs, what they found to be difficult or easy, and what strategies helped them learn a math skill for math medication administration. See Appendix B for survey for open-response survey questions. A math part was included to triangulate the findings from the quantitative.

## Setting and Sample

### Participants

The study population was nursing students who formally accepted into a Midwestern school of nursing. The sample consists of nursing students enrolled in a medication clinical calculation course; and specific archived course data in the school's database. The course is mandatory for all nursing students. This math course is an introductory course; therefore, most of the students were either freshman or sophomore in status. Participants may vary in age from 18 to 45, the number of years of experience, gender, number of years out of school such as one to 15 years, educational level such as just out of high school to having a college degree and other demographics.

The prerequisites needed for acceptance to the school of nursing include three years of high school math, i.e., algebra I and II, geometry, and one other course, along with the usual core basics offered pending the high school semester structure. The additional prerequisites are to have a high school diploma or equivalent, SAT and or ACT, and take the standardized admission exams the nursing school uses. All are required to take the HESI standardized admission exams, which cover many subject areas, including math and learning style. Due to the school's mission statement, the

school of nursing accepted all students, regardless of scores obtained on the standardized admissions exam.

The number and specifics of those nursing students were not known until after obtaining the data from the archive of the school's database, once permission was given to conduct the study. There was 267 students' data pulled from the 2011 to 2013 terms. Demographic data, enrollment, and other statistical data of the participants enrolled in the school were available in the archive of the school of nursing's data bank. The data identified population characteristics of gender, age, ACT/SAT composite scores, level of education, and HESI standardize test scores; however, stratification was not used to set up the sample. Each student participant self-selected the delivery method for their math course, and that information was archived in the school's database along with the pretest and posttest score.

All nursing students in the Midwestern school of nursing, who are still in the nursing program, have completed the clinical math course during terms of 11-1, 11-2, 11-3 and 12-1, 12-2, 12-3 and 13-1, 13-2, and 13-3, were asked to participate in the study if they meet the inclusion/exclusion criteria. Exclusion criteria are as follows: students who did not complete the clinical calculation course, thus, would not be eligible to complete the exam testing. The students who repeated the course due to failure during the first enrollment were excluded as these students had prior experience in the course. I excluded any student of which I did not have consent or decided self-removal from the study at any point after providing consent.

**Sample.**

The sampling method chosen was a non-probability-convenience sample. To determine sufficient sample size, the rule of 30 was applied (Gravetter & Wallnau, 2009); thus, with three interventions a total of 90 participants would be the required number (traditional: 30; online: 30; and hybrid: 30). But, to ensure there were enough students and to account for attrition 50 students per cell, a total of 150 students were needed (Polit & Beck, 2014; Schmidt & Brown, 2012). Thus, the goal was to have 50 students in each of the delivery methods. The final number of students in each delivery method was, 56 in the traditional, 50 in the hybrid, and 42 in the online delivery method.

I used the sample size calculator retrieved from Creative Research Systems using the confidence level of 95% with the confidence interval at five sample size needed is 150 with $\alpha = 0.05$ to determine sufficient sample size. In the first phase 148 nursing students were used for the data obtained from the archives of the school's database from the years 2011 to 2013. In the second phase nine students were randomly selected from the initial 148.

**Role of Researcher**

I am an instructor in the same school the study was conducted. I do not teach the math course nor the level of students used in the study. I chose the school for convenience and cost savings.

The students in the freshman year, taking the math course, are on the main college campus. The courses I teach and my office are on another campus, which is 40 miles

south of the main campus. I did not have access to the archived grades, admission test, and final exams for the freshman courses on the main campus. I had to request this information from one of the chairs. I requested the data I needed from the school via the chair after permission and agreement forms were signed by the director of the school.

Permissions from the students were obtained through emailing the forms with the explanation of confidentiality and protection of the data. The chair pulled that data off the archived school database and removed identifiers before giving the data to me via a file. The second phase of the study required the use of nine students to do a survey. The invitations were sent out to all students via e-mail with explanation and permission forms. Nine students were chosen randomly, three from each delivery method, and were sent the link to SurveyMonkey. The software keeps the identity of the student unknown. The results will be reported later to the school and students, once the study has been completed and accepted by Walden University.

## Instrumentation/Materials

The MAC exam contains 20 questions of mathematical problems with drug calculation application. Each question is worth 1 point, thus 20 questions correct equals 100%. Each nursing school uses a MAC exam to assess the student's competency in administering medications on the clinical floor. The MAC exam contained questions are developed by each individual school, and the MAC exams were used as the post-test assessment. The reliability was measured by the Kuder-Richardson 20 statistical formula, which ranges from -1 to +1. The closer the exam is to the +1, the more consistent are the

results, according to Gravetter and Wallnau (2009). The reliability and validity for the MAC exam is KR20 = 0.71. To view the MAC exam, see Appendix A.

Another instrument used is the HESI standard entrance exam A2. All nursing schools use some type of standardized admission testing program such as HESI, ATI, and Kaplan. The HESI standardized admission exam has many parts/sections. Data from only two parts, the math and the learning style, was obtained. The HESI admissions exam math part was used as the pretest to be compared to the post-test (the MAC). I used the other section of the HESI (learning style), for content in the Section 5, discussion of this study. The estimated validity and reliability coefficient for the HESI standard entrance exam is measured by the KR20 ranges from 0.86 to 0.99, the number of items used on the exams can range from 180 to 47,320 (Morrison, Adamson, Nibert, & Hsia, 2004).

The last instrument used is a questionnaire for the qualitative part of the study to capture student perceptions of each delivery method. A pilot test of the questionnaire was done with three nursing students (one from each delivery method) and then adjustments were made to the questions before the survey was used. The three students answered the piloted survey questions online using SurveyMonkey and did not have any problems working through the program. The students stated the questions made sense but wanted more suggestions to create clearer understanding of question intent. Questions were adjusted based on the feedback obtained and given to the five nursing experts for construct validity.

For validity, face and content validity was used to measure if the survey questions appear to measure the concept of the student's perception of learning. According to Polit and Beck (2014), face validity requires that people who will be completing the survey review it and determine if it is measuring the appropriate phenomenon being investigated. The construct validity then was looked at the how representative the questions are in capturing the phenomenon. Thus, panels of five expert nursing instructors were used to evaluate the survey questions. The intent was to obtain a content validity index (CVI) of 0.90 "which is the standard for establishing excellence in a scale's content validity" (Polit & Beck, 2014). The CVI obtained from five nursing experts for the open-ended survey questions was 0.87. The CVI is close to the standard which stated that the five expert instructors were mostly in agreement in that the survey questions are representative of questions used to capture the phenomenon.

**Survey Guide Setup**

The invite sent for the open-response survey to all nursing participant students who have met the inclusion criteria occurred about one month prior to allowing the person to read the materials and to respond. Included in the materials were the invite, the consents, purpose, use of material/information, human protecting rights, what outcome and advantages that the information may have, any disadvantages, who will have access to the material, and what information will be needed. There was also explanation about the use of SurveyMonkey and that SurveyMonkey kept the identity of each student secured. A follow up email was sent out one week later as a reminder. When the students signed into

SurveyMonkey, there was a statement that opened before the survey could be taken and had to be answered before the open-response survey could be taken that stated: "By opening this open-response survey you are stating that you are doing this of your own free will and understand your rights, responsibilities, and purpose of this open-response survey." See Appendix B for the open-response survey questions.

**Data Collection/Recording Tools**

In the first step, a grid was used that included student numerical identifier, HESI math score, HESI learning style, MAC score, number of times taken to pass the MAC, and the delivery method for each of the participates. The data were obtained from the school's archived database via the administrator and the freshman teaching team. The administrator and freshman teaching team then applied an alphanumerical code for each student data that was collected after consent has been received. The only person who knew the name of the student as connected to that data and the created ID code were the administrator and the freshman teaching team. The administrator applied the data to the grid sheet and sent it to the researcher in electronic copy format in a secured system. See Appendix C for example of the grid.

In the second step, I used a questionnaire on SurveyMonkey. I pulled the data from SurveyMonkey® at the completion time and placed the copy on the electronic secure drive in a labeled folder for the results to be used in the study. I looked at the file of students' typed responses and then I transcribed their responses into a spreadsheet for analysis. I used open-ended questions (see Appendix B) and for some I provided what I

called assistive ideas to prompt the students. For example, one question asked: When did you feel the most engaged in the course and delivery method chosen? Immediately following the question was the text: Assistive ideas: Describe the activities and delivery methods that assist you in being most engaged. Describe the activity that worked the best for your learning. Students then typed their answer into a textbox.

## Data Analysis

### First ANCOVA Analysis

The analysis method ANCOVA was used to conduct the hypothesis testing for the medication administration competency (MAC) exam. The first hypothesis that was proposed is: ($H_0$1) There will be no differences between the nursing students MAC scores among the three delivery methods, $H_0 1: \mu = \mu_0$. The alternative hypothesis ($H_a$1) stated there will be differences between the nursing students MAC scores among the three delivery methods, $H_a 1: \mu \neq \mu_0$. A 95% alpha level was used to reject the null hypothesis.

The ANCOVA examined the mean differences and analysis of variance from the testing of the MAC and the advancement made from the baseline. The first ANCOVA test analyzed the HESI pretest math baseline to the MAC scores to detect any significant differences among the three delivery methods. The ANCOVA was to assist to reduce/remove any bias of any confounding variables known that may influence the dependent variable (Field, 2012; Gravetter & Wallnau, 2009).

Another reason to use the ANCOVA was to reduce the amount of error in the variance, meaning if unexplained variance were explained, then the error can be controlled or measured as a covariate, according to Gravetter and Wallnau (2009) as well as Field (2013). The use of an ANCOVA was to ensure the treatment did, in fact, cause a significant difference in the dependent variable and not some covariant. In addition, the ANCOVA measured the strength and the influence of the covariant on the dependent variable. The comparison of the HESI pretest math baseline to the MAC answered the research question: Is there a significant difference among the three delivery methods as associated with the passing grade?

**Second ANCOVA Analysis**

Use of the second ANCOVA was to detect any significant differences between the pretest exam (HESI) and the number of times the students took the post-test MAC exam before passing among the three delivery methods. The null hypothesis ($H_0$2) stated there would be no differences between the nursing students number of times MAC is taken to obtain a passing score among the three delivery methods, $H_0 2: \mu = \mu_0$. The alternative hypothesis ($H_a$2) stated there would be differences between the nursing students number of times taking the MAC to obtain a passing score among the three delivery methods, $H_a 2: \mu \neq \mu_0$. Again, I used the 95% alpha level to reject the null Hypothesis. ANCOVA was used for analysis for the same reason as stated for the first ANCOVA used above: to control the variability and to decrease error. The ANCOVA

answered the second research question: Is there a significant difference among the three delivery methods as far as number of times the MAC exam is taken?

**Qualitative Analysis**

The second phase (qualitative) answered the last research question, which occurred outside the classroom and after the Phase 1 data collection. The survey was field tested with three students and later with five nursing experts.

An invitation was sent to each student who participated in the first phase of the study from each of the delivery methods, with a follow-up reminder one week later via the school's email system. The administrator of SurveyMonkey deployed the link to the students who participated in the first phase that agreed to complete the open-response survey, thus protecting the student identity from the researcher.

Data were collected from the open-response survey of open-ended questions asking the students how the delivery method assists their learning, how the delivery method did not assist their learning, and math problem questions showing the work of how the answer was obtained. The open-response survey contains these three types of questions for triangulation. The open-response surveys' results and math problems were compared to the quantitative analysis results. The use of positive and negative open-response survey questions with the quantitative analysis assisted in the accuracy of the data analysis and to judge if there were a connection between delivery method and MAC scores for the best recommendation for teaching the math course.

I developed a coding procedure to code the open-response survey responses from the students to look for themes or categories that run throughout the responses. According to Seidel (1998), a code is developed for use to mark significant statements, of the students' responses to questions. A master list contained the developed and recorded coding (Seidel, 1998). Usage of a master list assists in controlling inter-reliability for coding each survey by the same researcher. The coded items indicate categories of themes and meanings.

According to Creswell and Plano-Clark (2011), the coding procedure should have a "top down and bottom up" approach to analysis of qualitative data. This is a "core element" in qualitative data analysis. In the "top down" analysis, the students are responding to the questions and ideas the researcher is using to study the phenomenon. Then one additional question/statement asked on the open-response survey was for the student to place any additional comments they wish regarding learning math. The additional question may spark ideas that the researcher does not ask or consider in the open-response survey but may be important to analysis; students also may, throughout the open-response survey, write unexpected ideas, thus a "bottom up" analysis (Creswell & Plano-Clark, 2011).

I used color highlighting or code to mark significant student statements s indicating an understanding of the student's perceptions. Next, placement of the highlighted or coded items into categories of themes/meanings occurred by rereading the

highlighted/coded statements and using a number coding to decide which theme it should belong.

Each theme/meaning coded was reread for further in-depth information and possible subcategories that may be present in each major theme and codes developed that indicate each subcategory found and applied to a face-sheet of codes as well as look for co-codes, meaning data that falls into more than one of the categories of meaning (Seidlel, 1998). An example, coding for themes and sub-themes in each question occurred with each of the 30 questions in the survey, which are broken up into three sections. Next, a written summary for each question with a summary for each of the three sections of the 30-question survey transpired. After completion of the three section summaries, a large summation of all the themes emerged.

In each theme/meaning category, a written description/summarization capturing the essence of the participant experience as well as quote support from the original survey transcription finalized the process (Creswell, 2003, 2007, 2011). The summarization included enumeration, as described by Seidel (1998) as searching to find any relationships that may be presented in the data, such as the number of times a certain theme arises. Based on the relationships found, a table may need to be put together to further the understanding of the relationships (Creswell, 2003, 2007, 2011), a type of typology as discussed by Seidel (1998). Then to increase research validity, I held a participant feedback and discussion session of the researcher's interpretations and

conclusions to provide insight and to verify that data gathered with the participants (Seidel, 1998).

Research validity and reliability increases by the use of triangulation in the qualitative phase (Creswell & Plano Clark, 2011). The triangulation setup included the use of quantitative analysis, but also the survey development covered three different angles of a student's perception for similarities and differences comparisons. The first sets of questions in the open-response survey ask positive open-ended questions of a student's perceptions of the delivery method of choice. An example is: What teaching methods and interactions do you judge to be the most beneficial to your learning experience in the classroom delivery method of your choice and most classmates you know? This allowed me to obtain information from the student in detail and their positive views of the course. The next set of questions captured the negative views of the course. An example is: When did you feel the least engaged within the course and delivery method of choice? Why did the other two methods not work for you? Another angle is a set of questions asking the students to work math problems showing every step of how they obtained the answer. These set of questions cover three different angles of student perceptions. Each of these three angles—the positive question, the negative questions, and the math problems—assist in judging if the (a) strategy of the math problems makes sense; (b) the results of the math problems are correct; (c) if there is a relationship between the strategy and the best recommendation for teaching the course; (d) and the delivery method chosen.

Next, all of the categories were collected together with the written descriptions from each category to write another description that puts all of the items and parts together as a whole and use quotes from each category to support the written material. The expectations were the results explain the perception of the student in each of the delivery methods, the interpreted quantitative data and qualitative data resulted from a deeper mathematical understanding, and evidence assists faculty in choosing a delivery method having the best outcomes for the math course.

## Protection of Participants' Rights

I provided all of the participants an explanation/information regarding the study objective and participants' rights acknowledged in order to gain access to the archived data of 2012–2014 students. These students were still attending the school. The nursing students received a consent form, once signed; their data (archived) were used for the study, and the questionnaire.

Informed consent forms emailed to all nursing students fitting the sample inclusion criteria via the freshman teaching team and admissions coordinator/department chair occurred. The emailed informed consent form indicated the study objectives and the rights of the participant. The informed consent information also indicated that I planned to keep all the information confidential and would not know which data belonged to which name. The participants were informed the data collected would not be used by the school nor affect the grade received in the course. I accepted to the study those who voluntarily signed the informed consent form. Protection of names and personal

information occurred by the use of an electronic secure drive. The signed consent forms received are on this secure drive. All data for the study received are also on a secure drive. The names of all those who signed the consent forms were placed on a master code sheet that the freshman teaching team, HESI administrator, and the admissions coordinator/department chair used to give each student a master alphanumeric code ID. The master code sheet will be kept secure by the freshman teaching team; HESI administrator, admissions coordinator, and department chair where I do not have access (see Appendix D for sample). I received the worksheet that has the alphanumeric code and the student information matching that code, so I did not know which data information and personal information goes with which name of the signed consents.

I completed the utilization review report (URR) of the school of nursing and institutional review board (IRB) process of Walden University (IRB approval number 06-04-15-0126229) and the Midwestern school of nursing ethics committee processes before I obtained any informed consent forms from participants. The students in the sample received information and then they signed consent forms that allowed the data collection. I signed the protection of information consent, and I submitted a copy to the school of nursing and Walden University. I also submitted a copy of my National Institutes of Health (NIH) ethics certificate to both of the schools.

## Summary

The purpose of the sequential explanatory, mixed-methods, nonexperimental pre-posttest alternative treatment design was to obtain statistical data from a sample of

student nurses' math abilities for medication administration. The design was chosen to answer which of three delivery methods created the most advancement from base-line data. This obtained data were from the school's archived data from 2012 to 2014, then a follow up with a survey to nine students who participated in Phase 1. The study could indicate one method is best practice or that another different method for a certain group may be the best practice. The study could also indicate two or more methods meet the nursing student's needs and the students are choosing the delivery method right for them. The data may well show there may be no, one best method for all. The study in turn, may have an effect on delivery methods of math programs within schools of nursing.

# Section 4: Results

## Introduction

I conducted this study in two phases; the first phase was quantitative and the second phase was qualitative. The results are presented in three sections, the quantitative phase (divided into ANCOVA 1 and ANCOVA 2), the qualitative phase, and the conclusion. The goal of the first phase was to obtain data from 150 participants from the school's archived database. The nursing chair of the school obtained the raw data from the school's archived database, removed the identifiers, and I accepted the raw data via secured password protected email. The raw data on two students was incomplete and these were removed from the study. The 148 students whose data were complete were used in Phase 1 with 56 participants in traditional delivery method math course, 50 participants in the hybrid delivery math course, and 42 participants in the online delivery method math course. Phase 2 used nine students from the total 148 that participated in Phase 1. Three student participants were randomly chosen from each of the three delivery methods to makeup the nine student participants.

## Findings

### Phase 1: Quantitative Phase

**ANCOVA 1.** ANCOVA 1 was conducted using 148 students. The descriptive statistics indicated that the participants were within one standard deviation from the mean. The Levene's test of equality of error variances tested the null hypothesis that the error variance of the dependent variable is equal across all groups.

The results of the first ANCOVA revealed that the delivery method of the math course (independent variable) had no effect on the MAC score (dependent variable). Thus, the null hypothesis was accepted based on the results. The relationship between the covariate (HESI) pretest and the dependent variable (MAC) posttest is significant, as evidenced by $F(1, 144) = 14.457$, $p < .000$ (see Table 2).

Table 2

*Tests of Between-Subjects Effects MAC Scores and Delivery Method*

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 16.583[a] | 3 | 5.528 | 5.779 | .001 |
| Intercept | 949.036 | 1 | 949.036 | 992.158 | .000 |
| delivery | 1.439 | 2 | .719 | .752 | .473 |
| HESI | 13.829 | 1 | 13.829 | 14.457 | .000 |
| Error | 137.741 | 144 | .957 | | |
| Total | 50438.000 | 148 | | | |
| Corrected Total | 154.324 | 147 | | | |

*Note*. *R* Squared = .107 (Adjusted *R* Squared = .089)

According to the plots on Figure 1 the traditional delivery method had a higher mean score, but not enough to consider to be significant as evidenced by $F(2, 144) = .752$, $p = .473$.

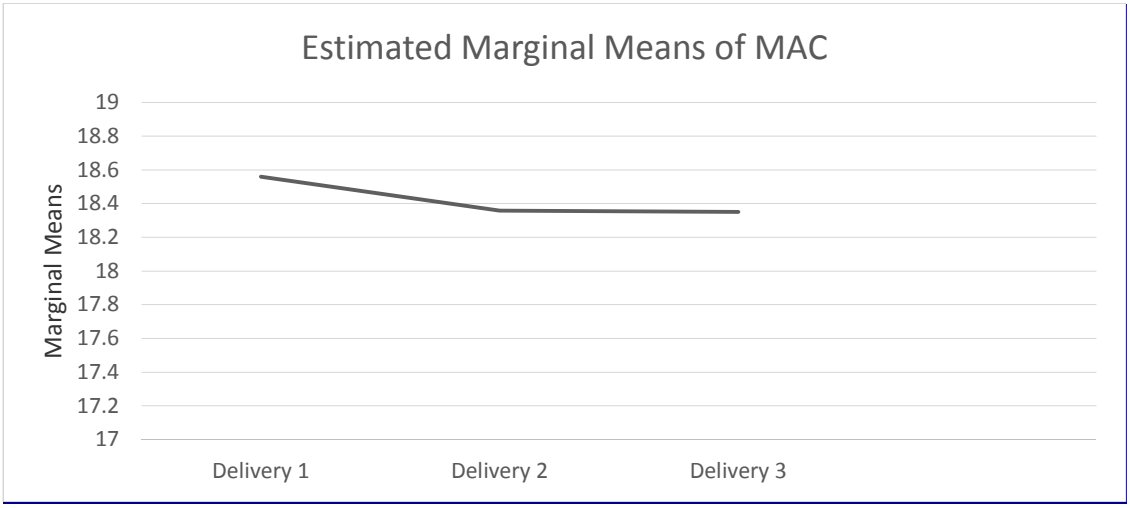


*Figure 1.* Delivery method and MAC score profile plots.
1=Traditional delivery method, 2=Hybrid delivery method, 3= Online delivery method

In Table 3, the means for each delivery method are very close together with no more than 0.2 difference at a 95% confidence interval. There is not enough difference between each delivery method to support that there is a significant difference.

Table 3

*Delivery Methods Means and Standard Deviation*

| Dependent Variable: MAC | | | | |
|---|---|---|---|---|
| Delivery | Mean | Std. Error | 95% Confidence Interval | |
| | | | Lower Bound | Upper Bound |
| 1.00 | 18.560[a] | .131 | 18.300 | 18.819 |
| 2.00 | 18.358[a] | .139 | 18.084 | 18.632 |
| 3.00 | 18.351[a] | .151 | 18.053 | 18.650 |

*Note.* Covariates appearing in the model are evaluated at the following values: HESI = 77.3026. 1 = Traditional delivery method, 2 = Hybrid delivery method, 3 = online delivery method

ANCOVA 1 answered the first research question: is there a significant difference among the three delivery methods as associated with the passing grade for the MAC? The answer is no, there is not enough of a statistically significant difference among the three

delivery methods in having an effect on the MAC score. The only effect found was the pretest (HESI) does have an effect on the MAC score as evidenced by $F(1, 144) = 14.457$, $p < .001$; therefore, the null hypothesis stands.

**ANCOVA 2.** ANCOVA 2 was conducted using the same 148 students in ANCOVA 1 with 56 participants in the traditional delivery method math course, 50 participants in the hybrid delivery math course, and 42 participants in the online delivery method math course. The purpose was to find differences in number of times the MAC was taken, between the three delivery methods. The descriptive statistics indicated that the participants are within one standard deviation from the mean. The Levene's test of quality of error variances tested the null hypothesis that the error variance of the dependent variable is equal across all groups.

Table 4

*Dependent Variable: Number Times MAC is taken to pass*

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 9.380[a] | 3 | 3.127 | 4.621 | .004 | .088 |
| Intercept | 54.922 | 1 | 54.922 | 81.173 | .000 | .360 |
| HESI | 8.813 | 1 | 8.813 | 13.025 | .000 | .083 |
| delivery | .253 | 2 | .127 | .187 | .830 | .003 |
| Error | 97.431 | 144 | .677 | | | |
| Total | 944.000 | 148 | | | | |
| Corrected Total | 106.811 | 147 | | | | |

*Note. R* Squared = .088 (Adjusted *R* Squared = .069)

The results of the analysis indicated that the null hypothesis should be accepted as evidenced by $F(2, 144) = .187$, $p = .830$. Thus, the delivery method of the math course (independent variable) has no effect on the number of times MAC is taken to obtain a passing score (dependent variable) Figure 2, indicated that the traditional group took the MAC exam fewer times than the other groups in order to pass. The traditional group did better, but not significantly. The difference in the means with a 95% confidence interval is only about 0.04 to 0.1 difference between the groups; thus, not enough to be considered significant as seen in Table 5.

Table 5

*Delivery Method Means and Standard Error*

| Dependent Variable: Number Times MAC taken to pass | | | | |
|---|---|---|---|---|
| delivery | Mean | Std. Error | 95% Confidence Interval | |
| | | | Lower Bound | Upper Bound |
| 1.00 | 2.335[a] | .110 | 2.117 | 2.553 |
| 2.00 | 2.377[a] | .117 | 2.146 | 2.607 |
| 3.00 | 2.438[a] | .127 | 2.187 | 2.689 |

*Note.* Covariates appearing in the model are evaluated at the following values: HESI = 77.3108.

1= Traditional delivery method, 2 = Hybrid delivery method, 3 = online delivery method

According to the plots seen in Figure 2, the traditional delivery method participants had overall taken the exam less times to pass than the other participants in the other two methods but only slightly, not enough to be considered significant, $F(2, 144) = .187$, $p = .830$.

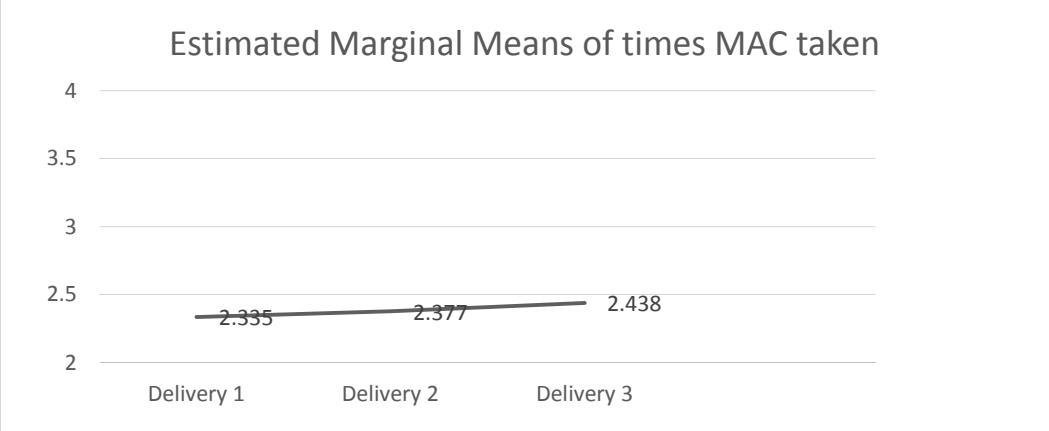


*Figure 2.* Delivery method and number of times MAC taken to pass profile plots. 1 = Traditional delivery method, 2 = Hybrid delivery method, 3 = online delivery method

ANCOVA 2 answered the second research question: is there a significant difference among the three delivery methods as far as the number of times the MAC exam is taken? The answer is no. There is not enough of a statistical significant difference among the three delivery methods. The only effect found was the pretest (HESI) does have an effect on the number of times the posttest (MAC) is taken to obtain a passing score, $F$ (1, 144) = 13.025, $p$ = 000. The conclusion is that the null hypothesis is correct.

Table 6

*Students with HESI Scores < 60%*

| Number of times MAC exam Taken to pass | MAC Score | Number of students |
|---|---|---|
| 6 | 17 | 1 |
| 5 | 17 | 1 |
| 4 | 17 | 2 |
| 3 | 17 | 5 |
| 2 | 17 | 3 |
| 4 | 18 | 2 |
| 3 | 18 | 1 |
| 2 | 18 | 4 |
| 1 | 18 | 1 |
| 2 | 19 | 2 |
| 2 | 19 | 2 |

**Descriptive Statistics.** The score needed to pass the MAC exam is 17 or higher out of 20; the score equals an 85% score. Many of the students (71 students out of 148) received a score below 19 out of 20 on the MAC posttest exam. The breakdowns of scores are as follows: There are 36 students who received a score of 17 out of 20, 35 students received the score of 18 out of 20, 52 received the score of 19 out of 20, and 25 students received a score of 20 out of 20. Out of the 148 students, 10 passed the MAC exam on the first try and the other 138 students needed to take the exam more than once. Out of the 138 students, 87 took the MAC exam the second time and passed. There were 39 out of the 138 students who took the Mac exam three times before passing. The 12 students left needed over three times to take the exam to pass and five needed five or more times to complete the MAC exam with a passing grade. Out of the 148 students 24 received a score equal to or less than 60% on the pretest (HESI exam).

Table 6 shows the group of students who obtained HESI pretest scores that are 60% or under. The 12 students who obtained a score of 17 on the MAC exam took the test on average three times. There were eight students who obtained a score 18 on MAC exam. Most of these students took the test, on average, twice. The two people who obtained the score of 19 on the MAC exam took the test two times. Somehow, these two outliners were able to comprehend the material to take the test fewer times as compared to the rest of the cohort with a (HESI) pretest score under 60%. The higher the pretest score for each student was, the higher the posttest score was and less number of times the exam is taken to pass. The statistics support that the more knowledge a nursing student brings when entering the medication calculation math course, the better the score and less times the test is taken to obtain a passing score of 17 out of 20. The delivery method does not influence the students' retention and understanding of medication math.

**Phase 2: Qualitative Phase**

The qualitative research section was used to explore the nursing students' perceptions of learning medication math. A 30-question survey (see Appendix B) was used to obtain the students' perceptions of learning needs being met, barriers that affected their test performance, and the delivery method used to help find the answer. The students' perceptions were also used to answer the research question: how do the students assess the value of each delivery method? I was looking for any differences or similarities between the perceptions of the students and the quantitative results. The next sections are in two parts: first is the procedure and the second is the results.

**Procedure.** I developed a 30-question survey (see Appendix B). The survey was put into three sections to provide triangulation; the sections were: delivery methodology, learning preference, and math knowledge. Once the survey was developed, it was analyzed by two nursing experts to provide an additional triangulation for inter-rater reliability. Then the survey was sent to five nursing experts to review the questions and send feedback for any corrections. Corrections were made based on the feedback and then the survey was posted on the SurveyMonkey program. SurveyMonkey was used to deploy the survey to the students and provide the answers to be sent in anonymously.

Nine students were randomly chosen out of the 148 that participated in Phase 1; three from each of the delivery methods. The students were given 3 weeks to complete the survey from the time they received the email with the instructions and link. Email reminders were sent out each week to the students to complete the survey if not done so. The survey raw data results were pulled by the researcher for qualitative analysis. I coded the raw data and set up a master code list (see Appendix D). Once the master code list was completed, the list and the raw survey data were sent to a second rater for inter-rater reliability. The second rater returned the data and the Cohen's Kappa was used to determine the strength of the agreement between the raters.

I developed themes from each question based on the coded material and wrote a summary for each of the three sections (see Appendix E) from the themes. I wrote one large Phase 2 section summary from the three sections of themes summaries. Finally, I

reviewed the themes and summaries to find any differences or similarity between the perceptions of the students and the quantitative results (see Appendix E).

**Qualitative results.** The Cohen's Kappa was conducted on SPSS21software to detect inter-rater reliability. The agreement showed to be strong or considered as substantial agreement as evidenced by $k = .778$. The agreement found between the raters is more than by chance and statistical analysis supports the themes developed to be in strong agreement between the raters.

There appears to be no difference between the three delivery methods and the themes discovered. The themes indicated that the delivery method did not seem to matter and did not increase by much the retention and math knowledge of the students. According to the students' perception what made a difference in understanding math was not the delivery method but the strategies used within the delivery method. Students' perception was that strategies that were active or interactive work best, such as group work, many practice problems, and hands on activities. Nursing students felt that there is a need for structured learning when first encountering medication math. The students wanted the structured learning to become flexible to be more semi-structured learning as experience is gained and self-confidence is developed. Some examples from students' statements that support the flexible classroom are; "I think that since every student learns differently it is helpful to have all options available" and "I like the flexibility to work at my own pace on my own but having a flexible structure with due dates to keep me motivated to complete tasks".

In the math problems of the questionnaire, students had difficulty with identifying the correct items or relationships and patterns to pull out of the problem the items needed to set up the problem to be solve. The nursing students found it difficult to understand the rules or actions needed to solve the problem. About 50% of the students made some type of math error after completing the course no matter what delivery method chosen. Delivery method did not seem to have an effect on the number of errors made by each group and appears to be evenly distributed. Students found ratio proportion, fractions, decimals, and remembering conversions from three systems to be the most difficult tasks in the math course.

The qualitative data answered the research question: How do the students assess the value of each delivery method? Seven themes were drawn from the data that support that the delivery method made no difference in the students' math skills:

1. Delivery method did not matter in retaining material.
2. Delivery method did not affect math errors made.
3. The better the skills of the student upon entry to the course the less difficulty the student had in preforming math skills.
4. Discussions, interactions, group work, flashcards, and other similar teaching strategies worked best no matter what delivery method was used.
5. Visuals, videos, pictures, stories, activities that relate to the content help retain the material.

6. Class room flexibility was mentioned and seemed important to the student no matter the delivery method.
7. Students valued teaching strategies used to help retain the material rather than the delivery method.

## Summary

The findings are in general that the delivery method had no discernable effect on student perception or success on the MAC. Delivery method had no effect on the score of the MAC. The delivery method has no effect on the number of times the MAC exam is taken. Students pointed to strategies used to help retain the material that is not always used. There is a need for a flexible classroom environment no matter the delivery method. Student's entering with better math skills has an advantage over others with less math skills.

Section 5: Discussion, Conclusions, and Recommendations

## Introduction

The purpose of the study was to discover which of the three delivery methods—traditional, online, or hybrid—used to deliver the clinical math course for pre-license nursing students brings about the best outcome. The first phase, quantitative research, addressed the relationship and/or comparison of each delivery method from a collection of three. The first phase was used to answer two research questions:

1. Is there a significant difference among the three delivery methods as associated with the passing grade for MAC?
2. Is there a significant difference among the three delivery methods as far as the number of times the MAC exam is taken?

The second phase was qualitative. An open-ended survey was used to answer the third research question:

3. How do the nursing students assess the value of each delivery method?

The questionnaire's purpose was to explore the participants' views regarding learning needs being met barriers that affect test performance, and the delivery method used. The intent of the survey was to discover themes that may support any differences and/or similarities between the perceptions of the students and the quantitative results. The results of the study showed that no one delivery method is better than another. The students in the qualitative section claimed it was the teaching strategies used within the delivery method that made a difference. The discussion section will be presented in

several subsections: interpretation of findings, practical implications, recommendations for action, recommendations for future research, implications for social change, and conclusions.

## Interpretation of Findings

The first ANCOVA test answered the research question: is there a significant difference among the three delivery methods as associated with the passing grade for MAC; the answer was no. The results of the analysis indicated that there was no significant difference between groups, $F(2, 144) = .752$, $p = .473$, as seen in Table 1. This finding is similar to other studies.

Lim et al. (2006) conducted a comparison study using 69 undergraduate students majoring in human resource development. Lim et al. compared online learning with blended, or hybrid, learning and found no significant difference when comparing online, traditional, or blended learners. McLaren's (2004) study of undergraduate business students also found that there were no significant data to support that any one delivery method made a difference in learning. Thirunarayanan and Perez-Prad's (2001) study using 29 undergraduate students majoring in education in a course to teach English, was similar to this study's results, where the traditional classroom did do better but not statistically significantly. Ni's (2013) study regarding students in a public administration program also looked at three delivery methods and found there was no differences in the group's learning effectiveness. There are some studies that say they did get significant

results that the delivery method of a course made a difference: Maybe these significant findings were due to small sample size (Murray et al., 2013).

The only significant relationship found was between the pretest and posttest, $F(1, 144) = 14.457$, $p < .000$. The pretest (HESI) appears to be able to predict how well a student will do on the posttest and could be used to set up a cutoff point to admit a student to the nursing courses. The pretest could also be used to show a need for a remediation math course before starting nursing courses. The higher the pretest score the more likely the student would pass the MAC exam and the higher the MAC score would be (as seen in Figure 2 and Table 6).

The second ANCOVA was used to answer the second research question: Is there a significant difference among the three delivery methods as far as the number of times the MAC exam is taken? The answer was no, as shown in Table 2. The results of the analysis indicated that the null hypothesis should be accepted, $F(2, 144) = .187$, $p = .830$. After searching many databases, there were no studies found that discussed the number of times a student took the posttest (MAC) before passing it. In this study, the only significant relationship found was between the pretest (HESSI) and number of times the student takes the posttest before receiving a passing grade which is significant $F(1, 144) = 13.025$, $p < .001$. The relationship supports that the pretest (HESI) could predict how many times the student took the MAC exam before passing. The most recent research that I found was Shapiro, Keller, Lutz, Santoro, and Hintze (2006). Shapiro et al. conducted a study regarding math skills and standardized testing as a predictor of grade

school math grades. Shapiro et al. found similar results with a moderate to strong relationship between standardization testing and future math scores, ($p < .0001$) with correlation of .56 to .64. However, Shapiro et al.'s research is over 11 years old. Future research could investigate the development, use, and effect of an additional math course for students who score low on the HESI and then take the MAC.

Phase 2 of the study was used to gain insight into the students' experiences with the different classroom delivery methods. Similar work was done by Mackie and Bruce (2016), who conducted a qualitative study with eight nursing students to identify challenge areas in medication dosage calculations. Mackie and Bruce identified challenges related to conceptual understanding as well as numeracy skills. The students' responses from the study included that a variety of methods of instruction and conceptual teaching worked best to assist the student learning.

Dobbs et al. (2009) conducted a qualitative study to explain students' experiences with face-to-face and online learning methods. Dobbs et al. and Forman (2011) reported that the students found the traditional classroom was easier than online courses and their GPAs were higher than students from online groups.

According to Billings and Halstead (2012), there are three factors that help develop a positive outcome for the student. The first factor is the interaction of the instructor, second is the media involvement, and the third is interactive teaching strategies used regardless of the delivery method. Murray et al. (2013) felt this difference could be due to the fact that the courses used or required detailed matching to the content

and used active and interactive teaching strategies within the delivery method; whereas in this study I conducted, the same teaching methods, active and interactive teaching strategies used, were the same in all delivery methods. The delivery method was the only difference.

I discovered that in both phases, quantitative and qualitative, the data supported that the delivery method made no significant difference in student learning and that 50% of the students failed the math problems on the qualitative section. What made a difference, according to the students' perceptions, was the use of active and interactive teaching strategies within the delivery method chosen. Mackie and Bruce (2016) also came to the same conclusion. The students in my study felt that the discussions, interactions, group work, flashcards, and other similar teaching strategies worked no matter what delivery method was used for the course.

The nursing students answered the third research question: how do the nursing students assess the value of each delivery method. According to the students, it did not seem to matter what delivery method was chosen for the course. What the nursing students valued were the strategies chosen to use within the delivery method. The students felt visuals, videos, pictures, stories; activities that relate to the content and help the material stick in my brain seem to work the best no matter what the delivery method is for the course (see Appendix E). Mackie and Bruce (2016) study concluded similar results. In the authors' findings, "students identified conceptual understanding deficits, anxiety, low self-efficacy, and numeracy skills as primary challenges in medication

dosage calculations" (Mackie & Bruce, 2016, p. 10). Mackie and Bruce also found that using strategies that are multi-modal seem to assist the student's abilities to calculate dosages.

I used only nine students, three from each of the delivery methods to obtain student perceptions; that may have made a difference in this study as compared to others. The group of nine may have been too small to get a complete picture of how delivery methods are valued. However, the quantitative portion of my study was very clear.

The theory used in this study was from novice to expert (Benner, 1984). Benner pointed out that the learner gains skills over time with practice and experience. The students in this study match more of the "novice" side of the scale, having very little experience with medication math in general. The students in this study felt that, as adult learners, they needed to have experience gained through the use of many different teaching strategies no matter the delivery method. Students stated that they believed strategies for teaching needed to range from being very structured in the beginning of the course, , to more self-regulating learning structure as they gained experience in learning medication math. The study supports Benner's (1984) theory in working with novices and supporting learning to become an expert.

Knowles's (1984) adult learner concept also applies here, in that students want to be involved and engaged in the leaning, with instructors taking into account where they are at in the learning process. Knowles (1984) assumed that the learner wants to participate in setting up the learning environment and faculty must know the experience

the student possesses. The students perceived the need to have instructors at the beginning of their math education to assess their learning and their evolution of gaining skills. A beginning learner is dependent upon the instructor and a teacher centered model of instruction; therefore, the beginner is a pedagogical learner (Heise, & Himes, 2010; Knowles et al., 1998; Merriam et al., 2007). As they gain skills, students want to make their own assessment of their learning and determine what they need. This is also one of Knowles's (1984) assumptions, that the learner wants some control as to when and how the information is learned. The student may be transitioning as skills are gained and becoming more of an adult learner and wants more control over learning; such as in Benner's theory the advanced beginner or beginning competence phase learner (Benner, 1984; Bower & Hollister, 1967; Erikson, 1964).

## Practical Implications

The learning environment may not be a physical place but can affect a learner's development and/or growth (Galbraith, 1990; Merriam & Caffarella, 1999; Merriam et al., 2007). Using effective teaching strategies may increase math competency, provide a more through education for nursing students, assist in strengthening the nursing student's math proficiency, and retention of the math concepts. Math should be taught with strategies, such as conceptual teaching, that have been shown to work for nursing students (Billings & Halstead, 2012). Conceptual teaching may decrease medication errors that could be fatal to healthcare consumers. The practical implications section was

broken down into two sections, the Phase 1: quantitative phase and Phase 2: qualitative phase.

**Phase 1: Quantitative Phase**

The data in the quantitative phase supported that the delivery method made no difference in the students' learning (as shown in Tables 1 and 3 in Section 4). Therefore, because the data supports the efficacy of all course types, the school can choose the most cost-effective delivery method. The instructors also need to look at the teaching strategies used within that delivery method and improve them. This study indicates that interactive teaching strategies are valued by students and helps them understand and retain the content of their courses.

Also, students who are in the bottom 60% on the pretest (HESI) exam took the posttest MAC more times and had overall lower scores than other students above 60% as seen in Figure 1. It appears that students with a stronger background in math did better, regardless of the delivery method chosen to deliver the course. The school may use this data and make a choice to provide a math remediation for these students before they enter main nursing courses and take the clinical math course. The quantitative data could also be used to set a cutoff on the pretest exam for entry in to the school of nursing until the student is able to get the pretest score needed for entry. The school setting up a cutoff and or remediation courses for math may help their retention rate for students and graduation rate to increase as well as first time NCLEX pass rates.

**Phase 2: Qualitative Phase**

The qualitative phase data also supports that the delivery method made no difference on the ability to learn math (see Appendix E). The data also indicated that the students wanted a more structured learning environment due to being more in a pedagogic phase, *novice* in learning math skills. The data appeared to support according to the students' perception the use of the traditional delivery method; which would provide the structured environment but not enough to be significantly different. What the students stated was of help in learning was the teaching strategies used with in the delivery method as stated by one student "face to face methods: standard lecture benefits me because I learn well from information devices…group activates, required pre-class activities, …hands on activities." Another student's perceptions of teaching strategies stated they help the content to stick in the mind and retain the information longer. Yet about 50% of the students in the qualitative phase made many math mistakes on the survey after the course were completed, which means that the current solutions do not work. The delivery method itself does not help in student achievement. Thus, instructors need to change teaching methods used in the math course and include more active learning strategies that match the delivery method and content. If the instructors learn more ways to use effective strategies with in a delivery method to match content, then more likely students would pass the posttest exam with less attempts and higher scores. Maybe with students graduating with stronger math skills may lead to the possibility of less medication errors as licensed nurses.

## Recommendations for Action

Based on the results of the study the current system to produce nurses with good math skills does not work. The school should consider staff development activities that teach active, interactive, and conceptual teaching strategies that match content and delivery method. According to Sulosaari et al. (2015), there is a need to discover and develop teaching methods that are most effective, which in turn will increase healthcare clients' safety. Students overall in the study stated that "visuals, videos, pictures, stories, and activities that relate to the content" work very well in assisting the students to retain and understand the material. Students also agreed that "discussions, interactions, group work, flashcards," and other similar teaching strategies worked to help retain content no matter what delivery method was used for the course. Wright (2005) conducted research using 45 nursing students in a clinical math course using different teaching strategies to find the most effective way to teach math to nursing students. Wright found that teaching didactically with the use of exercises, visual clues, smaller class size, and other interactive strategies and allowing students to work at their own pace worked best. Wright (2004) found that nursing students were able to integrate math skills learned into the clinical area, when different types of interactive strategies were used to teach the content. The strategies assisted the learner to develop conceptual and procedural knowledge and retention of the math concepts and skills (Wright, 2004). The students in turn then had stronger math skills and retention of the concepts.

The interactive strategies used in Wright's (2004) study may assist the learner to develop conceptual and procedural knowledge and retention of the math concepts and skills. Thus, the student gains stronger math skills, which may lead to less medication errors as a student and later as a graduate. Nursing schools may also choose to accept only students above a certain cut off in math based on standardized admission tests. Another option is to divide students to two different tracks; the low math students will have to take more math courses before they are allowed to go to the clinical math course.

Early math education is a major influence in students' ability to retain and use strong math skills. Students with stronger math scores and who have taken the posttest less times with higher scores could lead to less medication errors as nursing students and as graduates. Counselors should guide prospective students to work on strengthening math skills: support/supplemental math instruction course for enrolled students with low pretest scores could be recommended by the counselors, to increase success in completing courses (Wright, 2004).

It is recommended that the math course be delivered in one format to save money on staffing and need of classrooms. The use of small class size no matter delivery method would lead to more student-centered teaching that may meet the learning needs of nursing students. It is also recommended allowing fewer times for students to pass the MAC may encourage students to work at having strong math skills. Providing a math remediation course for students that do not pass the MAC in the first or second testing may also help increase retention of math skills. In summary, separating between low and

high math students (based on pretest), and using conceptual and interactive teaching strategies might bring better results.

## Recommendations for Future Research

The study revealed that the delivery method of a math course does not affect the students learning but that teaching strategies may make the difference. The study also showed that the pretest does have an effect on the students' math score and the number of times the exam is taken to receive a passing score. It would be interesting to do a longitudinal study, to follow the students in this study after graduation regarding if less medication errors were made.

This study only included clinical math course conducted at one school of nursing. This researcher would like to replicate/ conduct the study using more schools of nursing and math courses and compare the results to see if a large group would yield a significantly different result.

I would like to conduct another possible study to compare teaching strategies and find which ones really are the most affective in teaching math compared to others. The use of more effective teaching strategies that match the delivery method and content the more likely the student will retain the content and more likely to make less medication errors.

## Implications for Social Change

The ability of enrolled nursing students to retain and understand math concepts lies with the instructors providing supplemental instruction. The student needs assistance

to bridge the gap between the math skills the student enters college with and the skills necessary to be successful in the math course which may lead to decrease medication errors. The course could be delivered in whatever format the school chooses; saving money, time, number of courses, and staff teaching the courses. Putting the focus on teaching strategies used that are effective with teaching math, in the long term may affect the retention of nursing students and help them to be successful. Nursing students with strong math skills may have less medication errors as newly licensed nurses in the clinical field, which would increase patient safety in the healthcare environment. Today's technologies allow schools to offer courses in different formats. But the course delivery is secondary to learning that takes place. More research is needed into teaching and learning to assist nursing students to retain and apply math concepts.

## Conclusions

The problem that sparked the need for the study was the level of math skills seen in nursing students. The problem can lead to injury or loss of life to the client in the care of a nurse with low math skills. The literature review contains articles, books, and research from the years of 1926 to 2016. The vast set of years show a consistent history that the problem still exists and remains unsolved.

Various methods have been used in the past and in most recent times to solve the issues of low math skills. Some of the strategies used were the calculator during testing, computer assisted learning, group work, and various delivery methods. Some researchers concluded that the delivery method made a difference, while other researchers concluded

it did not make a difference. The literature reviewed was inconclusive regarding the various methods truly solving the math skills problem.

My study used three delivery methods but kept the same instructor, book, and strategies to teach the math course. What I learned from the study was that none of the delivery methods were superior for improving the math problem solving skills of nursing students. The quantitative analysis evidence supported that none of the delivery methods used made a difference in the nursing students learning of the math skills. The qualitative analysis evidence supported the same conclusion; the students agreed that the delivery method made no difference in their learning but that certain strategies used within the delivery method seemed to assist the learning.

Schools of nursing have the option to only accept students with high level math scores to begin with, or when accepting students with low math skills, they need to have several math classes with conceptual teaching strategies. Using effective teaching strategies, such as conceptual teaching, may develop nurses with a strong sense of math skills which in turn may decrease medication errors providing a safe environment for healthcare consumers free from injury or loss of life.

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# Appendix A: MAC Exam Questions

1. Glyburide (anti-diabetic) 20 mg has been ordered. This is equivalent to how many grams? 0.02

2. Pravastatin (antilipemic) 20 mg has been ordered. This is equivalent to how many mcg? 20,000

3. Guaifenesin (expectorant) 0.6 gm has been ordered. This is equivalent to how many mg? 600

4. Docusate (stool softener) 100 mg has been ordered. This is equivalent to how many grams? 0.1

5. Aspirin (anti-inflammatory) 650 mg/1tab bid has been ordered. Aspirin is available in mg. How many mg would be administered in one day? 1300

6. OxyMorphone (narcotic analgesic) 0.02 gm has been ordered. OxyMorphone is available in 10mg tablets. How many tablets should be administered? 2

7. Sertraline (selective serotonin reuptake inhibitor) 100 mg has been ordered. Sertraline is available 20 mg per 1mL. How many tsp should be administered? 1

8. Ciprofloxacin (anti-infective) 300 mg has been ordered. Ciprofloxacin is available 10 mg per 1mL. How many tbsp should be administered? 2

9. Naproxen (nonsteroidal anti-inflammatory) 750 mg has been ordered. Naproxen is available 125 mg per 5 mL. How many Tbsp should be administered? 2

10. An adult weighs 230 lbs. This is equivalent to how many kg? 104.5

11. An adult weighs 90 kg. This is equivalent to how many lbs? 198

12. Thyrotropin (thyroid hormone) 75 mcg has been ordered. Thyrotropin is available in 25 mcg tablets. How many tablets should be administered? 3

13. Fludrocortisone (corticosteroid) 200 mcg has been ordered. Fludrocortisone is available in 0.1 mg tablets. How many tablets should be administered? 2

14. Bumetanide (loop diuretic) 0.008 gm has been ordered. Bumetanide is available in 2 mg tablets. How many tablets should be administered? 4

15. The physician has ordered 250 mL of 0.9%NS to be infused over two hours. The infusion rate should be set to: 125 mL/h

16. The physician has ordered 1000 mL of Ringer's Lactate to infuse over 10 hours. The infusion rate should be set to: 100 mL/h

17. D5 0.45%NS is infusing at 75 mL/hr. How long will it take to infuse 1 liter? 13.3 hours
18. 1gm Vancomycin (anti-infective) is mixed in 150mL of IV fluid. The infusion pump is set to administer the dose at 50mL/hr. After 15 minutes, the IV site has infiltrated. How many mg of Vancomycin were received? 83.3

19. Sotalol (anti-dysrhythmic) is mixed 300 mg in 20 mL D5W. How much Sotalol is in 1 mL of this solution? 15

20. Heparin (anti-coagulant) is mixed 25,000 units in 500 mL. How many units of Heparin is in 100 mL of this solution? 5000 units

Use the following sliding scale insulin to answer the question.

Blood Sugars(mg/dL)

<70 Initiate hypoglycemia protocol

70-130 give 0 units of Regular Humulin insulin

131-180 give 2 units of Regular Humulin insulin

181-240 give 4 units of Regular Humulin insulin

241-300 give 6 units of Regular Humulin insulin

301-350 give 8 units of Regular Humulin insulin

351-400 give 10 units of Regular Humulin insulin

>400 give 12 units of Regular Humulin insulin and call the doctor.

Ordered is 35 units of Humulin N insulin to be mixed with a regular insulin based on the blood sugar of 325. How many units of the Regular Humulin insulin should be used with the Humulin N?

## Appendix B: Open-Response Survey Questions

1. What course delivery method did you use and why did this work for you? (hybrid, online, face to face)
2. Why do the other two methods not work for you?

   Assistive ideas: What is wrong or not working in the other two delivery methods not used? Give an example with details with rationale of why it does not work for you.
3. What learning style do you feel works best for you?

   Assistive ideas: Hands-on, auditory, visual, structured learning, self-directed learning, combination of styles.
4. What do you perceive as the best way for you to learn math skills? Describe the methods used.

   Assistive ideas: working alone or in groups, use of interactive tools, books, computer interactive lessons, flash cards, with the instructor lead activities, self-directed activities.
5. What do you perceive to be a barrier for you to learn math skills? Describe the barrier.
6. When did you feel the most engaged in the course and delivery method chosen?

   Assistive ideas: Describe the activities and delivery methods that assist you in being most engaged. Describe the activity that worked the best for your learning.
7. When did you feel the least engaged in the course and delivery method chosen?

8. What would be your recommendations to strengthen the math course and meet your learning needs?

   Assistive ideas: what activities should be included and how should they be presented, in a PowerPoint, lecture, online in an interactive self-learning format, book, in classroom with instructional presences, etch.

9. What experience best assisted in meeting your learning needs?

   Assistive ideas: course content delivery methods, procedural versus conceptual teaching methods, what helps your comprehension and memory.

10. What experience least assisted in meeting your learning needs?

11. What course documents, text, and activities were helpful in your understanding of the concepts?

    Assistive ideas: Describe in more detail the content/strategy you found to be helpful.

12. What course documents, text, and activities were least helpful in your understanding of the concepts?

13. What teaching methods and interactions do you judge to be most beneficial to your learning experience in the classroom delivery method you chose and most of the classmates you know?

    Assistive ideas: best way for you to learn facts, concepts, or rules.

14. What teaching methods and interactions do you judge to be the least beneficial to your learning experience in the classroom delivery method you chose and most of the classmates you know?

15. What strategies help you learn and what you think helps most people you know to learn math skills?
16. What strategies least help you learn and what you think is least helpful to most people you know to learn math skills?
17. Which math concepts are easier?

    Assistive ideas: give an example with details and rationale why it is easier.
18. Which math concepts are more difficult?

    Assistive ideas: give an example with details and rationale why it is difficult.
19. Complete the following math problem. Show all of your work in steps.
20. Problem: 342 mg of an antibiotic (Cephalosporin) must be prepared to be given per doctor orders. A 1 g vial of the antibiotic in powdered form is available. Directions for reconstitution: Add 10 ml of normal saline to yield 95 mg/1ml. How many ml should you withdraw from the reconstituted vial? _____ml
21. Complete the following math problem. Show all of your work in steps
22. An infant weighs 13 lbs and 11 oz. 13 lbs and 11 oz. are equivalent to _____kg.
23. Complete the following math problem. Show all of your work in steps
24. A liquid antibiotic is available for po use labeled 125 mg/5 ml. 250 mg of the antibiotic has been prescribed by the doctor. How much should be prepared of the antibiotic for administration? _____ml
25. Complete the following math problem. Show all of your work in steps

26. The doctor has prescribed 150 mg of chlorpromazine hcl to be given po. The medication is available in tablets labeled 50 mg. How many tablets should you administer? _____tablet(s)
27. Please place here any other additional comments you wish to share regarding learning math content.
28. Do you find when learning medication math that you need the instructor to set up the learning environment?

    Assistive Ideas: Do you feel you need face to face, classroom, and classmates present , to learn. Do you feel you need immediate face-to-face feedback and structured learning? Do you feel lost and not sure of what learning is needed? Do you feel you do not have much experience to base the learning? Do you feel you need a step-by-step procedure to calculate medication math? Explain in detail you answers.
29. Do you feel you need only some structure to learning provided by the instructor and the rest you control and set up?

    Assistive ideas: Do you need some face to face time to get feedback or clarification on some items but others you are able to structure and learn on own? Do you feel you have some past learning experiences to assist the learning of medication math but not enough to be independent? Do you feel when you look at a problem you are able to pull out the information needed due to some experience and the solution to solve the problem but may want some face to face feedback? Explain in detail you answers.

30. Do you feel you need the instructor as a facilitator and that you control and set up the learning?

    Assistive Ideas: Do you feel you have enough experience in learning medication math the pull out the information needed, choose the best way to solve the problem, and apply the information per self? Do you feel you get enough feedback from asynchronous communications online? Do you prefer to set up your own learning schedule so it is personalized to your learning? (set up your pace to learn the material)

31. Do you prefer self-regulated learning, structured regulated learning, or semi structured with self-regulated learning? Explain in detail and give examples.
32. Is there any other information you wish to share regarding self-regulated learning, structured regulated learning, or semi structured learning? Give details and examples.
33. Do you seek out your own self-assessments or do you require instructor assessments or somewhere in-between?

    Assistive Ideas: Do you check your own work for errors or do you need others to assist with the assessment? Do you feel more confident with the instructor checking your work on a regular basis, a few times, or only when asked?

# Appendix C: Data Collection/Recording Tool

**Directions:** Data to be gathered from the school's database by nursing instructor chair to deliver to the researcher.

| Student | HESI Math score | HESI Learning style | MAC score | Number of times taken to pass MAC | Delivery method used | Gender | Age/ Birth date | Year starting nursing school | Term | No. of years out of school |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |

Appendix D: Master Code sheet

**STR** = Teaching strategies that work

**STRN**= Teaching strategies that do not work

**Next set of codes are various <u>strategies</u> that STR or STRN could be used with**

**Example: STR- FC= Strategy that works is Flash cards**

-PP = Practice Problems

-FC = Flash Cards

-BD = Board work

-Dis= Discussions

-HA= Hands on activities

-WP = Work at own pace

-AQ = Ask Questions

-SEA = See, Do, Engagement activities

-GW = Group Work

-Multi = use of many strategies

-WA = Work alone

-RT = Read to or off of PPT, books, or other

-QS = Quizzes without rationale

-QC = Quizzes with rationale

-FB = Feed Back immediately

-ARR = Amount of reading required

-LHL = Lecture handouts that are long

-TH = Text book helpful

_TNH text book not helpful

-VS= Visual

-NTN = No time to learn or not enough time to learn/pace

-NP = Not prepared

-ANX= Anxiety

-PIC = Present in class

-STS = Step by step instructions

**Next set of codes are various <u>LNP (learning preferences)</u> that can be coded with**

**LNP --Example: LNP- hearing= Learning preference is hearing/Audible**

LNP= Learning preference

-Hearing = learns by hearing or audible

-Seeing = learns by visual activities

-reading = learns by reading material

-activities = learns by doing activities (various)

-hands on = Learns by doing hands on activities –real life situations

-Multi = Learns by use of many ways pending content

C= Correct

NH= Needs Help

PE = Professor involvement

DWP= difficult with percent

DWR/P = Difficulty with ratio proportion

ME = Math easy

FFT= Face to Face traditional delivery method = classroom

Hyb = Hybrid delivery method = in classroom and online

OLE = Online delivery method = class is online/electronic

DMD= Delivery method does not matter

OLEN = online delivery method did not work

HbyN= Hybrid delivery method did not work

FTFN= Face to Face traditional classroom delivery method did not work

STE = Structured Environment == teacher lead

SRL= Self-regulated learning

SLA= Self-assessment

TCA = teacher assessment

SSL Semi structured learning

# Appendix E: Interpretation Worksheet

Interpretation /delivery methods

Q1. Theme 7 Face to face preferred due to inter action---felt helped the learning/ hands activities in class reaches more different types of learners. (Engagement)

Theme 6 and 7 hybrid preferred due to interaction of face to face but has the ability to work at own pace and still ask questions and seems to reach more types of learners.

Q2. Theme 1 and 4 and 7 Delivery method of course does not matter as much as the strategies used with in the delivery method for the course work.

Theme 6 and 4 Hybrid liked structure to course but also allowed work at own pace. Where "seeing, doing, and hearing are all taking place together.

Theme 7 In face to face there is more engagement than the other 2 methods.

Q3 Theme 4, and 5 and 7 Felt most engaged when using hands on and all senses being stimulated.

Theme 4, and 5 and 7 Felt face to face helped with engagement-working in groups but--could ask questions and get answers right then (strategies within the delivery such as lecture with fill in blanks).

Theme 4 Strategies used helped more than the delivery method and the use of many types of strategies met more of each learner needs.

Q4 Theme 1 The strategies used with in the course –quiz without rationales, having to work alone, being read to---do not work to help learning--- not so much the delivery method.

Theme 4 and 5 and 7 Feel Face to face provides more engagement if used with good strategies to assist learning.

Q5 Theme 4 and 5 and 6 and 7 Strategies with in the delivery method chosen to match to help learners—practice problems then meet to go over answers and how to get that answer –the thought process of why this way. Practice tests, visuals, hands one and feedback on questions quickly.

Theme 1 and 4, 5, 7Again delivery method did not seem to matter---the strategy used in the delivery method did with many strategies being used to engage the learner's senses.

Q6 Theme 1, 4 and 5 again strategies of visuals, stories, hands on quiz, and face to face inter action in group work help best in meeting learning needs more than the delivery method.

Q7 Theme 4, 5, 6, and 7 Felt it is the students' responsibility to adapt to the strategy used or create one that works if needed to remember items such as flash cards.

Theme 6 , 1 Being read to the PPT or book, working alone, the need for face to face interaction and engagements to learn ---online does not offer this and is harder. Again I read this as meaning that face to face or hybrid works but again it is the strategies within the delivery method not the delivery method its self-Strategies that work, repeat, flash cards, discussions, ( again strategies used within the delivery method) etc. and working at your own pace.

Q9 Theme 1, 4 and 5 and 7 Again the items that do not help lecture handouts that are lengthy, read many chapters and cover many concepts at once, reading to me, wordy PPT

slides, no visuals, no hands on. Again, the strategies with in the delivery help more than the delivery method itself--

Q10. Theme 1, 4, 5, 6, 7 Idea is the same strategies come up that help, Practice problems –with group, by self and in class work with discussion. Examples with rationale and step by step process Visuals interaction. Again, I see here it is strategies used and interaction that helps and not the delivery method. And the matching of the strategies to the learners and delivery method chosen.

Q11 Theme 7 least helpful again is the strategy not matched to the learner needs ---not enough practice, too fast pace to learn, not prepared, anxiety on quizzes counting against the grade. Working alone. Again, interactive teaching with many types of strategies used works best and that face to face even if only part time helps with that interaction and engagement.

My interpretation thus far section 1 delivery methods:

The data seems to support that face to face first, hybrid second for delivery method as preferred. That supports the data seen in the quantitative where face to face showed that is helped more than the other methods but not enough to be significant. Most of the data in these 11 questions support that it is the teaching strategy used with in the delivery method is what matters. Also, that many of the same old teaching strategies used in face to face, such as discussions, practice in groups, by self, and in class work, flash cards, are preferred. These can be used in any of the delivery methods but need to be matched up on how it is applied in the delivery method.

Items that the students felt did not work were wordy PPT, long lectures, no activities, no visuals, being read to, fast pace of learning, not enough practice, large amounts of reading and concepts covered, no structure for the content. Adult students want to be involved per use of active learning strategies that allow the person to use all senses to learn.

Interpretation /Learning preference

Q12 Theme 4 and 5 Learning preference that the students perceive that they are is mostly visual with hands on and auditory following. Most see their self as multi modal learner of visual and hands on.

Q13 Theme 4, 5, 6, 7 Main idea here is the need for visual learning with practice problems with instructor, in groups or alone. The students seem to want somewhat of a structured environment; with the instructor lead inter active tools and activities that are visual and hands on to practice and learn the math.

Q14 Theme 2 Students see the barriers to learning to be not knowing how to use calculation tools, information of how to calculate a problem done only as a discussion or explanation, just reading the book, the pace of the course, and remembering conversions; also being put on the spot in a class. This tells me that it matches the above where the students say they need visuals and hands on practice with auditory last to give rationale of why this works this way to get the answer and that the delivery method did not affect errors made in math.

Q15 Theme 4, 5, 6, 7 Students found that the current clinical calculations book is most helpful due to having examples, visuals, with step by step instructions and practice problems. Others still want the instructor to start them out on the new concept with a few practice problems in class. Again, this seems the visual and semi to structured environment are what the student feels enhances learning.

Q16 Theme 4, 5, 6, 7 Most of the students felt the use of the textbook alone was least helpful including just reading the chapters, and discussion with only 1-2 examples. They felt the need for the instructor lead activities with many examples and practice. The non-visual activities did not help learn the math. I feel this is again this is supporting that the use of active learning strategies and the need for some structure learning but flexible.

Q17 Theme 6 The idea here seems to be the need for instructor lead environment with the use of many different active learning strategies, immediate feedback, and interaction with the instructor.

Q18 Theme 6 The theme in this question is that most students want structure that is more than half time but want to have some control as well within the learning environment.

Q19 Theme 6 The idea in this question is as the student just starts the learning of math a more instructor lead is needed but as learning takes place the student wants the environment to change to a more facilitator with allocating more of the responsibility and control of the learning environment to the student.

Q20 Theme 6 The student seems to want structure and self-regulating learning with having the instructor provide the structure but to slowly turn that over to the student to control the pace. This seems to follow more of a semi structure. There were a few that felt that total structure regulated learning worked best.

Q21Theme 6 The idea I see here is that the student likes to be able to do self-assessment for the most part with the instructor checking periodically and giving feedback. If the material is new the student would like the instructor to give feedback when starting out on a new concept and then turn it over to the student. Only 1-2 want the instructor to check each time or use the online resource that goes over those problems.

Q22 Theme 6 The only extra ideas were ones stated before that more of a semi structured, self-regulated learning works best. In some cases, the student wants to start out in a structured environment and move to semi structured environment.

My interpretation thus far for Learning preference:

What I see here as ideas is that the student feels the use of strategies that reaches them visually, then hands on, and last auditory works best in learning the math material. The learning environment that the student describes has more of an instructor lead environment with interactive, active learning strategies that reach the hands on and visual learner. But later in the survey the students indicated that a structured environment at first when starting to learn the math especially a new concept was best then slowly turn the control over to the student to more of a semi structured environment. The student also felt that just lecture and discussion alone, which reaches the auditory learner does not work

well in learning math. The use of a book that lends itself to be used for all types of learners was best; one with active, visual, and hands on activities for each concept. The students indicated that once they feel confident in their learning of the math, they need the instructor take on more of a facilitator role.

This seems to support in the quantitative phase 1 section on why there was a slight difference in the face to face environment and hybrid but not enough to be considered significate. But the student's perception of what really mattered is the strategies used with in the delivery method and that they need a flexible environment that supports both structured and semi structured learning environment with active and interactive learning tools used.

Math Knowledge

Q23 Theme 2 and 3 Students found that Addition, subtract and decimals were easier but then others found just addition, subtraction, multiplying, dividing whole numbers easier (Student's stated that what helped them the most had to do with a strong background in high school and the teacher's strategy of teaching the concepts. No one math concept was stated more than another.)

Q24 Theme 2 and 3 Students found ratio/proportion, fractions, and decimals most difficult especially when dealing with mixed numbers; others stated story problems created problems due to not sure what to pull out.

Q25 Theme 2 and 3

(The answer is 3.6mls several of the students used the dimensional analysis format other were able to see that only 342 needed to be divided by 95. 2 were unable to do the problem or obtain the correct response.) Ratio proportion

Q26 Theme 2 and 3

(2 Students here did not obtain the correct answer due to process of rounding not correct (conceptual). They pulled out the correct information needed but did not set up the problem correctly).

Q27 Theme 2 and 3

(students here were able to pull out the correct numbers needed and process to get the correct numbers when dealing with whole numbers. )

Q28 Theme 2 and 3

(1 Student did not do the conversion correctly- not understanding decimals (conceptual), leading to wrong answer, rest were able to set the process up to get the correct answer.)

Q29 Theme 2 and 3

(Students in this case were able to deal with the whole numbers and process to get the correct answer)

Q30 Theme 2, 3, 5, and 6

Students stated that a flexible class offering many teaching strategies that work in a flexible classroom no matter the delivery method chosen. They stated they need the strategies to help retain and understand the content

Summary: Students were having difficulty with ratio proportion, fractions, and decimals. They were able to pull out the correct numbers needed out of the problem but had difficulty with understanding conversions with decimals concept and process set up needed to obtain the correct answer, (conceptual and/or procedural) and it did not seem to matter what delivery method they were in it was relatively equal across all three delivery methods.

Most of the students were able to work most of the problems and obtain the correct answer.

Themes found in the survey are as follows and are coded above with each question.

1 Delivery method did not matter in retaining material.

2 Delivery method did not affect math errors made.

3 The better the skills of the student upon entry to the course the less difficulty the student had in preforming math skills.

4 Discussions, interactions, group work, flashcards, and other similar teaching strategies worked best no matter what delivery method was used.

5Visuals, videos, pictures, stories, activities that relate to the content help retain the material.

6 Class room flexibility was mentioned and seemed important to the student no matter the delivery method.

7 Students valued teaching strategies used to help retain the material rather than the delivery methods

Summary of all 3 sections

There is no difference in the delivery method's influence on math skills according to the students in this survey. What made a difference is the teaching strategy use with in the delivery method. If the student comes with a strong math background then dealing with fractions, ratios, and decimals are not difficult. Other articles supported that they found the same thing; in that ratios, decimals, fractions were the most problem. Other articles also spoke of conceptual and procedural were problems as well. This is also my finding. The qualitative section seems to support the quantitative section in which math skills obtained before entering nursing school does have an effect on the MAC score and the student's ability to retain the math. Teaching strategies used with in the delivery method according to the nursing students made a difference in them understanding the math skills and retaining them.

Next laid phase one results next to phase two results to compare then wrote summary

Quantitative results

Tests of Between-Subjects Effects

Dependent Variable: Number Times MAC

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 9.380[a] | 3 | 3.127 | 4.621 | .004 | .088 |
| Intercept | 54.922 | 1 | 54.922 | 81.173 | .000 | .360 |
| HESI | 8.813 | 1 | 8.813 | 13.025 | .000 | .083 |
| delivery | .253 | 2 | .127 | .187 | .830 | .003 |
| Error | 97.431 | 144 | .677 | | | |
| Total | 944.000 | 148 | | | | |
| Corrected Total | 106.811 | 147 | | | | |

a. R Squared = .088 (Adjusted R Squared = .069)

The test evaluates the relationship between the covariate (HESI) and the dependent variable ( times taken to pass the MAC).

The relationship is significant, as evidenced by $F(1,144) = 13.025$, $p < .001$. Thus the HESI (covariate) exam does have an effect on the number of times the MAC exam is taken to pass the exam (dependent variable). The results of the analysis indicate that the null hypothesis should be accepted as evidenced by $F(2, 144) = .187$, $P = .830$, $p > .001$. Thus the delivery method of the math course (independent variable) has no effect on the

number of times the MAC exam is taken to pass the exam (dependent variable).

Tests of Between-Subjects Effects

Dependent Variable: MAC

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 16.583[a] | 3 | 5.528 | 5.779 | .001 |
| Intercept | 949.036 | 1 | 949.036 | 992.158 | .000 |
| HESI | 13.829 | 1 | 13.829 | 14.457 | .000 |
| delivery | 1.439 | 2 | .719 | .752 | .473 |
| Error | 137.741 | 144 | .957 | | |
| Total | 50438.000 | 148 | | | |
| Corrected Total | 154.324 | 147 | | | |

a. R Squared = .107 (Adjusted R Squared = .089)

The test evaluates the relationship between the covariate (HESI) and the dependent variable (MAC) The relationship is significant, as evidenced by $F(1,144) = 14.457$, $p < .001$. Thus, the HESI (covariate) exam does have an effect on the MAC score (dependent variable). The results of the analysis indicate that the null hypothesis should be accepted as evidenced by $F(2, 144) = .752$, $p > .001$. Thus, the delivery method of the math course (independent variable) has no effect on the MAC score (dependent variable).

Summary of quantitative

It did not seem to matter what delivery method the student chose; it did not effect the MAC score nor the number of times the MAC was taken. What did matter was the skill set each student had before entering the course in the pretest had influence on the scores and number of times the exam was taken to pass.

Summary of phase one and two.

The qualitative section seems to support the quantitative section in which math skills obtained before entering nursing school does have an effect on the MAC score and the student's ability to retain the math. Teaching strategies used with in the delivery method according to the nursing students made a difference in them understanding the math skills and retaining them.