Research Article

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Improving Nursing Student's Confidence with Dosage Calculation After Implantation of a Comprehensive Teaching Strategy

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Abstract

Correct calculation of doses is crucial for nursing students to administer medications safely. Studies show students' prior experience with mathematical calculations and their self-beliefs in their own mathematics abilities correlate with student success on dosage calculation assessments. Few studies have evaluated a pedagogical strategy designed to strengthen math confidence and learning outcomes of those undergraduate nursing students. The purpose of this study was to describe the experience of nursing students acquiring confidence with dosage calculation skills after the implementation of a comprehensive dosage calculation teaching strategy. Participants (*n*=12) were recruited from a four-year nursing program to measure student confidence and experience with a comprehensive dosage calculation teaching strategy using a mixed methods exploratory descriptive survey design. Descriptive statistics and measures of central tendency were used to analyze quantitative data. Grounded Theory methods were used to analyze qualitative data. Students reported high levels of confidence post intervention in the majority of dosage calculation skills. Repetition and review of dosage calculations concepts improved student confidence with dosage calculation.

Keywords: Dosage calculation; Math confidence; Nursing student

Background

Medication administration errors are the leading cause of medical harm in the world [1]. In the United States (US), between 7,000 and 9,000 patients die from medication administration errors [2]. 40 billion dollars per year is spent treating patients who have been harmed by medication errors in the United States [2]. Incorrect calculation of doses is listed as one of the leading causes of medication errors [3]. Mastery of dosage calculation is essential for nursing students to safely administer medications and prepare for the NCLEX-RN licensing exam [4]. Dosage calculation competency impacts patient safety and impedes a nursing student's progression and graduation further impacting the nursing workforce shortage [5,6]. Nursing students often struggle with confidence and competency with dosage calculation required for clinical practice even after receiving instruction [7,8]. Factors associated with nursing students' lack of success with dosage calculation include lack of knowledge of essential math skills, difficulty with applying math skills to dosage calculation problems, clinically relevant instruction and a lack of reinforcement of dosage calculation skills throughout the program [3,9].

Nurses must be able to multiply and divide whole numbers, understand the relationship between fractions and percentages, comprehend ratios and proportions, perform basic algebraic equations, and conversions between units to safely administer medications [5]. Although students may have been assessed

to have mastered these skills prior to their admission to their nursing program, struggles occur when applying them to the clinical setting. Current pedagogical approaches to teaching dosage calculation may not be appropriate in assisting the nursing student in application of these concepts when caring for patients. Teaching nursing students' dosage calculation in isolation of the clinical context is not effective in achieving competency in dosage calculation [10,11]. In addition, students need frequent opportunities to practice these skills [12]. Although quality of instruction, essential knowledge of math skills, and understanding of the clinical context dosage calculation takes place, nursing students' self-confidence, personal beliefs about math, and success on previous dosage calculation assessments have been correlated with student overall success on dosage calculation assessments [5,13,7].

Currently, the nursing students who volunteered for the study are required to take a comprehensive dosage calculation quiz in their fundamentals of nursing course and prior to entering each clinical course. The students are required to achieve a 90% on the comprehensive quiz and subsequent clinical course dosage calculation quizzes in order to administer medications. Many of the students were unable to reach this competency and faculty became overwhelmed with a large quantity of time spent remediating students; students began missing out on the experience of administering medications in the clinical setting as it was not allowed until they proved competency. It was determined that students needed more support and opportunity to gain confidence in their math skills before being competent in dosage calculation.

Purpose

The purpose of this study was to describe the experience of nursing students' acquisition of medication dosage calculation skills and development of self-confidence after the implementation of a comprehensive dosage calculation teaching and remediation program.

Methods

A mixed methods study design was used to determine if a comprehensive dosage calculation teaching strategy improved nursing students' confidence with dosage calculation. The study was submitted for IRB approval from Marymount University and expedited approval was given. The description of the teaching strategy, study design, data collection procedures and analysis are described below.

A comprehensive dosage calculation teaching strategy was developed to assist students in developing confidence with dosage calculation utilizing creative pedagogical strategies to address the issues identified in the literature [14-16]. Beyond the standard teaching of dosage calculations during one class

period and a review during another, a student student-centered teaching strategy which focused on content, dosage calculation skills, remediation and faculty support was developed. Strategies included the development of the Medication Math Adviser Faculty Advisor role, the implantation of providing case scenarios using an online graphing calculator, the implementation of low fidelity simulation, and progressive remediation with topics that proved to be challenging

Medication Math Faculty Advisor Role

The Medication Math Faculty Advisor role was developed to provide student support, faculty support, and remediation sessions for students throughout the nursing program when challenges arose. The Medication Math Faculty Advisor oversees the medication math instruction process, collaborates with faculty to develop teaching strategies, develops quizzes and testing, and implements policies regarding medication administration pedagogy.

Online Practice Using Desmos, a Graphing Calculator Tool

Using techniques described by the Dana Center, Desmos, an online graphing calculator, (https://www.desmos.com/) was used to embed animations and images into the medication calculation problem providing more meaning and clinical context to the problems. Using Desmos, example problems are provided which mirror the exam content and provide the ability to fill cups, fill a syringe, or count drops of intravenous fluid after computing the problems correctly. Building the content using Desmos provides content at no cost to students and mirroring the content of the exam while practicing questions, decreases exam stress. Virtual Case Studies are also included in the Desmos activities. Virtual case studies give students an opportunity to apply medication calculation skills to a patient scenario. In the scenarios, the students document demographics, allergies, and medication orders on the medication administration record (MAR). Using the MAR, students perform the medication calculation and are asked to identify the correct images of the medications.

Low Fidelity Simulation

Once practice scenarios in the virtual environment are completed, case studies in a low-fidelity lab brings similar exercises to life. The student is required to calculate the drug dose and administer the medications based on a patient scenario supervised by faculty.

Progressive Remediation

Medication calculation assessments proceed from simple to complex and are scaffolded throughout the program. Students are introduced to dosage calculation in their first nursing class, where the dosage calculation concepts are divided into units.

Each unit has a Desmos practice activity and assessment. After each assessment, if the student does not score a 90% or above, they need to meet with the Medication Math Faculty Advisor for review of that unit's content and additional practice problems. This process continues until the student takes the comprehensive dosage calculation exam. If the student does not successfully pass the comprehensive exam at a 90%, the student is required to meet with the Medication Math Faculty Advisor for remediation. The process continues for a total of three attempts to achieve a 90% passing rate.

All clinical courses are required to administer a dosage calculation quiz prior to clinical. The student is given a review and a study guide prior to the quiz. Review sessions are conducted prior to the initial quiz with the Medication Math Faculty Advisor. After the first attempt, if the student does not pass at a 90%, the student is required to meet with the Medication Math Faculty Advisor prior to the next quiz, to review quiz content and provide content consisting of quiz review and practice problems. If the student does not pass after the second attempt, the student will meet with Medication Math Faculty Advisor for specialized remediation consisting of practice problems and demonstration of competency under Medication Math Faculty Advisor supervision. These comprehensive strategies support the students in gaining confidence and mastery of medication calculations.

Data Collection

Data was gathered through the use of a secured Google forms link. The variable student confidence was measured by using a dosage calculation skills confidence inventory scale. The scale measured students' confidence with essential math skills needed for dosage calculation, dosage calculation skills, experience with math courses prior to nursing school, and their experience with the teaching strategy. The inventory contained both quantitative and qualitative questions to assess the students' feedback about the intervention. Quantitative questions were answered by using a Likert scale of 0-5: "0-not at all," "1-willing to guess," "2-nervous, not very sure," "3-maybe," "4-fairly comfortable," "5-I know this!" to provide student feedback on their confidence level with math and dosage calculation skills. The inventory included the following open-ended questions: "Describe your experience with previous math classes" and " How did the learning activities support your learning?"

Sampling

Nursing students in their first year of the nursing program were recruited from Spring 2021-Spring 2022. Twelve of the 52 students agreed to participate in the study. Students were eligible for the study after the completion of a comprehensive dosage calculation exam and submission of course grades. Data was collected at the end of the Fall and Spring semesters. Consent was obtained via the online Google questionnaire.

Data Analysis

Descriptive statistics and measures of central tendency were used to analyze quantitative data while using complementary grounded theory methods to analyze qualitative data derived from the open-ended questions from the survey. Comparative analysis of the data was used to code data and identify themes. This involved coding the data, comparing codes and revising the codes to identify common themes and patterns.

Results

The results of the survey indicated that students achieved high levels of confidence on the Likert scale in essential math concepts and the majority of dosage calculation skills post intervention. Students achieved low levels of confidence on the Likert scale with performing special intravenous fluid calculations.

Essential Math Skills	Mean	Standard Deviation
Decimal Placement	4.9166	0.288867
Rounding	5	0
Proportions	4.38	0.77849
Multiplying Fractions	4.36	0.996
Converting Between Units	4.08	1.1645
Ratio and Proportion	4	0.953
Algebra	4.25	1.356801
Percentages	4.25	0.8660

Table 1: Essential Math Skills.

Dosage Calculation Skills	Mean	Standard Deviation
General calculation of doses	4.5	0.797724035
Calculation of doses based on weight pediatric	4.1	0.937436867
Calculation of doses based on weight adult	4.3	0.651338947
IV flow rates by pump	4.1	0.83484711
Safe Therapeutic Range	4.5	0.668557923
IV flow rates to gravity	3.6	1.497472618
Special IV fluid Calculations Maternity	1.16	1.642245322
Special IV fluid calculation Critical Care	1.6	2.015094554

Table 2: Results of Math Confidence Inventory Scale.

In response to the question "Describe your experience with previous math classes." Three out of 12 students indicated they were comfortable with math, two out of 12 students indicated they had statistics class prior to entering the nursing program and four out 12 students indicated that they found math difficult. In response to the question: "How did the learning activities support your learning?" Seven out of 12 students indicated study halls and review/remediation sessions most supported their learning, three out of the 12 students indicated the need for more instruction and explanation of dosage calculation and math concepts, and two of 12 students voiced that the Desmos learning activities most supported their learning. The analysis of the qualitative data identified three common themes: "struggle," "more instruction," and "explanation."

Questions	Themes	Documentation of Responses from Sample
Describe your experience with previous math classes.	Struggle	"Math has never really been my strong suit, but with practice I can nail it down." "I have always struggled with math." "I used to be good in math but I had a math teacher in high school that made me doubt myself a lot so now I am not confident in my math ability," "I find math difficult to understand."
How did learning activities support your learning?	More instruction	"I had to teach myself how to correctly use the formulas for dosage calculations. I do not think they were focused enough in fundamentals." "Remediation was the only time when the math was explained. I was basically self-teaching myself when I was doing Desmos because it was not taught during class time. "Remediation allowed me to understand where I went wrong making specific mistakes during particular problems. Desmos learning activities were helpful with giving several examples of the same time of problem to work out. The issue was when Desmos was the only method of learning without the Study Hall session."
How did learning activities support your learning?	More explanation	"Review and study halls helped to understand the thought process behind problems and to understand where I went wrong" "The repetitive nature of these reviews helped me. The more I practiced the easier I recalled it each time " "The review helped most."

Table 3: Results of Qualitative Data.

Limitations

There were several limitations to the study including sample size, absence of previous assessment data for comparison, students' clinical course when taking the survey, variability in review and study hall sessions, the sample did not exclude students who repeated a clinical course and the use of online/hybrid teaching methods which may limit generalizability of the findings. As the intervention was implemented during the time of Covid-19 pandemic, classes were taught online and review sessions were conducted online. Online format may not have been optimal for students to learn dosage calculation. In addition, although dosage calculation skills and confidence inventory scales have been used in previous studies [7,17-18] validity and reliability has not been established with the scale used in this study.

Conclusion

It is imperative, for patient safety, to determine which pedagogical approaches are most effective for teaching dosage calculation. Confidence is a predictor in determining a student's success on dosage calculation assessments. The findings of this study indicated that students gain confidence in dosage calculation skills after implementing the teaching strategy with faculty support. In addition, the qualitative findings indicate that students need support with dosage calculation outside the classroom, clinically relevant dosage calculation instruction, and preparation for dosage calculation prior to entry into the nursing program. Recommendations include assessment and remediation of the math skills prior to entering the nursing program, a math course which reviews the essential math concepts students needed to be successful in dosage calculation, and to continue with the process of review and remediation of dosage calculation skills throughout the program. As the research for essential math skills for nursing students is well over ten years old, future research is needed to determine what essential math skills are needed and which strategies best develop confidence in nursing students' dosage calculation skills.

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