

Progression Rates Among Rural Junior-I Pre-Licensure Nursing Students Using a Math Academic Coaching Program (MACP): A Quality Improvement Project

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Abstract

Purpose: Math competency is a content area in which some rural pre-licensure baccalaureate nursing students struggle, contributing to lower completion rates. The purpose of this project was

to determine if a Math Academic Coaching Program (MACP) can increase first semester nursing student success with math proficiency in medication dosage calculations.

Sample: First semester Bachelor of Science nursing students at a rural, public university in the Southeastern United States participated in this study.

Method: Six online learning modules were provided. A quantitative, quasi-experimental approach was used to measure successful completion of the Medication Dosage Competency Exam (MDCE) and Junior-I progression using frequency distributions and means to compare MACP group to the traditional teaching math group. Participation was voluntary.

Findings: The MACP improved MDCE scores and progression rates compared to previous semesters of students who did not complete the MACP.

Conclusion: The MACP was an effective way to teach math skills to rural first-semester nursing students, assist them in success in the MDCE, and increase patient safety through proper medication calculations and dosing.

Keywords: nursing students, drug dosage calculations, academic success, rural nursing education

Progression Rates Among Rural Junior-I Pre-Licensure Nursing Students Using a Math Academic Coaching Program (MACP): A Quality Improvement Project

Student completion rates remain a major concern for many nursing schools or colleges due to the difficult and rigorous curriculum of nursing education (Barbe et al., 2018). Student completion is defined as the percentage of students who graduate within a defined period of time (Barbe et al., 2018).

Background

Academic coaching is one strategy to assist students in achieving academic success in nursing programs (Bumby, 2020; National Council of State Boards of Nursing, 2013). Universities and colleges that offer additional academic student support, based on student needs and availability of nursing program services, have shown high satisfaction ratings and positive learning outcomes among student participants (Tantillo et al., 2017). Student success services, specifically academic coaching, aim to identify and remove obstacles and generate various opportunities that allow advancement in academic development and improved successful student outcomes (University of Maryland, 2019). Bumby (2020) found that academic coaching along with electronic resources was associated with improved student success.

Factors that directly influence success or failure in nursing school include age, gender, and ethnicity (Lancia et al., 2013). Barbe and colleagues (2018) found that students with diverse racial, ethnic, or cultural backgrounds had higher attrition than other groups of students, so academic coaching programs may be beneficial. Self-awareness of bias and acknowledging barriers in nursing education with demographic considerations can bridge this gap (Bagnasco et al., 2016). By identifying demographic, academic, and social determinant factors that influence student outcomes, attrition rates caused by course failures can improve in first-semester upper-division nursing students (Bagnasco et al., 2016).

Math competency is an area in which some rural pre-licensure students struggle, contributing to low completion rates (Bagnasco et al., 2016). Rural nursing students often have difficulty with basic math skills like multiplying and dividing fractions and decimals (Bagnasco et al., 2016). In the study by Bagnasco and colleagues (2016), 22% of students had difficulty completing drug calculations without a calculator and 30% demonstrated poor math skills. To

assist pre-nursing students in bridging the knowledge gap in mathematical competencies, intervention is needed.

Problem

Medication dosage calculation exam (MDCE) failure rates have remained consistent for many first-semester Junior cohorts using the current in-class review sessions alone at the project site (Francis Marion University [FMU], 2019). Although students are allowed two attempts on the MDCE, they cannot score poorly on the second attempt MDCE and progress in the program despite earning an overall passing grade in the course. The problem was identified by faculty when reviewing completion data for Junior-I nursing students (see Table 1).

Table 1

MCDE Success and Completion Rates

Success and Completion Rates	2014	2015	2016	2017	2018
MDCE Success 1 st attempt	58%	45%	50%	59%	61%
MDCE Success 2 nd attempt	9%	15%	12%	10%	7%
Program Completion Rates	85.4%	82.3%	70.17%	68.3%	*66.75%

“MDCE Success Attempt” defined as earning 90% or greater on the MCDE in the first or second attempt and data show % of students not meeting the 90% requirements. “Program Completion Rates” defined as a C or better in all nursing courses; completing all requirements for graduation and data show for each entering cohort, measured by (# of graduates) / (Number of program entrants – number of students who electively withdraw). () Reflects completion rates as of Spring 2018. Students have 5 years to complete the 2 years of nursing coursework.*

These findings suggest that proactive math support, in addition to the MACP, may be needed. The purpose of this project was to increase first-semester nursing student success with math proficiency in medication dosage calculations using a math academic coaching program (MACP).

Resources

The addition of the MACP was designed to make the preparation for the MDCE more effective and efficient while providing resources for safe medication administration. Medication

administration safety is imperative for nursing students. Aggar & Dawson (2014) found that non-traditional teaching and learning methods of medication administration may improve the students' perception of readiness to administer oral medication. Hayes and colleagues (2017) concluded that interrupting medication administration simulation improves awareness and management strategies of the nursing student in addition to increasing their confidence. Tabassum and colleagues (2015) conducted a retrospective review to identify reported medication errors, their types, and associated factors. The environmental factors reported were increased patient acuity (14.3%), stress due to attendants' shouting (14.3%), and an insistence by staff (14.3%) (Tabassum et al., 2015).

At this Bachelor of Science in Nursing program, the program completion rate is lower than desired. Approximately 15% of students each semester does not progress beyond the Fundamentals of Nursing course in the first semester, which includes a MDCE. Failure to meet the required benchmark of 90% on the MDCE results in students being withdrawn from the course. These students can re-enroll in a future semester and may be able to progress and complete the program later.

Literature Review

Medication administration safety is one theme noted within the literature. Aggar & Dawson (2014) conducted a quasi-experimental study to determine the possible relationship between student demographics and their perceived preparedness for oral medication administration. Results suggested that non-traditional teaching and learning methods of medication administration may improve the students' perception of oral medication passes (Aggar & Dawson, 2014). Hayes et al. (2017) conducted a qualitative study to measure undergraduate nursing perceptions to simulated medication administration interruptions. Findings concluded that interrupting medication administration simulation improves awareness and management strategies of the nursing student

in addition to increasing their confidence (Hayes et al., 2017). Tabassum et al. (2015) conducted a retrospective review to identify reported medication errors, their types, and associated factors. The environmental factors reported were increased patient acuity (14.3%), stress due to attendants' shouting (14.3%), and an insistence by staff (14.3%) (Tabassum et al., 2015).

The second theme identified within the literature review was teaching strategies. The meta-analysis review conducted by Lee & Quinn (2019) aimed to identify methods for incorporating medication administration safety into the undergraduate nursing curriculum (Lee & Quinn, 2019). Specifically, research studies in North America have shown that online learning modules are an appropriate method to incorporate medication dosage calculation and competency into the undergraduate nursing curriculum (Lee & Quinn, 2019). Ramjan et al. (2014) suggest that shifting away from traditional methods and implementing Contextualized Teaching and Learning (CTL) engages students in active learning and promotes best-practice teaching. Kelly et al. (2018) conducted a quasi-experimental study in which data was collected on the implementation of advanced medication administration through non-traditional learning and educational activities to improve student outcomes with medication administration. Results showed higher confidence in identifying and safely implementing the rights of medication administration (Kelly et al., 2018). This project was based on the review of multiple studies indicating that academic improvements occur among nursing students who were provided additional learning opportunities in the form of coaching (Harris et al., 2014; Tantillo et al., 2017). Tantillo et al. (2017) suggest that coaching can take the form of providing resources in non-traditional formats, such as e-learning. Data also revealed a correspondence between identified student needs and the use of program services together with improved learning outcomes (Tantillo et al., 2017).

Researchers have investigated how e-learning platforms foster self-reliance in undergraduate nursing students. One study suggested that cooperative learning that evolves through online resources' interactive nature promotes higher student achievement, self-reliance, collaborative culture, and lifelong learning skills (Amandu et al., 2013). Literature supported the use of technology in nursing education and supported that the MACP is a learning/teaching tool to improve students' pre-licensure preparation through active and motivational learning.

Student challenges were addressed in Bagnasco et al.'s quasi-experimental study of 726 undergraduate nursing students to explore where students have the most difficulty and find interventions to bridge the gaps (2016). Nursing students had difficulty with basic math skills like multiplying and dividing fractions and decimals (Bagnasco et al., 2016). Of the sample, 22% had difficulty completing drug calculations without a calculator and 30% had a low score showing poor math skills (Bagnasco et al., 2016).

Methods

Project/Study Design

A quantitative, quasi-experimental approach was used to examine MACP effectiveness, successful completion of the MDCE, and Junior-I program progression using a pre-test/post-test analysis. Frequency distributions and paired *t*-tests were used to compare mean scores among students who completed the MACP intervention. Coaching was provided in this project through both virtual and face-to-face platforms to include podcasts and voiceover PowerPoints that accompanied each online learning module and face-to-face review sessions. One method that was used to promote student success was e-learning.

Project Site and Population

This study was conducted at a Bachelor of Science in nursing program at a rural, public university in the southeastern United States. This unique geographical and educational area has the only pre-licensure Bachelor of Science in Nursing (BSN) nursing program in the Pee Dee Region as defined by the South Carolina (SC) Office of Healthcare Workforce Analysis and Planning (Area Health Education Consortium [AHEC], 2014). Nine out of the 12 counties in this region are classified as rural and medically underserved areas/populations (MUAs) (U.S. Department of Health and Human Resources [DHEC], 2018). An area with less than 50,000 residents is considered rural according to The US Census Bureau (2010). The Federal Office of Rural Health Policy considers all non-metropolitan counties as rural (HRSA, 2020). The Index of Medical Underservice (IMU) is a scale that ranges from 0% to 100%, where zero percent represents the completely underserved. Areas or populations with IMUs of 62.0% or less qualify for designation as a MUA/P (HRSA, 2018).

The racial demographics of the Pee Dee region are 53.3% White, 45% Black, 2.3% Hispanic, 0.5% American Indian, 1.3% Asian, Pacific Islander, and mixed-race (U.S. Census Bureau, 2015b). Five of the 12 counties in the Pee Dee Region have minority population levels greater than 50% (U.S. Census Bureau, 2015b). Four of the five counties with the highest minority population are among the lowest in economic standing compared to the state. Economic standing is defined as social and economic factors that affect access to education and other crucial resources (American Psychological Association [APA], 2021).

The study was approved by the institution's Institutional Review Board (IRB) (Protocol # Pro00099952). In this nursing program, students begin their nursing courses at the junior level and

complete four sequential semesters in the nursing program. Junior-I level students have two attempts to achieve 90% or higher on MDCE to remain in the fundamentals of nursing course.

Intervention

This project addressed progression rates among first-semester nursing students at a rural public liberal arts state university. Although multiple factors contribute to non-progression, this project targeted math competency, a variable that accounts for approximately 10% of the non-progression rate. The classroom teaching strategy currently used has not met the learning needs of many students who struggle to succeed on the MDCE. Although students are allowed two attempts on the MDCE, they cannot score poorly on the second attempt MDCE and progress in the program despite earning an overall passing grade in the course.

A MACP, designed by the project manager for this study, was added to current in-person teaching/learning methods in the first semester of the nursing program. The intervention included six required learning modules to include: 1) basic conversions; 2) oral medication calculations; 3) weight-based calculations; 4) safe dose range calculations; 5) reconstitutions, and 6) medication labels. Each module contained an interactive worksheet, a 10-15-minute podcast recorded by the Project Manager, and a ten-question knowledge check quiz with unlimited attempts. The podcast included step-by-step instructions and a review of the interactive worksheet. If unsuccessful after the third attempt, an additional exercise was made available to the student. The quizzes were completed following each MACP learning module during weeks two through seven.

Implementation/Procedure

The MACP took place in the summer of 2020 before the students attempted their fundamentals of nursing course in the Fall of 2020. Students were notified approximately ten weeks before the start of the academic semester of their acceptance into the nursing program. As

a part of their acceptance package, information outlining pre-entry requirements was provided. Beginning in May 2020 information regarding the MACP was included in this package. Students also received email notifications from the Project Manager regarding the MACP completion requirements. Students were automatically enrolled in the MACP through the Blackboard® learning platform. The informed consent notified students that the MACP is a pre-entry resource for the fundamentals of nursing course and is part of a project and research study. By logging into the online learning modules, students consented to participate in the project. The Project Manager tracked student access and login attempts through Blackboard's® performance dashboard feature.

Junior-I students were given one attempt to complete a 20-question pre-assessment test to measure baseline knowledge of mathematical skills and medication dosage calculation competency during week one. Following this assessment, students completed the required six modules, interactive worksheet, podcasts, and knowledge check quiz. During weeks eight through 11, students attended one-hour in-class review sessions weekly to include a review of math practice questions and rationales. At the start of week 12, students were given a single attempt to complete a 20-question post-assessment proctored test that measured the effectiveness of the MACP.

The final proctored MDCE was administered at the start of week 13. Students who failed to meet the benchmark of 90% on the first attempt were allowed a second attempt at the end of week 13. There was a one-on-one remedial review session offered for students before taking the second attempt MDCE. The rate of successful students in the fundamentals of nursing course and the percentage of successful students in the Junior-I semester were also measured.

Data Collection

The control group data from Spring 2020 was collected using the grade book function of Blackboard Learn®. The number and percent of students who achieved a 90% or higher on the

MDCE and the number percentage of students who completed the course were obtained from the fundamentals course. Students' names were recorded and deidentified by assigning a code only accessible to the Project Director. The deidentified student data were placed in an Excel® spreadsheet on a password-protected computer. Following implementation, the same data were collected from the Fall 2020 Blackboard Learn® platform.

Data Analysis

Data analysis was conducted to determine MACP effectiveness, successful completion of the MDCE, and Junior-I progression. Numbers, percentages, and frequency distributions of unsuccessful students in two Junior-I courses were analyzed for both groups and compared. A paired-samples *t*-test was conducted among students who received the MACP intervention to compare pre-MACP and post-MACP scores.

Results

Students enrolled at the project site, and SC's RN graduates do not reflect the state's diversity (see Table 2). Specifically, male RNs are underrepresented when compared to females. Upon admission into the upper-division nursing program at the project site, students range in age from 18 years to 50+ years. The National League for Nursing (NLN) reported that 18% of students enrolled in baccalaureate nursing programs were over 30 years (2014).

Table 2

Demographics of Student Population Compared to Percent of RN Graduates & State's Diversity

Demographics	Project Group	Comparison Group(s)	
Gender		SC RN's	SC General Population
Female	88%	93%	49%
Male	12%	7%	51%
Other	0%	0%	0%
Race		2018 SC RN Graduates	SC General Population
White	85%	75.6%	63.7%
Black	11%	14.3%	26.6%
Hispanic	1%	3.4%	5.8%
Asian	2%	1.9%	1.7%
American Indian	1%	0.6%	0.4%
Pacific Islander	0%	0.2%	0.1%
Two or more races	0%	2.0%	1.7%
Age at Junior-I Enrollment		National	
18-20	61.5%		
21-22	15.6%		
23-25	7.8%		
26-30	7.8%		(18-30) 82%
31-40	5.2%		
41-50+	2.0%		(> 31) 18%

Students' backgrounds were characterized by exceptionally high levels of poverty, unemployment, health problems, illiteracy, and poor schools. Students from the Pee Dee region comprise the vast majority of the students on the university campus (71%), which is the only state educational institution in the Pee Dee region (FMU, 2019). Ninety-five percent (95%) of students on this campus are drawn from SC, and 34.2% of the total student body are the first in their families to go to college (FMU, 2019). The Pee Dee region also lags behind state and national statistics for education. Across the state, 25.3% of the adult population holds a bachelor's degree or higher, while nationally, that percentage is 29.3% (U.S. Census Bureau, 2015a). In the Pee Dee region, none of the 12 counties meet either the state or national average for college graduates, according to the latest information from the U.S. Census Bureau (2015a). This below-average level of baccalaureate education is reflected in the background of the nursing students who participated in the project; of the 80 participants, 73.75% were first-generation college students.

Descriptive statistics were used to show frequency, mean, and percent change on the MDCE from Time 1 to Time 2 to measure change correlated with the implementation of MACP. All students participated in the Time 1 MDCE ($n = 69$, 100%) and students who did not achieve a 90% or above on the Time 1 MDCE were then required to complete the Time 2 MDCE. Less than half (41%) of students were required to complete the Time 2 implementation of MDCE ($n = 28$). Of the 69 students enrolled in the course, 97% of students completed three or more of the six MACP modules ($n = 67$). Participation in Module 1 was highest (99%) and participation in Module 6 was lowest (91%).

Success on the MDCE was measured as a score greater than 90%. More than 75% of the students completing the Time 1 MDCE achieved a score greater than 80% ($n = 53$, 77%) and 100% of the students completing the Time 2 MDCE achieved a score greater than 80% ($n = 28$, 100%).

The mean score from Time 1 MDCE and Time 2 MDCE of the 26 students who completed 50% or more of the modules and who completed Time 2 MDCE was 81% and 95%, respectively, yielding a percentage change increase of 16% from Time 1 to Time 2 MDCE. A paired-samples *t*-test was conducted among students who received the MACP intervention, and there was a statistically significant difference in the mean scores from Time 1 to Time 2, 81.34 compared to 94.6 ($p < 0.05$). The non-intervention group had a mean score of 93.7 at Time 1.

Results also demonstrated a decrease in course withdrawal rates due to math failures compared to the previous semester. In Spring 2020, 12 of 70 students withdrew from the course (17%) compared to eight of the 80 students withdrawing from the course in Fall 2020 (10%), resulting in a 32% percent change in the withdrawals. Post-intervention data revealed that 84% of students believed the MACP made them feel more confident in medication dosage calculations and 89.9% were more confident in medication administration.

To further assess this subset, the following data was extracted: 100% ($n = 8$) were first generation college students; 50% ($n = 4$) took a major math or science class more than once; 62.5% ($n = 5$) were aged 18-22, 25% ($n = 2$) were aged 23-25, and one student (12.5%) ($n = 1$) was aged 31-34; 87.5% ($n = 7$) were black, and 25% ($n = 2$) were males. These findings suggest that proactive math support, in addition to the MACP, may be needed.

Discussion

Enrollment in pre-nursing is not a challenge at the project site; retaining and graduating students is the issue. Math competency is a specific challenge. Math competency is an area in which some rural pre-licensure students struggle, contributing to low completion rates (Bagnasco et al., 2016). Many of the students who apply to the project site's 2 + 2 baccalaureate nursing program live in rural areas of the SC where basic education in math is lacking. Students arrive

under-prepared in mathematical skills and abilities with nearly 50% of the students enrolled in the Fall 2019 semester upper-division nursing program taking remedial math in their prerequisite courses (FMU, 2019).

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More students successfully passed after completing the MACP compared to students who did not. Results indicate a positive correlation between participation in the intervention and increased math competency scores. The impact of the intervention decreases score differences between at-risk students and non-at-risk students.

This project assisted rural nursing students to be successful in math calculations, along with improving Junior-I completion rates. The MACP along with the face-to-face instruction led to a 32.2 % decrease in withdrawals due to math test results. The MACP encouraged students to become responsible, self-disciplined, and improve confidence in their math skills through a series of self-paced modules that built on one another. This intense math instruction helped students to have greater confidence in their math calculations and to be successful.

In addition, practice partners at local medical centers indicate that new graduate nurses in rural areas often face challenges with medication management and medication dosage calculations, which can impact patient safety. The MACP may have a positive impact on medication safety when nurses are in practice at rural hospitals. The impact of this project improved student confidence in math calculations skills and MDCE scores were higher than previous student performance. The findings are similar to those of Tantillo et al. (2017), who also found that a

coaching program improved academic outcomes. However, our intervention used online modules combined with traditional instruction, while Tantillo et al. (2017) used only an e-learning method.

Online learning modules are an effective method to incorporate medication dosage calculation and competency into the undergraduate nursing curriculum (Lee & Quinn, 2019). Ramjan and colleagues (2014) suggest that shifting away from traditional methods and implementing Contextualized Teaching and Learning (CTL) engages students in active learning and promotes best-practice teaching. Kelly and colleagues (2018) found that non-traditional learning and educational activities improve student outcomes with medication administration. Multiple studies indicate that academic improvements occur among nursing students who were provided additional learning opportunities in the form of coaching (Harris et al., 2014; Barbe et al., 2018); Tantillo et al., 2017). Tantillo and colleagues (2017) suggest that coaching can take the form of providing resources in non-traditional formats, such as e-learning. Data also revealed a correlation between identified student needs and use of program services together with improved learning outcomes (Tantillo et al., 2017). Coaching was provided in this project through both virtual and face-to-face platforms to include podcasts and voiceover PowerPoints that accompanied each online learning module and face-to-face review sessions.

This study improved student confidence in math calculations skills, and the MDCE scores were higher than previous student performance. The findings are similar to those of Tantillo et al. (2017), who also found that a coaching program improved academic outcomes. However, our intervention used online modules combined with traditional instruction, while Tantillo and colleagues (2017) used only an e-learning method.

This project has implications for other rural areas. Bagnasco et al. (2016) found that rural nursing students have difficulty with medication calculations. Research by Aggar and Dawson

(2014) indicated that non-traditional teaching methods can improve nursing students' preparation for medication administration (Aggar & Dawson, 2014). The MACP program could be replicated by other rural nursing programs to improve the medication dosage skills of the nursing workforce in rural, underserved areas. The use of non-traditional teaching programs such as the MACP program could lead to a decrease in medication errors and improved patient safety. It is important to support rural nursing students who may struggle with medication dosage calculations so that they can have confidence in safely administering medications.

Strengths of this project include the use of self-paced online modules, along with traditional instruction. This allowed students to work on math before beginning the nursing courses, while still obtaining face-to-face instruction for clarification.

Limitations to this study include the use of one group of students at a single university in a rural area of the Southeastern United States. Another constraint included students being admitted at the last minute who could not participate. Specifically, 6.25 % of students started the MACP late due to delayed program admission. Also, because the project was not mandatory, some students did not complete each module, which may have contributed to the results. If it were mandatory in future semesters, there could be fewer math failures. Another constraint affected 10% of students who had never participated in online learning and who had difficulty navigating the modules. Additionally, students expressed additional stress related to the COVID-19 pandemic during fall 2020. Another stressor identified was that some students were unable to participate in the face-to-face review sessions due to a COVID-19 quarantine.

Recommendations for Education

Improving the math skills of nursing students is important for prelicensure nurse educators. Self-paced online medication math modules along with classroom instruction can be a useful, low-

cost approach with students who struggle with math skills. This approach allows students to review the math content at their own pace, while having individualized instruction in the classroom setting. Requiring the modules for all prelicensure students in a nursing program may also increase the success rate on students' math competency tests. Providing a tutorial for the online learning modules may be helpful for students who lack experience with online learning.

Conclusion

Concern over progression rates of first-semester nursing students prompted a review of the literature and the subsequent development of the MACP. This project improved Junior-I BSN nursing student success by providing a MACP to all first-semester nursing students at a rural, public university. The online learning modules provided additional mathematical support to students, which increased the MDCE success rates.

There are plans to continue this project in future semesters at the nursing program because of its successful outcomes with the rural nursing students. At this university, 34.2% of the total student body are the first in their families to go to college, and some may lack the necessary preparation and skills for college math (FMU, 2019). It is important to support rural nursing students who may struggle with medication dosage calculations so that they can have confidence in safely administering medications. Additionally, MACP interventions with nursing students may promote medication safety in the workplace at rural hospitals.

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