Nursing Student Math Aptitude and Success on a Medication Calculation Assessment

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The authors describe the relationship between nursing student math aptitude and success on a medication calculation assessment given during the second year of the nursing curriculum. The importance of understanding this relationship to nursing education is highlighted.

Mathematical proficiency is a prerequisite to the performance of many nursing functions, including medication administration, an essential aspect of providing high-quality, safe patient care. However, the literature clearly indicates that the math skills of practicing nurses and nursing students alike vary greatly. In one study, Kapborg investigated mathematical knowledge and skills of beginning nursing students who had been admitted to a 2-year nursing program in Sweden. The sample consisted of 975 nursing students with varied educational backgrounds and exposure to math education before enrolling in nursing school. Students were asked to take a math test and had to complete it without “rulers, hand-held calculators, and other external aids.” The results indicated that the nursing students answered about half of the questions correctly, and some were unable to answer any of the questions correctly. Nursing students with the least amount of math education tended to score the lowest on the math test. Kapborg concluded that students’ educational backgrounds influenced their level of math performance and that faculty members need to ensure that beginning nursing students have an adequate knowledge of mathematics.

RN Calculation Skills

The purpose of a study by Ashby was to assess the medication calculation skills of practicing medical-surgical nurses. A sample of 62 medical-surgical RNs from one Midwestern midsize hospital agreed to participate. Thirty-one (50%) of the RNs had baccalaureate degrees, 23 (37%) had associate degrees, and 8 (13%) had a diploma in nursing. Medication calculation skills were measured by the Bayne-Bindler Medication Calculation (BBMC) test, which is reported to have a high level of reliability (0.82). Test scores on the BBMC ranged from 45% to 100%, with a mean score of 82%. Twenty-seven (43.5%) of the nurses attained a score of 90% or better on the BBMC test, the percent designated by Ashby as sufficient to calculate medications correctly. The medical-surgical nurses with 13 to 15 years of clinical practice had the highest test scores, whereas those with 1 to 3 years of nursing experience had the lowest. Educational preparation was not a significant predictor of scores on the BBMC. Ashby concluded that there is an urgent need for the continual evaluation of the basic mathematical skills of practicing nurses.

Student Calculation Skills

The purpose of a study reported by Brown was to assess the math abilities of 2 cohorts of first-semester BSN students from accredited nursing programs in the northeastern region of the United States in 1988 (n = 234) and in 2003 (n = 294). Both groups of students were administered an adaptation of the Computational Placement Test of the College Board. The test is concerned with “basic arithmetic operations with whole numbers, fractions, decimals, and percents. It is intended for students with less than 1 year of algebra.” Calculators were not allowed. The mean scores on the test were 76% in 1988 and 77% in 2003. Most students were able to correctly calculate items involving addition, subtraction, multiplication, and division of whole numbers, but when the items dealt with fractions, decimals, and percentages, the average correct response rate varied from 38% to 92% (1988) and 42% to 97% (2003). Brown concluded that faculty members must not assume that students are well versed in mathematical skills required for medication calculation even if they have had courses in algebra.

Early Math Assessment

The lack of proficiency in basic mathematical skills is an issue requiring further examination by nursing faculty. Unfortunately, “there is a sparseness of published research offering substantive solutions for the mathematically under-prepared nursing student.” Faculty should not “be complacent in assuming that students will be competent at arithmetic.” Several authors...
recommend that faculty members should develop a mechanism of early math assessment, even when they have adopted policies of minimum qualifications in math for admission to the nursing program. Mathematics assessment scores could be used to alert faculty about students who may have difficulty with drug calculations and may be an indicator of challenges in analytical reasoning as well. Another recommendation is that faculty members should administer a math skills test early in the nursing program and at specified intervals to ensure the maintenance of mathematical competence.

One mechanism for early math assessment is to require students to take a standardized nursing aptitude test and for its data to be adjunctive to other available admission data. One such test, the Test of Essential Academic Skills (TEAS), from Assessment Technologies Institute (ATI) assesses the academic preparedness of entry-level nursing students in reading, math, science, and English and language usage. The TEAS math subtest measures student knowledge of whole numbers, metric conversion, fractions and decimals, algebraic application, percentages, ratio and proportion, and data interpretation.

Unfortunately, limited data about the TEAS’ predictive ability are available in the nursing literature, and no studies were found that solely examined the TEAS math subtest. However, Newton et al. assessed the TEAS’ predictive ability on baccalaureate nursing (BSN) program first-semester success and found the TEAS to be a better predictor of academic success than pre-nursing grade point average. Newton et al. concluded that early academic achievement depends on BSN programs admitting academically strong candidates and that the TEAS provides data about BSN students’ core knowledge beyond that provided by pre-nursing grade point average alone.

With no literature found that specifically addressed the relationship between math aptitude and success on math-related competencies in the nursing curriculum, an evident gap in faculty understanding of this important clinical practice component exists. As a result, the following research questions were developed to guide this study:

1. Is there a relationship between BSN students’ math aptitude and their ability to pass a medication calculation assessment given during the second year of the BSN curriculum on their first attempt?
2. Is there a relationship between BSN students’ math aptitude and the number of attempts it takes to pass a medication calculation assessment given during the second year of the BSN curriculum?
3. Is there a relationship between BSN students’ nursing aptitude and their ability to pass a medication calculation assessment given during the second year of the BSN curriculum?
4. Is there a relationship between BSN students’ nursing aptitude and the number of attempts it takes to pass a medication calculation assessment given during the second year of the BSN curriculum?

### Methodology

#### Design and Sample

The study design was exploratory descriptive. The sample consisted of 2 cohorts of first-semester junior-level nursing students from one large, state-supported baccalaureate nursing program in the Midwestern United States. All admitted BSN students must take the TEAS during the first month of the first semester of their junior year. A requirement of the first semester junior-level theory course is that students must take a medication calculation assessment test and pass with a minimum score of 90%. Students who do not achieve a score of 90% or higher on the first attempt have the opportunity to take another medication calculation assessment test (second attempt). If the student does not achieve a score of 90% or higher on his/her second attempt, he/she is required to drop both the theory and corresponding clinical courses. Students who must drop the theory and clinical courses may choose to enroll in them during a subsequent semester, but they must retake the medication calculation assessment test and achieve a minimum score of 90% before being allowed to progress. There is no limit to the number of times a student may enroll in the theory course. The medication calculation assessment is never reused; instead, an original new examination is created for every testing opportunity. Before the first testing opportunity of each semester, a review session is given by one of the study authors. Students are allowed to use calculators during the test. Only students with both TEAS data and medication calculation assessment results available were included in the analyses.

#### Instruments

There were 2 dependent variables: whether the student attained a passing score (operationally defined as a score of 90% or higher) on the medication calculation assessment on the first attempt and the number of attempts it took the student to achieve a passing score. Data regarding the dependent variables were obtained from the 2 study investigators who taught the theory course and who administered the medication calculation assessment. The 2 independent variables were the TEAS math subtest composite score and the TEAS overall composite score. Reliability and validity data for the TEAS test were not found in the literature or the ATI corporate Web site. After administration, the TEAS is returned to ATI for scoring. ATI then provides Web-based diagnostic reports regarding student performance on the TEAS, including an overall composite score and a composite score for each of the 4 subtests.

#### Procedure

Data for this project were part of an undergraduate curriculum evaluation initiative at the study institution, and as such, institutional review board approval was not needed. However, the study investigators paid careful attention to protect participant confidentiality. Data were recorded on a computer-based spreadsheet designed specifically for this study that could be accessed by only 2 of the study investigators. All data were kept confidential, and results are reported only in aggregate form.

#### Results

The sample consisted of 127 junior-level BSN students from 2 admission cohorts (n = 64 and n = 63) who had been admitted to the BSN program...
during 1 academic year. The 2 cohorts’ TEAS math composite scores (mean [SD] = 64.6 [16.1] and mean [SD] = 63.8 [12.5]) and TEAS overall composite scores (mean [SD] = 74.5 [8.5] and mean [SD] = 73.9 [8.2]) were not statistically significantly different (P = .07 and P = .35, respectively).

Research Questions
To address the first research question regarding whether math aptitude was related to passing the medication calculation assessment on the first attempt, a correlation coefficient was calculated. The correlation coefficient (r = .264; P = .005) identified a weak positive relationship between math aptitude and passing the medication calculation assessment on the first attempt.

To address the second research question assessing whether math aptitude was related to the number of attempts it took a student to pass the medication calculation assessment, a correlation coefficient was calculated. The correlation coefficient revealed a moderately strong negative relationship between math aptitude and number of attempts to pass the medication calculation assessment (r = −0.326; P = .000), indicating that as math aptitude decreased, the number of attempts it took to pass the assessment tended to increase.

The third and fourth research questions were also answered by calculating correlation coefficients. The TEAS overall composite score was found to have a moderately strong positive relationship with passing the medication calculation assessment on the first attempt (r = 0.336; P = .000). Regarding the TEAS overall composite score and its relationship to the number of times it took to pass the medication calculation assessment, the correlation coefficient revealed a moderately strong negative relationship between the 2 variables (r = −0.385; P = .000).

Limitations
The sample for this study consisted of 2 cohorts of students from 1 BSN program in the Midwestern United States. As a result, the study findings may not generalize to other BSN programs that are qualitatively different from the study program.

Discussion
Our analysis of the study data indicated that BSN student math aptitude was significantly related to passing a medication calculation assessment given during the second year of the BSN curriculum on the first attempt. Students with higher math aptitude scores were more likely to pass the medication examination on the first attempt than students whose math aptitudes were lower. This finding is consistent with ATI’s description of cut scores. According to ATI, “the purpose of the cut-score is to separate test takers with demonstrated academic mastery from those who have not met the criterion.” Although the study institution does not use TEAS cut scores for admission or remediation purposes, further statistical analyses identified that a TEAS math subtest score less than 54 placed a student in the bottom 20th percentile for math aptitude of those who took the test. Of the 127 students in the sample, 32 (25%) had a math subtest score less than 54. Not surprisingly, those BSN students with very low math aptitude scores (placing them in the bottom 20th percentile) were the junior-level students most likely to need more than one attempt to pass the medication calculation assessment. Thus, low math aptitude is a risk factor for failing a medication calculation assessment given during the nursing curriculum. Perhaps more important is that BSN students who have very low math aptitudes and who must withdraw from nursing courses when they are unable to successfully pass a medication calculation assessment are at high risk of never completing the nursing major, a finding similar to that reported by Yess, who wrote that math aptitude was a factor associated with completing a nursing program.

Various authors have reported that when assessing mathematics proficiency among nursing students, it is unclear whether student difficulties are related to mathematical or conceptual/contextual issues. According to Bliss-Holtz, mathematical issues involve mistakes with arithmetic, whereas contextual issues involve mistakes in placing mathematical terms within the correct formula and manipulating them appropriately. Bachelor of science in nursing students who perform poorly on a medication calculation assessment might be unable to contextualize the problems being asked. “Not being able to contextualize the drug calculation can result in students attempting to solve a problem which has no meaning and achieving numerical answers which cannot be applied back to practice.”

Wright discussed how most formally taught mathematics is context-free and abstract and requires students to learn “a set of rules for operating on numbers.” However, to be successful on a medication calculation assessment, as in clinical nursing practice, the student must first be able to understand the question being asked to identify the appropriate variables to be used in the equation. When a student is unable to read a question correctly and/or does not understand what needs to be extracted from it, then the likelihood of successfully performing a medication calculation decreases dramatically, even if he/she were to know how to do the mathematics involved.

The findings from this study identifying the TEAS overall composite score as having a stronger correlation with passing the medication calculation assessment on the first and subsequent attempts than the math subtest may partially explain this phenomenon. Bachelor of science in nursing students who were unsuccessful on the medication calculation assessment might be unable to read and/or interpret the questions on the test and thus not know what variables to select for setting up the necessary mathematical equations. If this were the case, then mathematics remediation alone would not be sufficient to facilitate passage of the medication calculation assessment on future attempts. Students would also need to be assessed for their reading comprehension and understanding of the English language—2 content areas assessed by the TEAS.

Implications
For BSN students to have the holistic knowledge necessary for safe and efficient nursing practice, they must have not only a sufficient math aptitude to do clinical calculations but also the ability to read at the level demanded by the clinical questions being posed. When faculty members focus the issue solely
on mathematics ability, contextual issues related to clinical practice and the skills needed to read and interpret physician prescriptions and medication labels may be missed. Instead, faculty members need to “focus on researching and examining how best to support, assess, and develop the numeracy skills of nursing students.”

Conclusion

One of the skills most frequently used by RNs in clinical practice is mathematics. The literature clearly indicates that math proficiency is an ongoing problem for the nursing profession. Although much has been written on the severity of the issue, there was little literature found that examined methods used by BSN programs to assess students’ math aptitudes or how math aptitude impacted math-related outcomes during the nursing curriculum. The results of this study indicate that BSN students with low math aptitudes were less likely to successfully pass a medication calculation assessment given during the second year of the nursing curriculum on the first and subsequent attempts than students with higher math aptitudes. Bachelor of science in nursing aptitudes, thus giving credence to the ongoing need for BSN programs to be diligent in assessing applicants’ core academic skills preadmission to successfully graduate nurses with the skill set needed for 21st century clinical nursing practice.

REFERENCES