Mathematical Calculation Ability and Mathematical Anxiety of Baccalaureate Nursing Students

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ABSTRACT

Accurate mathematical calculations are a critical skill that nurses must demonstrate in order to safely administer medications. This study was designed to investigate differences in mathematical calculation ability and mathematical anxiety for a group of baccalaureate nursing students (n=56) and a group of undergraduate students majoring in fields other than nursing (n=56). Results showed the nursing students had significantly lower mathematical skills test performance than the non-nursing students. No group differences were found for mathematical anxiety. These results are consistent with previous findings that indicate that nursing students are seriously deficient in mathematical skills. The greater deficiency in mathematical skills performance noted in the nursing group indicates that nursing education must consider more selective admission requirements related to mathematics. Mathematical calculation skills must be evaluated early in the program of study and educational opportunities to increase mathematical proficiency must be planned throughout the nursing program.

Accurate mathematical calculations are a critical skill that nurses must demonstrate in order to safely administer medications, yet studies have consistently shown that nurses lack proficiency with mathematical calculations (Barker & McConnell, 1962; Chenger, Conklin, Hirst, Reimer, & Watson, 1969; Timpke & Janney, 1961). Deficiency in mathematical calculations is reported by Worrell and Hodson (1989) in 83% of the accredited programs in nursing throughout the United States. Bindler and Bayne (1984) reported that each year as many as 38% of junior level baccalaureate nursing students fail to pass a seventh-grade mathematics proficiency test at a 70% level. Blais and Bath (1992) found that 89% of junior-level baccalaureate students were unable to pass a 20-item medication dosage calculation examination at a 90% level.

Moreover, the problem of deficient mathematical skills in nursing students is not being resolved prior to graduation. Bayne and Bindler (1988) reported that only 35% of practicing nurses in their study attained a score of 90% or more on a medication calculation test. A similar study by Bindler and Bayne (1991) found that 43.6% of the registered nurses that were tested scored below 70% accuracy on a mathematical calculation test. Perlestein, Callison, White, Baenes, and Edwards (1979) reported that 56% of registered nurses in their study made medication calculation errors resulting in dosages that were as much as 10 times or as little as one-tenth the prescribed dosage.

Nursing students have been found to score lower on the math section of the ACT than on any other section of the ACT, which indicates mathematical ability may be a problem for nurses (Munday & Hoyt, 1965). However, Eaton (1989) indicated that university students in general are often unable to complete simple mathematical calculations. It is unclear whether nursing students are exhibiting a deficiency in mathematical skills that is typical of university students in general or if the problem is unique to nursing.

Deficiency in conceptual ability related to mathematics may also be compounded by anxiety which has been shown to interfere with the manipulation of numbers and the solving of math problems (Richardson & Suinn, 1972). In addition, higher levels of mathematical anxiety have been noted for females (Betz, 1978). With the nursing profession being predominately female, the potential debilitating effects of anxiety must be considered when measuring mathematical calculation ability.

The purpose of the present study was to compare undergraduate nursing students' mathematical calculation ability and mathematical anxiety to that of a group of undergraduate students with majors other than nursing. If nursing students are more deficient in mathematical skills and have higher levels of mathematical anxiety than undergraduate students in general, nursing education must address the problem.

Subjects

Subjects (N=112) were undergraduate students taking an introductory statistics course at a large midwestern university. The groups of subjects consisted of 56 students majoring in nursing and 56 students majoring in studies other than nursing. The comparison group of students from other areas of study was not limited to any specific major and included such majors as criminal justice, social work, psychology and biology. Subjects were matched for sex within the two groups and each group consisted of 54 females and 2 males. The mean age for students majoring in nursing was 23.88 years (SD=5.93) as compared to a mean age of 25.32 years (SD = 5.53) for the non-nursing group. The number of years reported since the last algebra course resulted in a mean value of 6.64 years (SD=5.38) for the nursing major group and
a mean value of 7.29 years (SD=6.11) for the non-nursing major group.

**Design**

A comparative descriptive design was used to compare the nursing and non-
nursing groups for differences in mathematical skills test performance and mathe-
matical anxiety. Three covariates (pretend state anxiety, computer anxiety, and the
number of previous algebra courses) were included in the design of the study in
order to adjust for pre-existing group differences and increase the power or sensi-
tivity of the design.

**Instruments**

The dependent variable of mathematical skills test performance was measured by a
25-item multiple-choice algebra test which was administered via microcomputer. The
algebra test consisted of items that required solving equations and working
with fractions and decimals which are the predominant skills required of nurses in
doseage calculation of medications and intravenous flow rates. Content validity
was established by a panel including both mathematicians and nursing experts. Total
test reliability as measured by coefficient alpha was .82 for the algebra skills test.

The dependent variable of mathematics anxiety was measured by the Revised
Mathematics Anxiety Rating Scale (RMARS) (Plake & Parker, 1982). An internal
consistency reliability of .98 is reported for the RMARS. The covariate of
pretend state anxiety was measured by the State Anxiety Scale of the State-Trait
Anxiety Inventory (Spilberger, Gorsuch, & Lushene, 1970). Internal consistency
reliability coefficients of .91 and .93 are reported for this instrument.

A second covariate, computer anxiety, was measured by the Computer Anxiety
Subscale of the Computer Attitude Inventory (Lloyd & Gressard, 1984). An internal
consistency reliability of 0.90 is reported for the Computer Anxiety Subscale.

The third covariate, number of previous algebra courses, was a self-report mea-
sure. Each student completed a brief demographic form that requested informa-
tion pertaining to the number of previous algebra courses.

**Procedure**

All testing and data collection was done
during the first week of the semester.
During the first class session each student
completed the RMARS, the Computer
Anxiety Subscale, and a demographic form.
Students completed a paper-and-pencil
form of the State Anxiety Scale prior to
completion of the computer-based Algebra
Skills Test. Scratch paper and pencils were
provided for use during testing and the use
of calculators was prohibited. Students
were allowed as much time as needed to
complete the algebra skills test.

**Data Analysis**

A one-way multivariate analysis of
covariance (MANCOVA) was used to test
for group differences in skills test performance
and mathematics anxiety. Univariate ANCOVA analyses were used to
follow up a significant multivariate
effect. A significance level of .05 was used
for all analyses.

**Results**

The nursing group had a lower mean
score correct on the algebra skills test as
compared to the non-nursing group. In
addition, only 15.9% of the nursing group
passed the algebra test with a score of 70%
or better, while 71.4% of the non-nursing
group achieved a score of 70% or better.
Mathematics anxiety was higher for the
nursing group than for the non-nursing
group. The nursing group also reported a
higher mean pretend state anxiety and a
higher mean computer anxiety than the
non-nursing group. The means for number
of previous algebra courses were fairly
comparable for the two groups. The Table
summarizes the means and standard devi-
ations by group for the dependent vari-
bles and the covariates.

The MANCOVA results were significant
(Pillai's F[2,106]=6.21, p<.01, indicating a
multivariate effect on the adjusted scores of the dependent variables. Follow-up uni-
ivariate ANCOVA analyses showed that
the dependent variable, algebra skills test performance, significantly contributed to the
overall multivariate significance while the
dependent variable, mathematics anxiety, did not significantly contribute to the
overall multivariate significance (Table).

The adjusted group means for the univari-
ately significant dependent variable, alge-
bra skills test, showed the nursing group
with a lower adjusted mean (15.32) than
the non-nursing group (17.65).

**Discussion**

The results of this research are limited to the
studied population; however, the problem
of deficient mathematical skills among nurses is further substantiated. Nursing
students in this study scored significantly
lower on average on the algebra skills test than the non-nursing students. It should
be noted that the groups were matched for
gender and in spite of this control for a possible gender effect, the nursing student
group was noted to have a higher mathem-
atics anxiety level than the non-nursing
group. This difference in anxiety level was
not statistically significant; however, from
a practical standpoint, potential debilitat-
ing effects of mathematics anxiety must be
considered. In addition, the measure of mathematics anxiety in this study is not
confounded by other forms of anxiety due to
the use of covariates to statistically con-
trol for potential differences in pretend
state anxiety, computer anxiety, and num-
ber of previous algebra courses between
the student groups.

**Implications**

Nursing students were found to be more
deficient in mathematical skills than their
non-nursing counterparts which indicates
that programs of nursing should consider
more selective admission requirements
related to mathematics (i.e., ACT and SAT
math score criteria) as recommended by
Warrell and Hodson (1989). Following
admission to a nursing program, students
should be pretested for early identification
of mathematical calculation problems.
Educational opportunities to increase
mathematical proficiency must be planned and initiated early in the pro-
gram of study. It is also critical to evaluate
mathematical calculation skills through-
out the nursing program and to suggest
tutoring or remediation as necessary.

Results of this study also indicated that
nursing students do suffer from mathemat-
ics anxiety. Nursing educators must
endeavor to structure the learning envi-
ronment such that mathematics anxiety is
TABLE

Means and Standard Deviations by Group for the Dependent Variables and Covariates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nursing Group (n=56)</th>
<th>Non-nursing Group (n=56)</th>
<th>Univariate ANCOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Correct</td>
<td>14.96</td>
<td>18.00</td>
<td>F(1,107)=11.89*</td>
</tr>
<tr>
<td>Algebra Test</td>
<td>(4.00)**</td>
<td>(3.74)</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>63.96</td>
<td>58.57</td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>(19.18)</td>
<td>(16.68)</td>
<td></td>
</tr>
<tr>
<td>Pretest State</td>
<td>45.91</td>
<td>41.04</td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>(11.10)</td>
<td>(11.08)</td>
<td></td>
</tr>
<tr>
<td>Number of Previous</td>
<td>1.96</td>
<td>2.09</td>
<td></td>
</tr>
<tr>
<td>Algebra Courses</td>
<td>(0.89)</td>
<td>(0.77)</td>
<td></td>
</tr>
<tr>
<td>Computer Anxiety</td>
<td>22.48</td>
<td>20.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.66)</td>
<td>(7.04)</td>
<td></td>
</tr>
</tbody>
</table>

*p<.01
**The number in parentheses below each mean is the corresponding standard deviation.

Decreased and students attain a positive attitude toward mathematics. Attitudes toward mathematics have been shown to affect mathematical proficiency (Chenger, Conklin, Hirst, Reimer, & Watson, 1989; Flynn & Moore, 1990) and educators must explore potential methods of instruction to decrease anxiety and to promote positive attitudes toward mathematics. Use of computer-assisted instruction (CAI) has been shown to be an effective and efficient means of providing mathematical instruction to nursing students (Connor & Tillman, 1990; Hamby, 1986; Reynolds & Pontious, 1986; Thiele, 1989). Additional studies using CAI and other methods of instruction are warranted in order to determine the most effective means of dealing with the noted mathematical deficiency and mathematics anxiety of nursing students.

Conclusions

The results of this study are consistent with findings of previous studies that indicate mathematical skills are seriously deficient in nursing students. Nursing education must assume the responsibility for graduating nursing students with the ability to correctly calculate medication dosages and intravenous flow rates in order to provide safe care to patients.

References


