

Convening Recommendations

Math and Statistics Education for Nurses



The University of Texas at Austin
Charles A. Dana Center

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Introduction

Mathematical competency and effective quantitative reasoning skills are essential for safe nursing practice, both in medication administration and in quality improvement. However, research on the mathematics and statistics education of nurses continues to identify a number of challenges, including a lack of consensus on the necessary quantitative learning outcomes for undergraduate nursing programs and the significant disconnects between typical educational practices and the essential quantitative skills for quality and safe nursing practice.

Since 2017, the High-Quality Mathematics Education for Nurses Task Force—supported by the Charles A. Dana Center at The University of Texas at Austin, the Mathematical Association of America, and Quality and Safety Education for Nurses—has built partnerships with educators to work towards the vision that “all students in nursing programs will gain the mathematical and statistical knowledge, skills, and attitudes to promote and provide safe, high-quality health care.”

In an effort to foster collaboration and to identify key areas for coordination between the nursing, mathematics, statistics, and education communities, the task force held the “Math and Statistics Education for Nurses” Convening in October 2019 at the University of Miami. Following the meeting, the task force released a draft report that highlighted areas of consensus and a set of recommendations for quantitative education in nursing, inviting the community for feedback.

This *Convening Recommendations* document reflects the feedback received from the field and responds to questions raised. Its purpose is to illustrate areas of consensus, clarify the seven recommendations for developing improved quantitative education for nursing practice, and offer topics to serve as the focus for further collaboration and research. Although not all of the challenges related to quantitative education practices in nursing have been addressed, this document clearly demonstrates the desire to promote quality and safe practice through collaboration and data-driven decisions.

The “Math and Statistics Education for Nurses” Convening

In order to build consensus and develop a strategy for realizing the task force’s ambitious vision, a convening of interprofessional leaders was held on October 5 and 6, 2019. The goals of the meeting were (1) to build connections among our communities, and (2) to develop a forward-thinking consensus on improving the quantitative education of nurses.

Transforming Post-Secondary Education in Mathematics (TPSE Math) sponsored the “Math and Statistics Education for Nurses” Convening, which was hosted by Dr. John Clochesy, Professor and Vice Dean of the School of Nursing and Health Sciences at the University of Miami.

Representatives from the following organizations and institutions attended:

- American Mathematical Association of Two-Year Colleges (AMATYC)
- Bayer – Crop Science
- The American Statistical Association (ASA)
- Bill and Melinda Gates Foundation
- CGFNS International
- The Charles A. Dana Center at The University of Texas at Austin
- Delta College
- Ferris State University
- Mathematical Association of America (MAA)
- National Association for Healthcare Quality (NAHQ)
- National Council of State Boards of Nursing (NCSBN)
- The National League for Nursing (NLN)
- The NROC Project
- Organization for Associate Degree Nursing (OADN)
- Pennsylvania College of Health Sciences
- Quality and Safety Education for Nurses (QSEN)
- The University of Miami

Recommendations for Developing Improved Quantitative Education for Nursing Practice

The information shared below is intended to serve as the initial groundwork for ongoing, collaborative dialogue among the nursing, mathematics, statistics, and education communities. It is important that this content evolves as empirical data are gathered and best practices continue to change and develop.

The seven recommendations discussed in detail below are the result of discussions that occurred at the convening, the feedback from the community, and revisions by a subgroup of convening attendees. The core content of the recommendations remains unchanged. Each recommendation provides direction for improving quantitative education for nursing practice, additional context to provide clarity, suggestions for moving forward, and relevant resources (please see the References section for full citations and, if available, direct links to the resources). This content will continue to evolve as empirical data are gathered and best practices continue to change and develop.

Nursing, mathematics, statistics, and education faculty and communities of interest should engage in structured conversations to . . .

Recommendation 1: Identify the quantitative skills and competencies necessary for quality and safe nursing practice.

In order to develop appropriate learning outcomes, educational curricula, and professional development needs, an updated inventory of essential quantitative skills and competencies should be constructed to reflect current nursing practices.

It is essential that an updated inventory also differentiates between the quantitative skills and competencies specific to a particular degree or certification level (e.g., LPN, ADN, BSN, NP, DNP) with those that are universal for all practicing nurses.

Further Reading

- Bagnasco et al., 2016. Mathematical calculation skills required for drug administration in undergraduate nursing students to ensure patient safety: A descriptive study – Drug calculation skills in nursing students.
- Pirie, 1987. *Nurses and mathematics: Deficiencies in basic mathematical skills among nurses; Development and evaluation of methods of detection and treatment.*
- Roberts, 1990. *Essential knowledge of mathematical calculation for the nurse.*
- Young et al., 2013. Safety in numbers 1: Essential numerical and scientific principles underpinning medication dose calculation.

Recommendation 2: Investigate the most appropriate sequencing of mathematics, statistics, and nursing educational offerings to ensure students acquire essential quantitative skills and competencies for quality and safe nursing practice.

A recent survey by the High-Quality Mathematics Education for Nurses Task Force identified significant variation in how mathematics and statistics content is delivered in nursing programs across the United States. For example, some programs require students to take mathematics and statistics courses designed specifically for nurses and other health professions (e.g., “Math for Nurses,” “Statistics for the Health Sciences”), while other programs require students to take general mathematics and statistics courses (e.g., Quantitative Reasoning, College Algebra, Introduction to Statistics). There are also programs that have no specific mathematics or statistics course requirement as this content is integrated within nursing courses.

These variations point to a critical need to establish an evidence-based rationale behind specific mathematics and statistics course offerings, the timing and delivery of quantitative instruction throughout the nursing curriculum, and the selection of faculty responsible for teaching the content (faculty from a mathematics, statistics, or nursing department).

Further Reading

- Ganter, 2016. Mathematics in the first two years: Moving the conversation forward.
- Ganter et al., 2011. *Partner discipline recommendations for introductory college mathematics and the implications for college algebra.*
- Hartzler et al., 2019. *Emerging issues in mathematics pathways: Case studies, scans of the field, and recommendations.*
- Hughes et al., 2019. *Emerging solutions in mathematics education for nursing.*

Recommendation 3: *Incorporate* recommendations and best practices in nursing, mathematics, and statistics education in the design of learning outcomes, instruction, materials, and assessments.

National organizations such as the Mathematical Association of America (MAA), American Mathematical Association of Two-Year Colleges (AMATYC), and the American Statistical Association (ASA) have published documents designed to improve the teaching and learning of mathematics and statistics. These documents equip educators with effective, evidence-based instructional strategies and provide recommendations for creating rich and engaging material.

Similarly, organizations such as the National League for Nursing (NLN), Quality and Safety Education for Nurses (QSEN), National Council of State Boards of Nursing (NCSBN), Organization for Associate Degree Nursing (OADN), the American Association of Colleges of Nursing (AACN), and the National Association for Healthcare Quality (NAHQ) have published recommendations, competencies, position statements, collaborative reports, and other resources to aid in the development of nursing curricula.

Evidence-based strategies and recommendations from these national organizations should guide the development of quantitative educational practices in nursing programs.

Further Reading

Abell et al., 2018. *MAA instructional practices guide*.

American Association of Colleges of Nursing, 2008. *The essentials of baccalaureate education for professional nursing practice*.

American Mathematical Association of Two-Year Colleges, 2018. *IMPACT: Improving mathematical prowess and college teaching*.

GAISE College Report ASA Revision Committee, 2016. *Guidelines for Assessment and Instruction in Statistics Education: College report 2016*.

Commission on Collegiate Nursing Education, 2018. *Standards for accreditation of baccalaureate and graduate nursing programs*.

Cronenwett et al., 2007. *Quality and safety education for nurses*.

National League for Nursing, 2010. *Outcomes and competencies for graduates of practical/vocational, diploma, associate degree, baccalaureate, master's, practice doctorate, and research doctorate programs in nursing*.

National Quality Workforce Report, 2020. *Key workforce competencies for quality-driven healthcare: Where we are and imperative for improvement*.

Spector et al., 2020. *NCSBN regulatory guidelines and evidence-based quality indicators for nursing education programs*.



Recommendation 4: *Integrate* learning experiences throughout the nursing curriculum that provide learners an opportunity to develop sound quantitative reasoning, data reasoning, and clinical judgment.

It is important to reject a “once-and-done” mentality with respect to quantitative education in the nursing curriculum. A student’s quantitative education should not be defined by passing a mathematics or statistics course; rather, it should include quantitative learning experiences that are explicitly embedded throughout the curriculum.

As students progress through their programs and experience the increasing complexities of nursing practice, they should be provided with opportunities for learning (e.g., simulations, case studies, clinical-based activities) that go beyond simply obtaining a numerical solution to a decontextualized mathematics or statistics problem. Instead, students should be prompted to notice, interpret, operate with, and reflect upon quantitative information within complex and authentic clinical environments.

Further Reading

Elrod, 2014. Quantitative reasoning: The next “across the curriculum” movement.

Good et al., 2020. *Teaching dosage calculations online: Virtual tools and open resources for creating engaging content.*

Hayat, 2014. Guidelines for Assessment and Instruction in Statistics Education (GAISE): Extending GAISE into nursing education.

Ozimek et al., 2019. *Teaching dosage calculations: Strategies for narrowing the theory-practice gap.*

Rocconi et al., 2013. Making college count: An examination of quantitative reasoning activities in higher education.

Tanner, 2006. Thinking like a nurse: A research-based model of clinical judgment in nursing.

“ It is important to reject a “once-and-done” mentality with respect to quantitative education in the nursing curriculum. ”

Recommendation 5: *Include* an ongoing analysis and discussion of ethical and effective communication of mathematical and statistical data, results, and recommendations.

Communicating quantitative information and results to patients, their families, and the community involves careful consideration of factors that extend beyond purely abstract calculations. For example, it is important for nurses to understand and discuss false positives and negatives of diagnostic tests, communicate differences between relative and absolute risk, and clearly articulate dosage administration guidelines.

An additional focus should be placed on the ethical considerations and critical analyses of quantitative information presented in research, publications, and in the media, including the identification and impact of misleading statistics and graphical displays.

Further Reading

American Association of Colleges of Nursing, 2006. *AACN position statement on nursing research*.

American Nurses Association, 2015. Code of ethics with interpretive statements.

Gigerenzer, 2009. Making sense of health statistics.

Piercey, 2019. Quantitative ethics.

Piercey, 2020. Quantitative literacy in the time of COVID-19.

Sorrell, 2017. Ethics: Ethical issues with medical errors: Shaping a culture of safety in healthcare.

Recommendation 6: *Incorporate* assessment measures that reflect changing licensure/certification requirements, integrate quantitative and data reasoning with components of clinical judgment, and provide learners the opportunity for continuous improvement (rather than serving only as a high-stakes benchmark for academic progression).

It is common for nursing programs to utilize high-stakes, quantitative proficiency exams consisting of decontextualized multiple-choice and short-answer problems. These assessments are often used for admission into nursing programs and as a benchmark prior to clinical experiences in order to identify learners who are “safe” for clinical practice. Given that these assessments often become barriers for academic progression, there is a need to (1) critically assess the reliability and validity of these assessments, and (2) establish an evidence-based rationale for their use.

To foster a culture of continuous improvement, educators should regularly incorporate valid, competency-based assessments, especially those that require learners to use critical thinking and psychomotor skills necessary for safe nursing practice. For example, simulations, case studies, and clinical-based activities can provide a safe and controlled environment for learners to build confidence and develop sound quantitative reasoning, data reasoning, and clinical judgment.

Further Reading

Dickison et al., 2019. Integrating the national council of state boards of nursing clinical judgment model into nursing educational frameworks.

Marchi et al., 2019. A medication dosage simulation strategy to improve patient safety.

Murphy et al., 2019. Applied pediatric math: Bridging the gap between theory and practice for a diverse group of learners.

National League for Nursing, 2012. *The fair testing imperative in nursing education: A living document from the National League for Nursing*.

Stolic et al., 2019. An integrative review of medication calculation assessment strategies for student nurses.

Wright, 2009. The assessment and development of drug calculation skills in nurse education—a critical debate.

Recommendation 7: *Inform* the community through collaborative engagements and professional development opportunities that integrate best practices from nursing, mathematics, and statistics education.

Effective quantitative education in the nursing curriculum requires the integration of mathematics, statistics, and nursing concepts and skills. Through collaboration, educators from these fields can develop a deeper understanding of these unique connections, and thus construct more meaningful quantitative learning opportunities throughout the nursing curriculum.

In order to support these collaborative efforts, it is essential that national nursing, mathematics, statistics, and education organizations continue to partner with one another to share expertise, develop professional development opportunities, disseminate resources, and advance best practices.

Further Reading

Coben, et al., 2014. Meeting the mathematical demands of the safety-critical workplace: Medication dosage calculation problem-solving for nursing.

Hayat et al., 2015. Statistical challenges in nursing education and research: An expert panel consensus.

* See Recommendation 4 for examples of professional development opportunities that were co-constructed by nursing and mathematics faculty (Good et al., 2020; Ozimek et al., 2019).

“**It is essential that national nursing, mathematics, statistics, and education organizations continue to partner with one another to share expertise, develop professional development opportunities, disseminate resources, and advance best practices.**”

Opportunities for Ongoing Collaboration

In addition to constructing the preceding recommendations, attendees of the “Math and Statistics Education for Nurses” Convening considered various strategies for *how* our communities might continue this important collaborative effort. Further discussions resulted in a list of research projects and topics that may potentially serve as the focus of ongoing collaboration among nursing, mathematics, and statistics educators.

To be clear, the following list is not inclusive of all areas in need of additional research and development. It highlights specific topics that came into focus during the structured conversations at the University of Miami. Many of the projects and topics also align with feedback received following the release of the draft report in January 2020.

Topics for Further Collaboration, Research, and Development

- Develop national content guidelines for high-quality quantitative education in nursing programs.
- Develop and evaluate course pathways and trajectories of quantitative learning experiences in the nursing curriculum, emphasizing those that do not incorporate College Algebra as a program requirement.

- Develop and evaluate simulations that focus on developing quantitative and data reasoning skills in the clinical setting.
- Develop and evaluate competency-based assessments that integrate quantitative reasoning, clinical judgment, and psychomotor skills required for safe practice.
- Develop and evaluate assessment measures and/or learning experiences to replace high-stakes, short-answer and multiple-choice examinations that often serve as a barrier for academic progression.
- Explore and mitigate the causes of math anxiety experienced by pre-licensure nursing students, practicing nurses, and nursing faculty.
- Explore the *Mathematics Content Knowledge for Teaching*¹ for faculty teaching quantitative concepts necessary for safe practice.
- Develop a guide of evidence-based instructional practices to support faculty teaching quantitative concepts and skills to nursing students.
- Develop ongoing, credit-bearing professional development opportunities that foster communication and collaboration among the nursing, mathematics, statistics, and education communities.
- Establish additional partnerships among nursing, mathematics, statistics, and education organizations to support interdisciplinary research and content development.
- Advocate for increased funding opportunities for research and content development focused on improving quantitative education for safe nursing practice.

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¹ See Ball et al., 2008.

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We focus in particular on strategies for improving student engagement, motivation, persistence, and achievement.

The Center was founded in 1991 at The University of Texas at Austin. Our staff members have expertise in leadership, literacy, research, program evaluation, mathematics and science education, policy and systemic reform, and services to high-need populations.

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