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.


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.


Hartzler et al., 2019. *Emerging issues in mathematics pathways: Case studies, scans of the field, and recommendations.*

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*.
- 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*.
- 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**


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


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


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


**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.


**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**


* 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).

**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.

References


\(^1\) See Ball et al., 2008.


Good L., Kelch, B., Ozimek, D., & Zimmermann, E. (2020, June 18). *Teaching dosage calculations online: Virtual tools and open resources for creating engaging content [Webinar]*. High-Quality Mathematics Education for Nurses Task Force. https://utexas.box.com/s/0rvyfm95ve93n5cm2c6jg9ctg3suf3g


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**About this resource**

**About the Dana Center**

The Dana Center develops and scales math and science education innovations to support educators, administrators, and policy makers in creating seamless transitions throughout the K–14 system for all students, especially those who have historically been underserved.

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.

For more information about the Dana Center, see www.utdanacenter.org.

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Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of The University of Texas at Austin. For permissions requests and other queries, please contact us at danaweb@austin.utexas.edu.
High-Quality Mathematics Education for Nurses Task Force Convening Recommendations

- Recommendation 1: Identify the quantitative skills and competencies necessary for quality and safe nursing practice.
- 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.
- Recommendation 4: Integrate learning experiences throughout the nursing curriculum that provide learners an opportunity to develop sound quantitative reasoning, data reasoning, and clinical judgment.
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- Recommendation 7: Inform the community through collaborative engagements and professional development opportunities that integrate best practices from nursing, mathematics, and statistics education.

1To read the full recommendation document, visit: https://dcmathpathways.org/resources/convening-recommendations-math-and-statistics-education-nurses
Excerpts from Existing Taxonomies of Quantitative Skills

Roberts (1990)²

- Basic mathematics, including operating with rational numbers.
- Understand when to round off numbers and when not to.
- Converting between systems of measurement, including having a “feel” of comparison of quantities.
- Concepts of ratio, proportion, and basic algebra.
- Understanding the difference between dosage of medication and the volume in which that dosage comes.
- Using formulas and applying the order of operations, including those involving fluid rates.

Young, Weeks & Hutton (2013)³

- Operating with whole numbers, fractions, and decimals.
- Conversions between units.
- Concepts in measurement (setting the appropriate rate, drawing up an appropriate amount of medication, etc.)
- Understanding and operating with ratios and percentages.
- Estimation.
- Use of tables, graphs and charts, and formulas.
- Recognition of indices.
- Basic understanding of statistics.

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National Recommendations to Improve Quantitative Education for Nurses

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Joan Zoellner, The Charles A. Dana Center at the University of Texas at Austin
Daniel Ozimek, Pennsylvania College of Health Sciences
Beth Kelch, Delta College

Equity — Access — Excellence
Current State of Math Education for Nursing

• Mathematics should be a tool, rather than a barrier, for safe, quality, and equitable nursing education that builds a strong workforce.

• Mathematical competency and effective quantitative reasoning skills are essential for safe nursing practice; need to align with current practice.

• Lack of mathematics recommendations from nursing and program accreditation organizations leads to significant instruction variation and repeated coursework.
National Norms

There is a lack of guidance from national education, accrediting, and licensure programs.

- No specific course is recommended.
- Professional associations tend to emphasize a broad liberal education along with professional competencies, but do not explicitly focus on mathematics.
- “End-of-program learning outcomes must be consistent with safe healthcare practice.” (ACEN, 2019)
- No national agreement on core quantitative competencies, and at what levels.
- No common pedagogical recommendations.
National Norms – Nursing Example 1

Quality and Safe Education for Nurses (QSEN) recommendations related to math:

• Demonstrate knowledge of basic scientific methods and processes.
• Describe Evidence-Based-Practice to include the components of research evidence, clinical expertise and patient/family values.
• Use data to monitor the outcomes of care processes and use improvement methods to design and test changes to continuously improve the quality and safety of health care systems.
• Explain the importance of variation and measurement in assessing quality of care.
• Use tools such as quality measures and charts.
• Describe processes used in understanding causes of error and allocation of responsibility and accountability (such as, root cause analysis and failure mode effects analysis).
National Norms – Nursing Example 2

American Association of Colleges of Nursing (AACN) recommendations related to math:
• Use skills of inquiry, analysis, and information literacy to address practice issues.
• Use improvement methods, based on data from the outcomes of care processes, to design and test changes to continuously improve the quality and safety of health care.
• Overview of Quality Improvement process techniques, including benchmarks, basic statistics, root cause analyses, and Failure Mode Effects Analysis in the quality improvement process.
• Overview of qualitative and quantitative research processes.
• The fundamentals of epidemiology and biostatistics (distribution, incidence, prevalence, rates, risk factors, health status indicators, and control of disease in populations).
High-Quality Mathematics Education for Nurses Task Force

A model for exploring the quantitative needs of nursing education programs.
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

• Daniel Ozimek and Joan Zoellner, co-chairs

• In October 2019 the Task Force held a Math and Statistics Education for Nurses Convening
Math and Statistics Education for Nurses Convening

Goals:
• Build connections among math education, nursing education, and nursing professional organizations.
• Develop a forward-thinking consensus on improving the quantitative education of nurses.

Attendees:
• 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
• Delta College
• Ferris State University
• Mathematical Association of America (MAA)
• National Association for Healthcare Quality (NAHQ)
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• The National League for Nursing (NLN)
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• Organization for Associate Degree Nursing (OADN)
• Pennsylvania College of Health Sciences
• Quality and Safety Education for Nurses (QSEN)
• The University of Miami
Convening Recommendations

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

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.

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

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

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

**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).

**Recommendation 7**: *Inform the community* through collaborative engagements and professional development opportunities that integrate best practices from nursing, mathematics, and statistics education.
Recommendation #1

Identify the quantitative skills and competencies necessary for quality and safe nursing practice.
Existing Taxonomies of Quantitative Skills

Roberts (1990)

- Basic mathematics, including operating with rational numbers.
- Understand when to round off numbers and when not to.
- Converting between systems of measurement, including having a “feel” of comparison of quantities.
- Concepts of ratio, proportion, and basic algebra.
- Understanding the difference between dosage of medication and the volume in which that dosage comes.
- Using formulas and applying the order of operations, including those involving fluid rates.
Existing Taxonomies of Quantitative Skills

Young, Weeks & Hutton (2013)
• Operating with whole numbers, fractions, and decimals.
• Conversions between units.
• Concepts in measurement (setting the appropriate rate, drawing up an appropriate amount of medication, etc.)
• Understanding and operating with ratios and percentages.
• Estimation.
• Use of tables, graphs and charts, and formulas.
• Recognition of indices.
• Basic understanding of statistics.
Discussion

At your table, discuss the following:

• What do you notice about the taxonomies?
• What do you wonder about the taxonomies?
• Is it clear what math skills are most crucial, and how they are used in practice?
• How might we better communicate the essential math skills and competencies so that they are easily understood by all stakeholders?
• How do these skills support the recommendations shared earlier?
Recommendation #3

Incorporate recommendations and best practices in nursing, mathematics, and statistics education in the design of learning outcomes, instruction, materials, and assessments.
Position Statement of the AMATYC on Fostering Learning

Learning is an **active, contextualized process** of building concepts in addition to acquiring knowledge. Learners can **improve their ability to learn** regardless of their current level of achievement. All educators of mathematics have a responsibility to **create and implement high-quality learning environments**, design understandable and coherent curriculum, build learning skills, and facilitate learning. A quality learning environment is characterized by respect, trust, openness, high expectations, support for risk-taking, a willingness to challenge performance, continuous assessment, and a growth-oriented mindset for everyone.

Therefore, it is the position of AMATYC that the following should be endorsed as standard best practices:

- Learners should work in communities or teams to increase their knowledge and/or learning skills through **collaborative and cooperative activities**.
- Educators should be provided with opportunities for professional growth and development to aid them in implementing and maintaining **instructional strategies that produce a growth mindset, promote critical thinking, and nurture continuous improvement**.
- Institutions of education that promote exemplary learning experiences require a culture of **higher expectations and standards, greatly-increased student effort, and extensive learning assessment that is timely, formative, summative, standard-based, and transparent**.
MAA Task Framework

“A mathematical task is a set of problems or a single complex problem that focuses student attention on a particular mathematical idea.”

“Group-worthy tasks provide opportunities for students to develop deeper mathematical meaning for ideas, model and apply their knowledge to new situations, make connections across representations and ideas, and engage in higher-level reasoning where students discuss assumptions, general reasoning strategies, and conclusions.”

MAA Task Framework

Low-level cognitive demand tasks, such as *memorization tasks* and *procedures without connection tasks*

- Producing or committing facts, formulas, etc. to memory.
- Not ambiguous.
- Algorithmic.
- Focused on producing the correct answer, not developing mathematical understanding.
- No connection to concepts or meaning underlying the process.
- Require no explanation, or only explanations that describe the procedure used.

MAA Task Framework

High-level cognitive demand tasks, such as procedures with connections tasks and doing mathematics tasks.

- Suggest pathways and general procedures to follow with close connections to underlying concepts.
- General procedures cannot be followed mindlessly.
- Incorporate or use multiple representations.
- Require exploration and understanding of mathematical concepts, processes, or relationships.
- Require self-monitoring and self-regulation.
- Require analysis of task to identify constraints and possible limits on solutions.

Clinical Judgment Model

- Notice
  - Focused assessment
  - Information seeking
  - Recognize deviations
- Interpret
  - Make sense of the data
  - Set priorities
  - Make a plan
- Respond
  - Complete the interventions
  - Be skillful (think in action)
- Reflect
  - Self analysis
  - Note the outcomes
  - Re-use or improve for the future

Figure. Clinical Judgment Model.

Alignment of Models

Tanner’s Model of Clinical Judgment
(Tanner, 2006)

- Notice
  - Focused assessment
  - Information seeking
  - Recognize deviations
- Interpret
  - Make sense of the data
  - Set priorities
  - Make a plan
- Respond
  - Complete the interventions
  - Be skillful (think in action)
- Reflect
  - Self analysis
  - Note the outcomes
  - Re-use or improve for the future

Polya’s Mathematical Problem Solving Steps
(Polya, 1945)

- Understand the problem
  - What is unknown
  - What is the data
- Devising a Plan
  - Find the connections
  - Have you seen this before
- Carrying out the Plan
  - Complete the solution
  - Check each step
- Looking Back
  - Examine the solution
  - Check the result
  - Use in the future
Example

First, without completing any calculations, which bag do you think will finish first? Explain.

Then... If both infusions started at 0230, determine the completion time for each.
Next Steps
Local Next Steps

• Partner Discipline Discussions
  • Work with faculty in the Nursing program to identify the math course(s) that will best support their students in becoming safe and quality providers.
  • How is math actually used by practitioners?
  • What are state and/or national quantitative recommendations, if any?
  • Examples of specific math competencies for mutual understanding.
National Next Steps

• **Prioritize recommendation #1**
  • How do we identify the quantitative skills and competencies and/or content standards for nursing?
  • Who needs to be involved in the conversation? How do we reach them?
  • How do we reach consensus? How do we share this information?
  • How do we actually get this work moving? Who will lead and organize? What expertise do you have that can help us move forward?
Looking for Better Alignment – National Question

• Once we have identified the skills and competencies needed, what math course best aligns with those skills?
• Do any courses really align well? What is missing?
• When and where are healthcare students learning additional quantitative skills?
• How does the entry-level quantitative course promote quality and safe nursing practice?
• How does the entry-level quantitative course act as a barrier to nursing?
National Next Steps

• How do we pursue the other recommendations?
  • Which recommendations should we prioritize? Which ones do you feel most equipped to support/participate in?
  • Which ones can we start on right away?
  • Which ones need to wait until we have the list?
To Continue the Conversation...

• Join the “High-Quality Mathematics Education for Nurses” Google Group and connecting with your peers, please follow this link: (https://groups.google.com/g/mathandnursing).

To request to join, be sure that you are logged into your Google account and click on "Ask to join the group." In your request, please include your name, institution, title, and connections to this work.

• Upcoming webinars: Nov 3, Nov 9, 3-5pm Central. Register here: https://app.smartsheet.com/b/publish?EQBCT=1a08a9b87df24204a9623be906b13a54

• Check our website for more resources: https://sites.google.com/view/mathfornurses
To Continue the Conversation...

• Do you want to support this work by:
  • Writing grants
  • Organizing discussions and working groups
  • Developing authentic tasks that utilize best practices
  • Something else...?

Contact Joan (joan.zoellner@austin.utexas.edu) or Dan (dozimek2@pacollege.edu)
Citations


Citations


High-Quality Mathematics Education for Nurses Task Force Convening Recommendations

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- Estimation.
- Use of tables, graphs and charts, and formulas.
- Recognition of indices.
- Basic understanding of statistics.

National Recommendations to Improve Quantitative Education for Nurses

Daniel Ozimek, Pennsylvania College of Health Sciences
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Lindsay Good, Pennsylvania College of Health Sciences
Joan Zoellner, The Charles A. Dana Center at the University of Texas at Austin

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There is a lack of guidance from national education, accrediting, and licensure programs.

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- Professional associations tend to emphasize a broad liberal education along with professional competencies, but do not explicitly focus on mathematics.
- “End-of-program learning outcomes must be consistent with safe healthcare practice.” (ACEN, 2019)
- No national agreement on core quantitative competencies, and at what levels.
- No common pedagogical recommendations.
National Norms – Nursing Example 1

Quality and Safe Education for Nurses (QSEN) recommendations related to math:
• Demonstrate knowledge of basic scientific methods and processes.
• Describe Evidence-Based-Practice to include the components of research evidence, clinical expertise and patient/family values.
• Use data to monitor the outcomes of care processes and use improvement methods to design and test changes to continuously improve the quality and safety of health care systems.
• Explain the importance of variation and measurement in assessing quality of care.
• Use tools such as quality measures and charts.
• Describe processes used in understanding causes of error and allocation of responsibility and accountability (such as, root cause analysis and failure mode effects analysis).
American Association of Colleges of Nursing (AACN) recommendations related to math:

• Use skills of inquiry, analysis, and information literacy to address practice issues.
• Use improvement methods, based on data from the outcomes of care processes, to design and test changes to continuously improve the quality and safety of health care.
• Overview of Quality Improvement process techniques, including benchmarks, basic statistics, root cause analyses, and Failure Mode Effects Analysis in the quality improvement process.
• Overview of qualitative and quantitative research processes.
• The fundamentals of epidemiology and biostatistics (distribution, incidence, prevalence, rates, risk factors, health status indicators, and control of disease in populations).
High-Quality Mathematics Education for Nurses Task Force

A model for exploring the quantitative needs of nursing education programs.
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

• Daniel Ozimek and Joan Zoellner, co-chairs

• In October 2019 the Task Force held a Math and Statistics Education for Nurses Convening
Math and Statistics Education for Nurses Convening

Goals:
• Build connections among math education, nursing education, and nursing professional organizations.
• Develop a forward-thinking consensus on improving the quantitative education of nurses.

Attendees:
• 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
• 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
Convening Recommendations

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

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.

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

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

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

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).

Recommendation 7: Inform the community through collaborative engagements and professional development opportunities that integrate best practices from nursing, mathematics, and statistics education.
Recommendation #1

Identify the quantitative skills and competencies necessary for quality and safe nursing practice.
Existing Taxonomies of Quantitative Skills

Roberts (1990)

- Basic mathematics, including operating with rational numbers.
- Understand when to round off numbers and when not to.
- Converting between systems of measurement, including having a “feel” of comparison of quantities.
- Concepts of ratio, proportion, and basic algebra.
- Understanding the difference between dosage of medication and the volume in which that dosage comes.
- Using formulas and applying the order of operations, including those involving fluid rates.
Existing Taxonomies of Quantitative Skills

Young, Weeks & Hutton (2013)

• Operating with whole numbers, fractions, and decimals.
• Conversions between units.
• Concepts in measurement (setting the appropriate rate, drawing up an appropriate amount of medication, etc.)
• Understanding and operating with ratios and percentages.
• Estimation.
• Use of tables, graphs and charts, and formulas.
• Recognition of indices.
• Basic understanding of statistics.
Discussion

Let’s discuss the following:

• What do you notice about the taxonomies?
• What do you wonder about the taxonomies?
• Is it clear what math skills are most crucial, and how they are used in practice?
Recommendation #3

Incorporate recommendations and best practices in nursing, mathematics, and statistics education in the design of learning outcomes, instruction, materials, and assessments.
AMATYC IMPACT: Improving Mathematical Prowess And College Teaching

AMATYC intends to foster mathematical PROWESS in all students by:

• Presenting multiple instructional approaches that will build mathematical proficiency as well as student ownership of learning

• Providing guidance to faculty to design and implement instructional programs that foster mathematical prowess in students

• Sharing successful models of redesigned mathematics curricula that will revitalize faculty and departments to engage in meaningful conversations as well as implement evidence-based strategies, courses, and programs.

• Informing policy makers and legislators of the needs and challenges ahead for students and institutions and subsequently helping to implement policies that will lead to student success

Clinical Judgment Model

- Notice
  - Focused assessment
  - Information seeking
  - Recognize deviations
- Interpret
  - Make sense of the data
  - Set priorities
  - Make a plan
- Respond
  - Complete the interventions
  - Be skillful (think in action)
- Reflect
  - Self analysis
  - Note the outcomes
  - Re-use or improve for the future

Figure. Clinical Judgment Model.

Alignment of Models

Tanner’s Model of Clinical Judgment
(Tanner, 2006)

- Notice
  - Focused assessment
  - Information seeking
  - Recognize deviations

- Interpret
  - Make sense of the data
  - Set priorities
  - Make a plan

- Respond
  - Complete the interventions
  - Be skillful (think in action)

- Reflect
  - Self analysis
  - Note the outcomes
  - Re-use or improve for the future

Polya’s Mathematical Problem Solving Steps
(Polya, 1945)

- Understand the problem
  - What is unknown
  - What is the data

- Devising a Plan
  - Find the connections
  - Have you seen this before

- Carrying out the Plan
  - Complete the solution
  - Check each step

- Looking Back
  - Examine the solution
  - Check the result
  - Use in the future
Example

First, without completing any calculations, which bag do you think will finish first? Explain.

Then... If both infusions started at 0230, determine the completion time for each.
Recommendation #5

Include an ongoing analysis and discussion of ethical and effective communication of mathematical and statistical data, results, and recommendations.
Communication Example

The incidence rate of HIV in the US is approximately 0.33%

The “Quick” HIV test is 91.7% accurate for individuals with HIV and 99.9% accurate for individuals without HIV.

A patient comes in and states their quick test result was positive for HIV. The individual asks:

“Does this mean there is a 91.7% chance that I have HIV?”
Ethics Example

A comparison of a second- and third-generation oral contraceptive pill found 1 in 7000 women taking the second-generation had a thrombosis, while 2 in 7000 women taking the third had a thrombosis.

<table>
<thead>
<tr>
<th>Absolute Risk Increase</th>
<th>Relative Risk Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The risk of thrombosis increased by 1 in 7000”</td>
<td>“The risk of thrombosis increased by 100%”</td>
</tr>
</tbody>
</table>

Discussion

Let’s discuss the following:

• What support and/or collaboration would you need in order to enact recommendations 3 and 5?
  • Incorporating best practices from math and nursing education
  • Preparing students to address numerical ethics questions
If You’re Interested -- An Upcoming Webinar!

“Ethical Data Communication in the Healthcare Curriculum”

- Facilitated by Dr. Victor Piercey (Ferris State University) and Dr. Anna Wendel (Rivier University)
- Tuesday, November 9th, 3:00 – 4:00 PM ET
- The webinar will consider the application of the ethics codes from nursing, statistics, and related professions and it will include a discussion of curricular opportunities to address related questions in healthcare programs.
- Please e-mail Joan Zoellner for registration information:
  - joan.zoellner@austin.utexas.edu
Next Steps
Local Next Steps

• Partner Discipline Discussions
  • Work with faculty in the Nursing program to identify the math course(s) that will best support their students in becoming safe and quality providers.
  • How is math actually used by practitioners?
  • What are state and/or national quantitative recommendations, if any?
  • Examples of specific math competencies for mutual understanding.
National Next Steps

• Prioritize recommendation #1
  • How do we identify the quantitative skills and competencies and/or content standards for nursing?
  • Who needs to be involved in the conversation? How do we reach them?
  • How do we reach consensus? How do we share this information?
  • How do we actually get this work moving? Who will lead and organize? What expertise do you have that can help us move forward?
National Next Steps

• How do we pursue the other recommendations?
  • Which recommendations should we prioritize? Which ones do you feel most equipped to support/participate in?
  • Which ones can we start on right away?
  • Which ones need to wait until we have the list?
To Continue the Conversation...

• Join the “High-Quality Mathematics Education for Nurses” Google Group and connecting with your peers, please follow this link:
  • https://groups.google.com/g/mathandnursing
  • To request to join, be sure that you are logged into your Google account and click on "Ask to join the group." In your request, please include your name, institution, title, and connections to this work.

• Upcoming webinar on Ethical Data Communication: Nov 9, 3-4 PM ET.
  • For registration information, please contact Joan Zoellner (joan.zoellner@austin.utexas.edu)

• Check our website for more resources:
  • https://sites.google.com/view/mathfornurses
To Continue the Conversation...

• Do you want to support this work by:
  • Writing grants
  • Organizing discussions and working groups
  • Developing authentic tasks that utilize best practices
  • Something else...?

Contact:
• Joan Zoellner, joan.zoellner@austin.utexas.edu
• Daniel Ozimek, dozimek2@pacollege.edu
Citations


Citations


