

Teaching Statistics to Nursing Students: An Expert Panel Consensus

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ABSTRACT

Statistics education is a necessary element of nursing education, and its inclusion is recommended in the American Association of Colleges of Nursing guidelines for nurse training at all levels. This article presents a cohesive summary of an expert panel discussion, "Teaching Statistics to Nursing Students," held at the 2012 Joint Statistical Meetings. All panelists were statistics experts, had extensive teaching and consulting experience, and held faculty appointments in a U.S.-based nursing college or school. The panel discussed degree-specific curriculum requirements, course content, how to ensure nursing students understand the relevance of statistics, approaches to integrating statistics consulting knowledge, experience with classroom instruction, use of knowledge from the statistics education research field to make improvements in statistics education for nursing students, and classroom pedagogy and instruction on the use of statistical software. Panelists also discussed the need for evidence to make data-informed decisions about statistics education and training for nurses. [*J Nurs Educ.* 2013;52(6):330-334.]

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Knowledge of statistics is essential for nurse scientists. Statistical considerations play a significant role in all aspects of a scientific investigation, including study design, instrumentation, and data analysis. Statistics is used in the nursing sciences to promote evidence-based nursing practice (EBNP), which is needed for answering the national call for nurses to lead change in the U.S. health care system (Institute of Medicine, 2010). Nursing education aims to prepare nursing students to read and understand the nursing and health care literature, to make informed data-based decisions, and to base practice decisions on the best available evidence. Because articles in the nursing and health care literature use statistical language, methods, and interpretations, statistical literacy and knowledge is needed for understanding and use of EBNP.

Statistics education is a necessary component of graduate nursing education. The American Association of College Nursing (AACN) has published recommended guidelines for the education and training of nursing students (at the baccalaureate [BSN], master's [MSN], and practice and research doctorate [DNP and PhD, respectively] levels) (AACN, 1996, 2006, 2008, 2010). These guidelines include recommendations for statistics coursework. In most nursing programs, statistics coursework is included as a core requirement at both the undergraduate and graduate level. Ironically, although statistics education is a core requirement, little is known about the state of the science of statistics education in the nursing field. For example, no known publications describe the amount and level of statistics training offered in nursing schools. No known data are available to assess nursing knowledge or statistics training and the applied experience of faculty teaching statistics to nursing students.

The goal of this article is to share the field experiences, the issues discussed, and the consensus on statistics education resulting from a panel discussion with a group of statistics experts actively teaching, consulting, and collaborating in the academic nursing field. The session occurred at the 2012 Joint Statistical Meetings (JSM), the largest gathering of statisticians held in North America, from July 29 through August 2, 2012, in San Diego, California. The meeting is held jointly with the American Statistical Association (ASA) and several international organizations. The 2012 meeting had 6,350 attendees. The panel discussion was a contributed session sponsored by the ASA Section on Teaching Statistics in the Health Sciences and was

titled “Teaching Statistics to Nursing Students.” The panel (the authors of this manuscript) consisted of five doctoral-prepared statistics experts, each holding a faculty appointment in a U.S.-based nursing school or college. All of the panelists were experienced biostatisticians, had previously worked with nurse scientists in both consulting and collaborative roles, and had experience teaching statistics to nursing students in a classroom or guest lecture setting.

STATISTICS EDUCATORS

The panelists are experienced statistical consultants and collaborators, with extensive involvement on a variety of nursing research studies. Each panelist manages a statistical consulting service for faculty and students in their respective nursing college or school. All have served on multiple dissertation committees or have worked extensively with PhD students in assisting and advising with predoctoral award-funding applications, dissertation proposal study designs, and dissertation data analyses. Panelists discussed bringing consulting experience into the classroom by way of examples of applications of statistical methods to nursing research study data. Other classroom activities mentioned included invited guest lectures by nursing faculty on research projects involving statistical analysis for their own research projects and the inclusion of faculty publications of completed nursing research studies in course reading material to demonstrate statistical topics covered in the classroom. Another idea discussed was the integration of statistical topics and knowledge throughout each degree curriculum, with supplementary statistical modules developed for focused topics as appropriate. As statistics educators, the panelists discussed and acknowledged that the statistician’s lack of clinical training and knowledge is an important consideration in deciding how to approach teaching statistics to nursing students. Some of the panelists described the benefit of using homework assignments in the classroom, which involved finding published articles with statistical results in the student’s area of research interest. The responsibility lies on the statistics educator at the beginning of the course to emphasize and demonstrate the relevance and importance of statistical knowledge and applications in the nursing sciences.

STATISTICS EDUCATION RESEARCH

The nature of statistics education has been changing (delMas, 2011). A relatively new subfield of statistics, referred to as *statistics education*, has evolved and focuses on studies to address the myriad challenges that arise with statistics instruction. A study by Hogg (1991) found that “Students often consider statistics as the ‘worst’ course they take while in college” (p. 342). Many resources have been devoted to changing and improving the student experience with a statistics class. The National Science Foundation has funded several large consortia to study how students learn statistics, explore alternative pedagogical approaches, and improve attitudes about the topic (delMas, 2011; Zieffler, 2008). Findings in the statistics education research field offer promising insights that may potentially transform the way statistics is taught to nursing students. For

example, studies in the statistics education research literature have shown that a knowledge base in statistical literacy and reasoning is needed for understanding published research (delMas, Garfield, Ooms, & Chance, 2007). This has broad-reaching implications, given that traditional statistics training has focused on statistical methods instruction involving the application of mathematical formulas and an overemphasis on computations. Students need a strong foundation in statistical literacy and a fundamental understanding of basic statistical concepts, such as variability, random processes, and sampling error, to benefit from a statistical methods course.

These are important findings that have widespread applicability in considering statistics education for nursing students. For example, the panel discussed the reality that many graduate nursing students return to school to pursue a graduate degree after having been out of school and working in practice for a number of years. The notion of returning to school and starting a DNP or PhD program with one or two semesters of statistics may be daunting for some students. All of the panelists acknowledged math anxiety as a challenge in teaching statistics to nursing students. Several panelists shared that their approach to teaching includes acknowledging possible student anxiety at the beginning of the course; emphasizing a focus on conceptual understanding of the material, with a limited focus on mathematical formulaic computations; and repeatedly making a connection between statistical concepts and methods to applications in nursing practice and research.

TEACHING OBJECTIVES

The aim of statistics training varies considerably for each nursing degree. Statistics course structure and content should be appropriately designed to address student needs. Currently, the state of statistics education for nurses at all levels usually includes a methods-based approach to instruction. However, this approach is not necessarily suitable and does not address the pressing need to prepare nurses to read the nursing and health literature.

BSN Degree

Undergraduate nursing students are not likely to perform data analysis or be involved in the planning of scientific investigations. The statistical skill set needed at the undergraduate level includes a strong foundation in critical thinking and an introduction to statistical literacy.

MSN Degree

Students at all graduate levels (MSN, DNP, and PhD) need to be statistically literate to read the nursing and health literature. EBNP places heavy reliance on the understanding of and ability to read publications in nursing and health-related journals. Students at the MSN level will need a strong foundation in statistical literacy and reasoning. However, most MSN students will not have a need to apply statistical methods or perform their own data analysis in the workforce on completion of their degree. One of the panelists discussed a previous experience of proposing a core curricula change to the MSN Curriculum Committee in a prominent school of nursing. The proposal

was to replace the required one-semester, traditional statistical methods course with a one-semester, statistical literacy and reasoning course. The change was approved by the committee, and the course is now in place for MSN students at that school of nursing. Student evaluations have been positive, and the material is much more accessible and relevant to their needs.

DNP Degree

The DNP degree program is a recent development in the academic nursing field. Curricular decisions regarding statistics education and training are an important consideration in DNP education and training. This is a practice-focused degree with an emphasis on EBNP. Students receive limited scientific training, and capstone projects are limited in scope, often with a one-group design, and are not research-based. Research usually entails selecting a random sample from a population of interest, with the goal of generalizing to the population using statistical inference. Because DNP capstones lack this structure, in most cases statistical inference is not appropriate or needed for analysis of the data collected. Inferential methods, such as statistical tests and confidence intervals, are not appropriate for these projects; instead, descriptive statistics should be used to summarize capstone project results. Given the focus on practice training for DNP students, statistical training should not be focused on the application of statistical methods or on developing data analysis skills. Instead, DNP students need a strong foundation in reading the nursing and health-related literature; therefore, it is important to provide DNP students with strong training in statistical literacy and reasoning. It may also be helpful to educate DNP students on the possible roles of a statistician in the planning and conducting of scientific investigation, as they may need to seek statistical services after graduation.

PhD Degree

The statistical needs for training the research-focused doctorate include a strong base in statistical literacy and reasoning, hands-on training on the use of statistical software, data analysis skills, and experience in the reporting of statistical results. In addition to a foundational course in statistical literacy and reasoning, JSM panelists discussed the need for a course in statistical inference, a course in statistical modeling, and a course on advanced statistical topics.

COURSE CONTENT

The panel session included a detailed discussion about statistical content covered in statistics courses for nursing students. Many challenges were discussed related to this topic, including many expectations and pressures placed on students to achieve clinical skills. The curriculum for each nursing degree is quite demanding and is usually focused on developing clinical expertise. Statistics has traditionally not been integrated into the training and other required coursework, too often placing the burden on the student to discover the relevance and presence of statistical knowledge while focused on other important topics. The nursing sciences cover a broad spectrum of interests and types of outcomes related to all aspects of health. Statistical knowledge and methods differ for various types of data. For

example, handling psychosocial data may require knowledge of psychometrics and advanced statistical topics related to analysis of correlated data. Analysis of biomarker data may necessitate understanding of longitudinal modeling techniques.

The **Table** displays statistical content for nursing PhD coursework discussed during the panel session. We have included our recommendations for required and optional content. These are general guidelines, and we deem the chosen required topics to be fundamental statistical topics essential for students pursuing a research-focused doctorate. Many topics chosen as optional are advanced topics, and knowledge of these statistical areas may be necessary for selected students on the basis of their research interests. All of the panelists spoke of extensive experience giving guest lectures to faculty and graduate students on many of the optional topics listed in the **Table**. Many of these topics can be covered at an introductory and topical level in a guest lecture. This may enable a graduate student or faculty member to make an informed decision about whether further education is needed or desired in this area. It was also noted that learning more deeply about many of the advanced statistical topics listed in the **Table** require advanced mathematical knowledge of calculus or linear algebra. Coincidentally, an editorial published recently emphasized the need for nurses to invest in mathematics knowledge (Henly, 2012).

An interesting approach discussed by the panel for deciding on course content was to review statistical methods used in the nursing literature. To date, only one known publication exists on this topic. Zellner, Boerst, and Tabb (2007) studied the most common types of statistical methods used in current nursing research. The authors reviewed 462 articles in the nursing literature and quantified the use of statistical measures. Ten statistical methods most commonly appearing in the nursing literature represented approximately 80% of the statistical measures used. These findings support earlier research into statistical methods used in professional research (Beitz, 1998; Beitz & Robinson, 1997; Polit & Sherman, 1990; Robinson, 2001; Taylor & Muncer, 2000). However, the results of this work may not reflect the vast increase in the use of advanced statistical methods in the nursing literature. For example, the 2012 May/June issue of the journal *Nursing Research* was a special focus issue on the topic of statistics in nursing research (Hayat, 2012). Of the 10 accepted articles for this special issue, all involved advanced statistical topics, such as analysis of correlated data, statistical considerations in instrument development and measurement, and causal inference. These topics were not included in the findings of Zellner et al. (2007). The panelists reiterated that experiences of consulting and collaborating with nurse scientists had necessitated the use of many of the topics cited as optional in the **Table**.

STATISTICAL SOFTWARE

Hands-on data analysis is an integral component of statistics training for nursing PhD students. Panelists discussed statistical software and cited the use of SAS®, SPSS®, or STATA® software for primary classroom instruction. Other specialty statistical software packages were mentioned, including LISREL, MPlus, R, and WinBUGS. A discussion ensued about the

use of menu-driven software, such as SPSS, and some of the challenges this presents for data management and documentation of data manipulation and analysis. For example, the panelists discussed the use of SPSS as a data management and manipulation platform. Some nurse scientists and students choose to use SPSS for their analysis. This can be problematic in documenting changes made to data and learning more sophisticated procedures, such as merging and manipulation of data formats. The panel agreed that nursing PhD students need training in writing code or syntax. This option is available in SPSS, although the panelists cited examples of nursing faculty opting for the menu-driven, point-and-click interface.

A CALL FOR DATA

Statistics education is a core component of nursing curricula for all nursing degrees. However, no known published data are available to make data-informed decisions about statistics education and training. For example, to date, no known studies have quantified graduate nursing student knowledge and attitudes toward statistics. It would be helpful to have a rigorous survey of the statistical methods used and published in the nursing literature over the past 5 years. No known studies quantify statistical reporting errors in the nursing literature. These type of data would be useful in deciding on what to focus when teaching statistics to nursing students. No known published studies examine the timing of statistics coursework, its quantity, and the background and training of statistics educators teach-

TABLE
Course Content for Nursing PhD Students

Topic	Panel Recommendation
Descriptive statistics	Required
Statistical inference	
Confidence intervals	Required
Hypothesis testing	Required
Statistical modeling	
General linear model (analysis of variance, regression)	Required
Generalized linear model (logistic, Poisson)	Required
Sample size determination	
Power analysis	Required
Precision estimation	Required
Statistical considerations in study design	
Intervention studies	Required
Observational studies	Required
Survival analysis	
Statistical tests (Kaplan–Meier, log-rank)	Optional
Cox proportional hazards models	Optional
Psychometrics	
Measures of validity and reliability	Required
Item response theory	Optional
Factor analysis	Optional
Advanced statistical modeling	
Longitudinal models	Required
Multilevel/mixed/hierarchical models	Required
Nonlinear models	Optional
Structural equation modeling	Optional
Latent class models	Optional
Advanced statistical topics	
Missing data	Required
Adaptive designs	Optional
Interim analysis	Optional
Bayesian inference	Optional
Intent-to-treat	Optional
Cluster analysis	Optional
Multiple testing	Optional
Complex sampling	Optional
Discriminant analysis	Optional
Causal inference	
Propensity scoring	Optional
Instrumental variable models	Optional
Moderation and mediation	Optional

ing in an academic nursing environment. It would be helpful to consider these characteristics and how they may relate to short-term and long-term outcomes with nursing graduates.

During another JSM session focused on “Consulting in an Interdisciplinary Nursing Environment,” one of the panelists described a descriptive study he recently completed to examine statistical preparedness of nursing graduates for the workplace (Kim, 2013). These type of data are needed to enable evidence-based decisions on statistics education for nursing students.

DISCUSSION

Statistics education and coursework within a nursing degree program is not intended to promote statistical expertise. Students learning to work with statistics and data for the first time in a classroom setting have limited training and experience with study design and data analysis. The panelists discussed the challenge with which some PhD students are faced when working with dissertation planning and data analysis. The statistics education curriculum component of each nursing degree program needs to be carefully and efficiently planned to best address students’ needs. Traditional statistics training is outdated and has been found to be ineffective in statistics education research. Emphasis on formulas and hand calculations does not provide students with the statistical literacy and reasoning skills needed to read the nursing and health-related literature.

Much can be learned from statistics education research study findings. The nature of statistics education is changing, and the stigma around the topic of statistics is being addressed with new and exciting approaches to statistics education.

Evidence is needed to make informed curricula decisions about statistics education, including which topics to cover, how much time should be devoted to the training, and where in the degree program trajectory each course should be placed. Statistics education and training can, and should, be fun and interesting for nurses. The relevance of the topic is apparent in reviewing the nursing literature, as well as noting the AACN recommendations for statistical training at all levels. Developing a statistical mindset, built on a solid foundation of sound statistical reasoning and thinking, enables nurse scientists to

think carefully and critically about evidence and what is required for EBNP.

REFERENCES

- American Association of Colleges of Nursing. (1996). *The essentials of master’s education for advanced practice nursing*. Retrieved from <http://www.aacn.nche.edu/education-resources/MasEssentials96.pdf>
- American Association of Colleges of Nursing. (2006). *The essentials of doctoral education for advanced nursing practice*. Retrieved from <http://www.aacn.nche.edu/publications/position/DNPEssentials.pdf>
- American Association of Colleges of Nursing. (2008). *The essentials of baccalaureate education for professional nursing practice*. Retrieved from <http://www.aacn.nche.edu/education-resources/baccessentials08.pdf>
- American Association of Colleges of Nursing. (2010). *The research-focused doctoral program in nursing: Pathways to excellence*. Retrieved from <http://www.aacn.nche.edu/education-resources/phdposition.pdf>
- Beitz, J.M. (1998). Helping students learn and apply statistical analysis: A metacognitive approach. *Nurse Educator*, 23(1), 49-51.
- Beitz, J.M., & Robinson, Z. (1997). Creative strategies for teaching statistical concepts in nursing education. *Nurse Educator*, 22(1), 30-34.
- delMas, R. (2011). *It takes a village: Future directions for statistics education research*. Retrieved from <https://www.causeweb.org/uscots/uscots11/program/delmas.pdf>
- delMas, R., Garfield, J., Ooms, A., & Chance, B. (2007). Assessing students’ conceptual understanding after a first course in statistics. *Statistics Education Research Journal*, 6(2), 28-58.
- Hayat, M.J. (2012). Statistics in nursing research. *Nursing Research*, 61, 147-148.
- Henly, S.J. (2012). Strength in numbers: Mathematics and nursing research. *Nursing Research*, 61, 241.
- Hogg, R.V. (1991). Statistical education: Improvements are badly needed. *The American Statistician*, 45, 342-343.
- Institute of Medicine. (2010). *The future of nursing: Leading change, advancing health*. Washington, DC: National Academies Press.
- Kim, M. (2013). *Investigating statistical preparedness of nursing graduates for the workplace*. Manuscript in preparation.
- Polit, D.F., & Sherman, R.E. (1990). Statistical power in nursing research. *Nursing Research*, 39, 365-369.
- Robinson, J.H. (2001). Mastering research critique and statistical interpretation: Guidelines and golden rules. *Nurse Educator*, 26, 136-141.
- Taylor, S., & Muncer, S. (2000). Redressing the power and effect of significance. A new approach to an old problem: Teaching statistics to nursing students. *Nurse Education Today*, 20, 358-364.
- Zellner, K., Boerst, C.J., & Tabb, W. (2007). Statistics used in current nursing research. *Journal of Nursing Education*, 46, 55-59.
- Zieffler, A., Garfield, J., delMas, R., & Reading, C. (2008). A framework to support research on informal inferential reasoning. *Statistics Education Research Journal*, 7(2), 40-58.

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