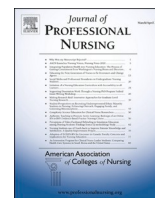




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Redesigning a PhD measurement course for a new era in nursing science

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ABSTRACT

Measurement is at the core of the research process. At the PhD level, students need to develop an in-depth understanding of measures relevant to their area of work and refine their knowledge of measurement issues. Traditionally, measurement coursework in Nursing focused on the psychometric evaluation of instruments measuring cognition and behavior. However, in the age of Big Data, precision medicine, and translational science, PhD students need to develop knowledge and skills relevant to these fields and to collaborate with experts from the different disciplines. Therefore, Nursing faculty need to recognize the state-of-the-science of nursing research and tend to a variety of measurement issues across a spectrum of operationalized concepts. Herein we present an overview of learning outcomes, instructional content and methods of delivery for a contemporary PhD-level course on measurement for Nursing Science. We also present our experience in the design, implementation, and evaluation of a novel PhD measurement course.

Introduction

Careful consideration of measurement aspects of research is essential in the construct of well-designed, rigorous studies (Waltz, Strickland, & Lenz, 2017). Historically, Nursing PhD curricula have included measurement or advanced research methods courses focused on the selection of appropriate design and methods of quantitative and qualitative analysis (Polit & Beck, 2016). Also, appraising the breadth and depth of instruments used in research has been a critical component of these programs, while utilizing methodology from the psychosocial sciences (Waltz et al., 2017). In such methodology coursework, students are guided on critically evaluating the adequacy of instruments, considering uncertainties in measurement, and examining sources of variability.

Contemporary scientific developments in the healthcare arena call for a transformation of the principal science content, and research training in nursing PhD programs (Henly et al., 2015). In this era of precision medicine, Big Data, translational science, patient-reported outcomes, and cost-effectiveness research, formal advanced training needs to be provided to PhD students (Henly et al., 2015). There is also a growing demand for multiple disciplinary research teams to observe problems from different perspectives, develop more comprehensive research hypotheses, and solve complex problems more effectively (Choi

& Pak, 2006). These recent trends towards producing applied science, i. e. research involving multiple disciplines is becoming increasingly appealing for funding agencies. The National Institute of Nursing Research (NINR) has been encouraging the integration of genetic or other biomarkers, data science and informatics in Nursing research, over the past 20 years (National Institute of Nursing Research, n.d.-a; National Institute of Nursing Research, n.d.-b). But, are PhD programs in Nursing preparing nurse scholars who can function adequately at the cutting-edge of science? To our knowledge, as of 2015, there has been only one study on Nursing PhD programs in the U.S. revealing that curricula do not sufficiently cover emerging areas in the sciences (Wyman & Henly, 2015). The amalgamation of new research methods in Nursing studies, as per the NINR recommendations, will get students up to par for collaboration with other disciplines.

The American Association of Colleges of Nursing emphasized the enlisting of faculty with established interdisciplinary research programs to mentor upcoming innovators in Nursing (American Association of Colleges of Nursing, 2010). Pursuantly, revamping PhD level measurement coursework will be a cornerstone for capacity building in the advancement of Nursing scholars, commensurate with the state-of-the-science.

In the upcoming sections, we present an overview of the learning

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outcomes, instructional content and methods of delivery within a research thought process framework for a PhD-level course on measurement in Nursing research. We also include our experience in course development and implementation along with the students' perspective and evaluation.

The learning outcomes of a new course on measurement

To begin with, it is essential to lay down the basic elements of the research thought process on measurement in Nursing (Fig. 1). Initially, the students identify the measurable constructs pertaining to their research question. Then, the conceptual and operational definitions are identified and translated into measurable elements as variables. Finally, the choice of appropriate measures and comparison with alternative measures are introduced; emphasis is placed on the rationale for using the measure and how it will be conducted. Additionally, research tools to guide the selection of a robust measure are discussed.

Learning outcomes clarify expectations for students and guide faculty members in the assessment of the overall learning experience. When developing learning outcomes, faculty ought to focus on skills and competencies needed for the successful implementation of a PhD dissertation, leading to a career path as a researcher (Denecke, Kent, & McCarthy, 2017). In Table 1, we suggest overarching general learning outcomes that can be considered during course development.

Throughout the course and in achieving learning outcomes, students would be encouraged to scrutinize aspects of measurement relevant to select concepts, as pertinent to their research work. A variety of topics, spanning multiple disciplines, may be included every week. The latter would help expand students' repertoire from which a nurse scientist may extract measurement tools.

Instructional content: the basics and advances

The content of the coursework will always stem from the foundational knowledge on measurement theory and frameworks. Concepts to be measured differ in level of abstraction and complexity and pertain to different categories: psychosocial, health services, clinical symptoms, physiological and laboratory measures, and informatics. The students delve into several levels of measurement for variables of interest and

Table 1
General learning outcomes for a PhD level measurement course in nursing research.

1) Develop an advanced understanding of principles of measurement theory and measurement error (systematic and random error)
2) Demonstrate ability to examine reliability, validity, accuracy, precision, sensitivity and specificity of measurement instruments and predictive values of assays
3) Evaluate the use of tissue and blood markers as surrogate outcomes in clinical research
4) Examine measurement problems related to the analysis of Big Data
5) Explore aspects of precision medicine in nursing science
6) Describe the translational research spectrum and implications in nursing
7) Discuss implementation science as methodology for addressing the effectiveness of clinical interventions
8) Identify the components of instrument development
9) Apply appropriate statistics for the analysis of a measure
10) Discuss the cultural validation process of questionnaires

detailed analytics.

Core competencies for quantitative measurement ought to be emphasized (Thompson et al., 2018). A variety of biobehavioral research instruments are introduced as measurement tools, with focus on instrument development basics. To ensure efficacy and accuracy, when developing or using cognitive and behavioral research tests, the psychometric properties-reliability and validity-are stressed. When utilizing biophysiological measures such as diagnostic tools, sensitivity and specificity calculations are essential.

As deviations of a measured value from a true value are inevitable, the possibility of measurement error, random and systematic error, is discussed throughout the course. Evident sources of distortions, bias, along with their corrective actions, are scrutinized. In addition to the consistency and soundness of a measure, appropriateness of its use for the particular construct and the target population is considered, along with sensitivity to change in the desired outcome, ease of administration, and public availability of the tool. The application of measures in diverse populations is also considered.

As mentioned earlier, the NINR encourages the exploration of physiological and biological mechanisms, particularly underlying symptom manifestation; for instance, studying the genetic underpinnings relevant to inflammatory markers associated with symptom

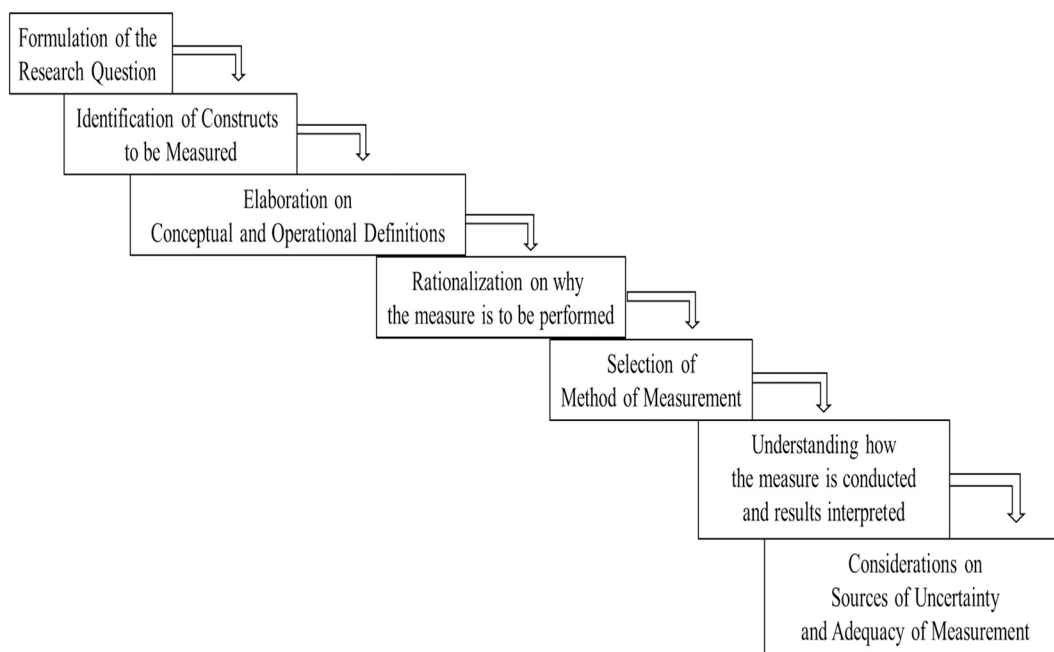


Fig. 1. Basic elements of the research thought process on measurement in nursing.

clusters like fatigue or pain in fibromyalgia. Measurement related to molecular genetics including microbiome analysis could be addressed in the context of precision Science in Nursing. Topics relevant to serum and tissue markers require scrutiny. It is also encouraged that faculty members integrate discipline-specific learning outcomes for examining select techniques such as real-time polymerase chain reaction (PCR) and functional imaging. The use of technology in research, such as in real-time data collection with ecological momentary assessment, informatics research and Big Data science can be studied. Measurement in health services-oriented research and interactive digital media may also be examined. Importantly, with current developments in Nursing Sciences and Medicine, measurement for studies that fall across the spectrum of translational and implementation sciences ought to be discussed as well. This will require that consideration be given to measurement in pre-clinical (cellular and animal research), clinical, and epidemiological studies on humans. Finally, measurement concerns that are particular to qualitative research may be discussed such as challenges relevant to the conduct of interviews, interpretive validity, and the limitation on generalizability.

It is important to emphasize that the integration of these methodological approaches in nursing research ultimately aims to enrich the capability of problem solving in Nursing-related research.

Method of course delivery

Faculty may resort to various instructional methods. These methods may include traditional faculty-led discussions, student presentations, hands-on work on data, article critique, and written assignments. PhD students must obtain different learning experiences and interact with the wider scholarly community; such encounters contribute to individual development and promote active engagement in PhD work (Vekkalia, Pyhatlo, & Lonka, 2013). Hence, course faculty preferably will host guest speakers with expertise in the psychosocial sciences, physiology, genomics, data science, public health, engineering, or other specialties.

Students are encouraged to reach out to resources beyond the classroom. Therefore, faculty should support engagement in activities like participation in independent study coursework, interdisciplinary seminars, sessions on advanced statistical methods and epidemiology, clinical trial coursework, and cross-training in laboratories. Additionally, faculty may expose the students to hands-on applications in advanced analytical methods such as confirmatory factor analysis, principal component analysis, cluster analysis, path analysis and structural equation modeling. Moreover, interpretation of various graphics like the receiver operating curves or Kaplan Meier estimator could be included as well. In fact, such endeavors will help expand students' discipline-specific vocabulary, and help the students immerse in an in-depth disciplinary inquiry. Students are also encouraged to delve into literature to develop knowledge of methodology. These individual experiences help shape the identity of the nurse scientist (Armstrong, McCurry, & Dluhy, 2017). Moreover, guiding on and providing opportunities for students to learn methodology and gain experiences in central areas of science today, such as in data science and genomics, will help expand the frontiers of nursing knowledge (Cummins, 2017).

While it is important for the PhD students to get exposed to various research methods, they are not expected to become experts in these techniques. However, as they build or contribute to multidisciplinary teams, they will be able to better communicate their knowledge in various contexts.

Course implementation and evaluation: the experience of the American University of Beirut

A novel 3-credit PhD-level measurement course was designed at the American University of Beirut, during the first year of the new PhD program in Nursing. This was a required course in the program, first delivered in the Spring semester of 2019. Only 3 students were enrolled

in the course, representing the first PhD cohort. We met in person twice per week for 1.5 h session.

During the Spring of 2020, the same course was offered to the second cohort of 3 PhD students, however, due to the novel coronavirus 2019 pandemic, we resorted to long distance learning. We taught using online platforms like WebEx and Zoom. This transition has allowed us to invite guest speakers from the US to address specialty topics such as structural equation modeling and advanced qualitative research methods. This experience was well-received by both the faculty members and the students. The course may be modified in the future to be delivered in a hybrid format.

With the same cohort, we have included readings related to emerging research on the coronavirus, for instance, the Randomized Controlled Trial (RCT) on Hydroxychloroquine and Azithromycin was added to the readings and discussion on RCTs and measurement of clinical outcomes. We have also addressed ethical considerations related to conducting clinical trials research in times of pandemics. Along the same line, in the session on technology use in data collection, measurement issues related to the topics of contact tracing and physical distancing that emerged during the coronavirus pandemic were also explored. This comes with a multitude of ethical implications on data protection and privacy.

The course covered a wide spectrum of measurement and content relevant to the State of the Science in Nursing. We followed the required foundational content, mentioned in the above sections, including psychometric analysis and instrument development. Additional assessment methods using advanced analytical approaches such as item response and Rasch analysis, structural equation modeling, path and survival analysis were discussed. Key clinical symptoms and outcomes measurement was elaborated on, for instance pain and quality of life. Measurement in advanced qualitative research was also presented.

We expanded the content to integrate a broader spectrum of research methods such as analysis of data collected using technology like smartphone applications or web-based surveys. We shed light on the specifics related to translational research methods spanning from pre-clinical to population studies. The management of various data sources such as blood, tissue or imaging in biomarker and genetic research was discussed. Analysis of Big Data and the use of bioinformatics in Nursing research were also introduced. Since the textbook alone was not sufficient to cover all the content of this course, we selected recent publications of expert faculty members and, when possible, we invited the authors to deliver and discuss the content. This allowed the students to hear about different research trajectories and experiences (challenges along the way), and programs of research. Several researchers from nursing and applied health disciplines were invited to explain these topics based on expertise. Coordinating such a course is demanding for the lead instructors as they work on ensuring robust integration of the different aspects of the course and students' needs.

Students selected weekly topics for write-up assignments, submitted a term paper on comparison of measures relevant to their areas of research, and presented on a select measurement tool relevant to their preliminary research question.

The university's Office of Institutional Research and Assessment collected end-of-semester student evaluations electronically. Course faculty reviewed student feedback to improve the course content, enhance instructor performance, and augment student learning. The first cohort of PhD students reported that the course was well-organized, provided valuable material, increased their interest in the measurement realm, and was designed to encourage analytical thinking. Article discussions were deemed helpful; it was suggested to have students select articles relevant to their respective research areas, for discussion sessions. Students valued course faculty sharing their real-life experience on measurement challenges that needed to be addressed in the conduct of research studies. Finally, students shared that having guest speakers from other disciplines provided for interesting and newer perspectives on research possibilities. In further developing measurement coursework, additional emphasis could be placed on data produced by

technologic enhancements in research. For example, considerations for the use of advanced statistical approaches to handle repeated measurements, and computational tools to facilitate recognition of meaningful patterns in data may be elaborated upon.

Conclusion

Advancements in health research call for the preparation of nurse scholars who generate knowledge for a new era of Nursing Science. PhD programs must be well-positioned to produce investigators who conceive, develop, and implement innovative initiatives in interdisciplinary contexts. Faculty need to be abreast of developments and to ensure the delivery of a curriculum that is at the forefront of science. In addressing a core aspect of the curriculum, it is essential to develop novel measurement coursework. Training students on measurement issues relevant to contemporary phenomena encourages them on unconventional thinking and interdisciplinary collaborations, and enhances state-of-the-science nursing research.

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Declaration of competing interest

The authors have no competing interests to declare.

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