Spring 5-10-2019

Learning Science: Physical and Life Sciences in Curricula Across U.S. Schools of Nursing

Valerie C. Sauda
University of Maine, valerie.sauda@maine.edu

LEARNING SCIENCE: PHYSICAL AND LIFE SCIENCES IN CURRICULA

ACROSS U.S. SCHOOLS OF NURSING

By

Valerie C. Sauda

B.A. Biology, University of Southern Maine, 1987

M.S.N. University of Southern Maine, 1992

A DISSERTATION

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

(In Interdisciplinary in Nursing and Education)

The Graduate School

The University of Maine

May 2019

Advisory Committee:

Patricia Poirier, Ph.D., R.N. Associate Professor of Nursing, Advisor
Michael Wittmann, Ph.D., Professor/Director, Physics Education Research Laboratory
Vanessa Klein, Ph.D. Assistant Professor of Education Assistant Extension Professor
Gail Tudor, Ph.D., Associate Dean, Southern New Hampshire University
Frank McGrady, Pharm.D.,Director of Pharmacy, Penobscot Community Health Center

LEARNING SCIENCE: PHYSICAL AND LIFE SCIENCES IN CURRICULA ACROSS U.S. SCHOOLS OF NURSING

By Valerie C. Sauda

Dissertation Advisor: Dr. Patricia Poirier

An Abstract of the Dissertation Presented
In Partial Fulfillment of the Requirements for the
Degree of Doctor of Philosophy
(In Interdisciplinary in Nursing and Education)
May 2019

Nursing educators are being challenged to provide curriculum that meets the changing healthcare environment and demand for creative, innovative nurses to assist in transforming healthcare into the future (Benner, Sutphen, Leonard, & Day, 2010; Institute Of Medicine, 2011). The liberal education provided within a baccalaureate of science in nursing (BSN) degree program provides a diversity of courses within the curriculum, including courses in the natural, physical, mathematical, and social sciences (American Association of Colleges of Nursing [AACN], 2008). Although nursing programs have included science courses in curriculum since the early 1900s (Nutting & Dock, 1907), there is lack of nursing educational research as to which science courses and how many should be included in nursing curriculum to help meet the changing demands of the healthcare environment. The purpose of this study is to explore natural and physical science specific curricula for Commission on Collegiate Nursing Education (CCNE) accredited nursing programs and to reveal differences and/or consistencies among programs. Through the collection and analysis of available data from public datasets, the retrospective observational study revealed consistency among the specific science courses offered within U.S. schools of nursing which have similar course titles to science courses offered in 1918 (Nutting and Stewart, 1918). Institutional factors such as the affiliated university or college research level or public/private status, whether a nursing program provides direct entry, or a nursing program's admission GPA appears to have little to no relationship with specific science curriculum offered in schools of nursing and no significant association with NCLEX-RN® examination pass rates based on science curriculum. Although the NCLEX-RN® examination is the benchmark end of program and entry into practice examination for nurses, the relationship between science curriculum and the NCLEX-RN® examination is unclear from the study. The impact of a science curriculum upon the practice and education of nurses today requires further study. The opportunity for enhancement of clinical thinking and collaborative opportunities that study in sciences offer could be a significant component of future study for nursing educators to ensure the future workforce is able to engage in innovation.

Keywords: Nursing curriculum, physical and natural sciences, NCLEX, U.S. schools of nursing

ACKNOWLEDGEMENTS

I would like to thank my committee members for their support and helpful feedback during my doctoral journey. In these times of online communication, I am especially grateful to the committee for their prompt responses and thoughtful feedback as I completed my study. I am thankful for the statistical feedback and support provided by Dr. Gail Tudor and Dr. Patricia Poirier as I challenged myself to learn more about the quantitative research process. A special thank you to my committee members, Dr. Michael Wittmann and Dr. Frank McGrady, who accepted positions on the committee and were willing to work on an interdisciplinary team with a doctoral nursing student. The input and critical thinking challenges each of them has given me has challenged me to work to my highest potential and success.

I cannot express my gratitude enough to Dr. Ann Sossong, Dr. Leah Hakkola, Dr. Vanessa Klein, Dr. Susan Gardner, Dr. Stacy Doore, Dr. Craig Mason, and Dr. Marilyn Gugliucci whose encouraging feedback gave me the courage to move forward as a doctoral student when I did not feel as though I had the knowledge or skill to succeed. You inspire me to strive to do better as an educator and as a researcher.

I thank Dr. Donna Beuk, Dr. Teresa Steele, Dr. Paula Tingley, and Dr. Lynne Coy-Ogan, who have been especially supportive of my doctoral process at my employer, Husson University. Listening to my challenges, permitting me to have extra hours in my office, and supporting of my work through academic resources was of great value. I am fortunate to have such strong role models in my academic work and research.

Finally, I thank my husband, Michael, my children, Kayleigh, Erynne, and Carolyne, and my in-laws, Karen and Gary, who have offered their love, patience, and support over the past few years in too many ways to name. I am thankful to have each of you in my life every day.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The increasing need for nurses due to changing population demographics and advances in healthcare and healthcare delivery (Finkelman & Kenner, 2012; Institute of Medicine, 2011) has demanded that nursing education develop innovative models of educational delivery with focus on curriculum efficiency and shorter times to completion, while increasing program capacity and enrollment (American Association of Colleges of Nursing, 2017). With an increasing focus on quality, innovation, and maintaining patient safety within a technologically advanced healthcare system, the nursing educational system needs change (Benner et al., 2010; Finkelman & Kenner, 2012). When looking specifically at nursing curriculum, Benner et al. (2010) highlighted the importance of the "deep and complex education that nurses would need-the array of knowledge from the nursing sciences, natural sciences, social sciences and humanities; skills of practice and ethical comportment-to function as professionals." (p.24). Of interest in this study, is how the complex education needed in natural and physical sciences is delivered within schools of nursing and if there has been any significant transformation in science course inclusion within the curriculum since sciences were included in U.S. nursing curricula in the early 1900s.

Natural and physical sciences are considered liberal education cornerstones in the nursing curriculum for the learning outcome of development of clinical judgement through critical thinking skills and science content knowledge development across the curriculum by scaffolding learning over time (Keating, 2006, p.86). The analysis of science curriculum including, but not limited to, the number and type of science courses included in the nursing curriculum, is important to analyze the potential implication of how science coursework influences the intended program learning outcome of clinical judgement. The study attempts to identify the relationships within the constraint of program and institutional factors of the sub-curriculum of sciences that have potential to influence the program learning outcome assessment measure on the NCLEX-RN® examination, the criterion-referenced end of program and entry into practice licensure examination required of all U.S. nursing students (NCSBN, 2016). Through analysis of science curriculum, future research as to how science education helps to enhance clinical judgement may help to advance nursing education to meet the collaborative and innovative demands of the healthcare environment of the future.

Scope of the Problem

The complex knowledge needed for today's nurse in the natural, physical, and mathematical sciences is often concentrated in the science and math coursework within the first two years of a baccalaureate nursing program (AACN, 2008). Although nursing programs have included natural and physical science courses within the nursing curriculum since the 1900s (Nutting & Dock, 1907), there is a lack of research as to what the contribution of sciences is to the development of both scientific knowledge and critical thinking skills within nursing education. As both content and critical thinking skills contribute to development of clinical judgement as a program learning outcome (AACN, 2008), the contribution of the natural and physical sciences, including number and type of science courses, is a gap within nursing educational research. With science coursework within the first two years of a nursing BSN program, the importance of science coursework as foundational to the scaffolding of clinical judgement development seems significant.

Inclusion of science courses within the nursing curriculum is dependent on both internal and external factors (Iwasiw and Goldenberg, 2015). Underlying general curriculum development factors which have potential for influencing science course inclusion include:

- academic and financial resources of the institution that house the school of nursing,
- geographical location of the school of nursing,
- educational resources available within the geographical region,
- program resources which help a nursing program meet learning outcomes related to the NCLEX-RN® examination, and
- state prescribed educational program curriculum (Iwasiw & Goldenberg, 2015; Keating, 2006).

Iwasiw and Goldenberg (2015) identify that curriculum decisions require contextual analysis to ensure that the educational process design meets learning outcomes and develops competent new graduate nurses who are ready to practice. An analysis of the sub-curricula of natural and physical science courses across a sample of U.S. schools of nursing, could inform nurse educators as to how to help scaffold curriculum to better meet the learning outcome of clinical judgement as well as identify the most efficient and effective science course delivery in curriculum.

The NCLEX-RN® examination is a high stakes criterion referenced examination measuring a new nurses' competence in provision of safe and effective nursing care. "Territorial jurisdictions" including state boards of nursing (National Council of State Boards of Nursing [NCSBN], 2016, p.3) use the examination as a gatekeeper measure to issue the initial registered nurse license. The NCLEX-RN® test blueprint is helpful in identifying specific science content knowledge required to provide safe nursing practice. For example in the nursing content area of safety and infection control, the science content of microbiology is evident in management of infectious disease and use of precaution methods. Further examples of science content outlined in the NCLEX-RN® test blueprint include:

- principles of physics in force, friction, and shear in maintaining safe environments of care through ergonomics and safe use of mobility and transfer devices,
- management of disease processes through understanding of the chemical properties of fluid and electrolytes, and electrical conduction in electrocardiogram interpretation, and
- pathophysiology of disease process to assure that side effects of medications administered are carefully monitored (NCSBN, 2016, p.9).

Administration of medications is one of the highest risk nursing actions; the knowledge of pathophysiology, anatomy, as well as mathematics to provide safe administration of medications is essential (NCSBN 2016, p.9). The exploration of science curriculum in this study helps to uncover the implied science content and potential critical thinking practice opportunities available to nursing students in the science coursework which may have effects on NCLEX-RN® examination pass rates.

Research findings that appear to have predictability for NCLEX-RN® examination success include:

- pre-admission Scholastic Achievement Test (SAT) scores,
- pre-nursing course grade point average,
- standardized nursing course assessment results such as assessments from Assessment Technologies Institute (ATI) or Health Education Systems Inc. (HESI),
- grades in science courses such as anatomy and physiology or pathophysiology,
- English grades, and

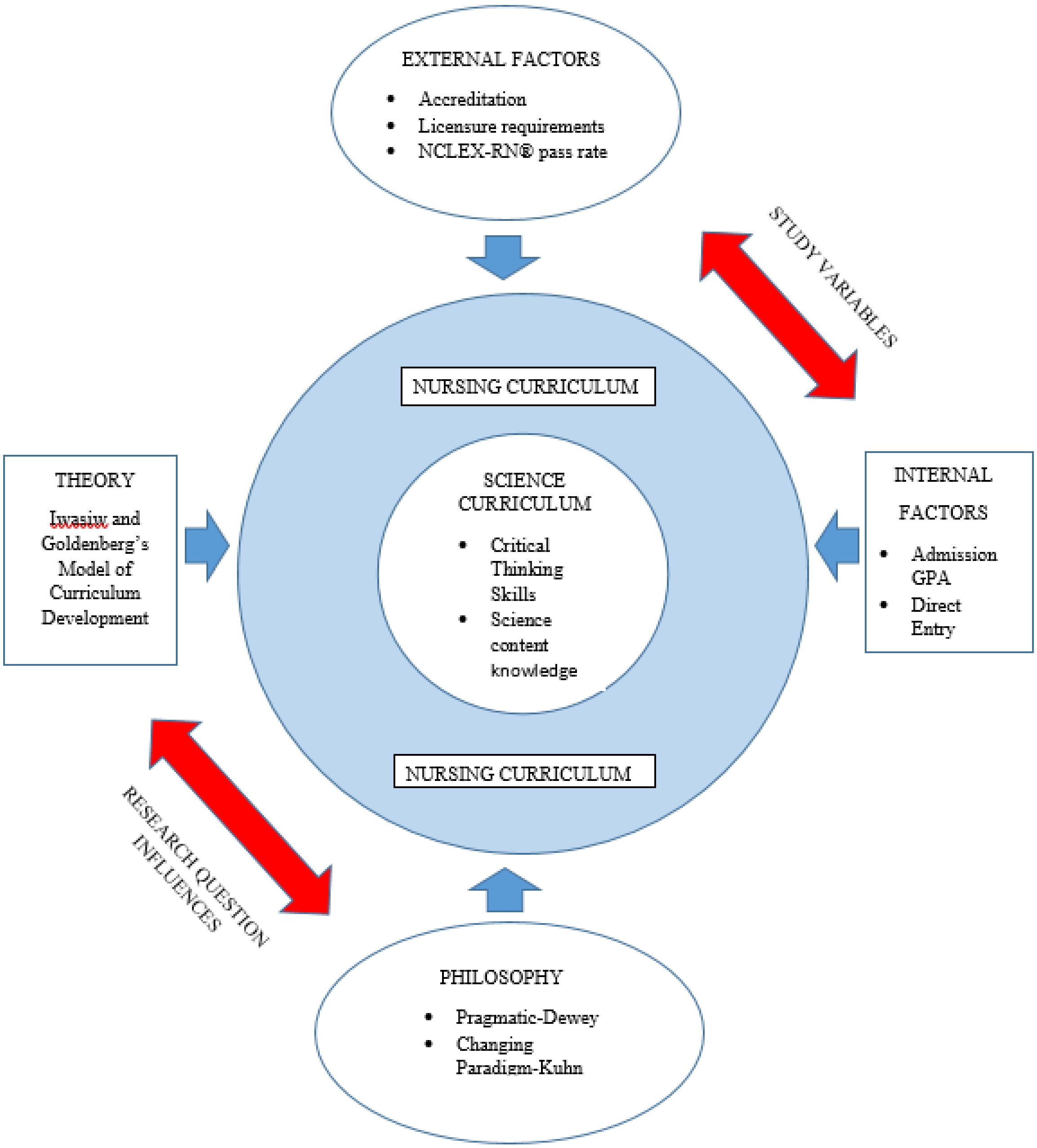
- academic advising and personal support (McCarthy, Harris, & Tracz, 2014; Simon, McGinnis, & Krauss, 2013).

There has not been a large volume of nursing educational research completed to date reviewing the predictors for NCLEX-RN® examination success related specifically to the nursing curriculum in part or as a whole. This study will contribute to the discussion by reviewing the relationship of the combination of science courses offered within nursing curriculum and NCLEX-RN® examination pass rate using the lens of program and institutional variables. As the nursing shortage continues within the United States and increasing requirements for curriculum efficiency and effectiveness continue, nursing educators need to explore all variables within a curriculum to help ensure success on the entry into practice NCLEX-RN® examination.

Conceptual Framework

A philosophical and theoretical framework is helpful to conduct a review of nursing curriculum (Iwasiw & Goldenberg, 2015). In completing this study, both theoretical and philosophical concepts help to frame the research questions and the answer to the philosophical question of why is it important to study science course inclusion within a nursing curriculum. Critical thinking definitions as well as philosophical ideas developed by Dewey (1910) and Kuhn (1962) contribute to research question development. The theoretical basis of the "Evidence Informed, Context-Relevant, Unified Curriculum Development in Nursing Education Model" developed by Iwasiw and Goldenberg (2015) underpins the study method and analysis. Figure 3.1 highlights the relationships within the review of the science curriculum in this study.

Figure 1.1 Relational Framework Of Study



Sciences as tool for critical thinking skills development. As suggested by Rega, Tellareti, Alvaro, and Kangasniemi (2017) and Okasha (2016), philosophy of science is a cornerstone for development of nursing as a discipline and practice. Of particular note, is the philosophical context within the areas of "inductive and deductive thinking and theoretical development" (Okasha, 2016, p.18). At the core of nursing education, is the concept of clinical judgement that requires critical thinking skill development. Byrnes and Dunbar (2014) outline the key components of critical thinking including:

- Metacognitive and reflective
- Evaluative
- Analytical
- Unbiased and open minded
- Time consuming, requiring effort
- Within the context of domain specific content (p.481)

"Skills of inquiry, analysis, critical thinking, and communication in a variety of modes, including the written and spoken word, prepare baccalaureate graduates to involve others in the common good through use of information technologies, team work, and interprofessional problem solving" are essential to the preparation of the baccalaureate nurse (AACN, 2008, p. 11). Nursing curriculum should include courses that help to develop both science content knowledge as well as critical thinking skills (AACN, 2008). The premise of science coursework as a tool for the development of critical thinking skills as well as set the foundation for science content knowledge is at the heart of this research study.

Described by Tirunch, DeCock, Weldeslassie, Elen, and Janssen (2017) a goal of sciences is that critical thinking is a function that helps the student to develop and engage thoughtfully within the discipline (p.664). Byrnes and Dunbar (2014, p.480) identified that critical thinking helps to uncover flawed reasoning which can lead, particularly in medicine, to errors that can cause harm. Talavera (2016) supports “encouraging them to develop the critical thinking skills necessary to analyze and evaluate all kinds of phenomena, scientific, pseudoscientific, and other.” (p.5). Missing the development of a critical, analytic lens, Talavera (2016) states that, “this could lead to a gradual hardening of beliefs that would seriously impede scientific inquiry and the attainment of scientific knowledge” (p.6). The importance of analysis and evaluation of phenomena is at the core of development of critical thinking skills within nursing curriculum.

The exposure to the framework of critical thinking used by the scientific disciplines is of significance to nursing education as critical thinking can be used “as a guide for decision making” (Rodgers, 2005, p.176). As suggested by Benner et al. (2010) and Brown, Hyslop and Barbera (2015), the increasing need to use collaboration in providing healthcare and integrating sciences in daily practice, exposes the opportunity to enhance critical thinking skills during engagement within science courses. The creation of interprofessional academic teams such as the Microbiology in Nursing and Allied Health team (Norman-McKay& ASM MINAH, 2018), underpins confidence in pursuit of a contribution through nursing educational research to embrace science education within nursing curriculum not only for content related knowledge but also as an opportunity to develop critical thinking skills. The exploration of science courses within nursing curriculum within this study may give insight into how nursing educators are addressing the need for development of science content knowledge as well as foundational scientific critical thinking skills. Confirmation of the value of science coursework within a nursing curriculum through analysis of number and types of courses as well as influencing variables, can help give insight into whether there is value placed on sciences as contributing to the development of a nursing student's critical thinking skills or as content focused knowledge development.

John Dewey and reflective thinking. Within this study, pragmatic thinking described by John Dewey and the "puzzle solving" model of Kuhn (Rodgers, 2005) influence the study lens of the importance of science education for nurses. John Dewey describes the value of thinking as "escape from the thoroughly impulsive or purely routine action." (Dewey, 1910, p.15). As Dewey explains, reflective thinking develops from areas of doubt or complexities. Finally, Dewey describes reflective thinking as the result of not just embracing what is observed or known, but intertwined with personal experience, history, ethics or what is more subjective (Maddux & Donnett, 2015, p. 67). Using the reflective thinking that Dewey describes may help identify patterns of science coursework that may be routine within the curriculum or identify complexities that influence inclusion of science courses in the curriculum.

An appreciation of the complexity of how science curriculum develops within context of a complex college or university setting underlies the research questions. As Dewey (1910) identified "routine actions", the study attempts to uncover the "routine" of science inclusion in nursing curriculum development (Dewey, 1910, p. 16) within and external to a school's nursing curriculum. Through exploration of the curriculum influences and identifying new data, a possible informed judgement of why science courses are included or excluded within nursing curriculum is an anticipated outcome of the study.

Using Dewey's principle of the intertwining of history with experience to guide inquiry, the lens of the history of the science coursework within nursing curriculum is an important consideration in the development of the research questions. To review and explore the historical curriculum of sciences within nursing education is helpful in identifying trends and hence, lead to possible identification of whether history has had influence on science course inclusion over time.

Thomas Kuhn and challenging paradigm. Thomas Kuhn's (1962) work in physics and philosophy of science challenges the paradigms or theories of science by what he defines as the practice of "normal science". "Normal science" identifies that scientists work to uncover detail in current scientific paradigms (defined as "puzzle solving") with no intention of changing underlying theory. Kuhn assumes that the small community of scientists within the field accept underlying scientific principles and rules. Shifting a paradigm as per Kuhn requires that the community of scientists accept that a paradigm is changing or has changed, often over significant time. As per Kuhn (1962), "the transfer of allegiance from paradigm to paradigm is a conversion experience that cannot be forced" (Kuhn, - p.164). He further outlines that the work of normal science or the "puzzle solving" nature of scientific work affords creativity and the evaluation of work within the scientific community.

A focus of this study is to review nursing curriculum to see if there is any difference in science courses offered at schools of nursing across the United States (U.S). The assumption of the study being that if there is limited difference in the science curriculum or if the science curriculum has not changed over time, shifting paradigm as suggested by Kuhn may not be possible. Further supported by the work of Benner et.al. (2010) suggesting a need for transformation of nursing education including in science education may not be possible without a shift in how nurse educators create and revise curriculum to meet future learning outcomes and needs.

Iwasiw and Goldenberg's Model of Curriculum Development. Within the study, the Model of Evidence-Informed, Context Relevant, Unified Curriculum Development developed by Iwasiw and Goldenberg (2015) structures the identification and analysis of factors influencing science courses within the overall nursing curriculum. The study assumes that factors influencing the overall curriculum also may influence the courses included within the curriculum. The interactive nature of the model allows for singular and multifactorial study of curriculum. The primary analytical focus of the study centers on the curriculum development step within the model to "Gather, analyze, and interpret data about internal and external contextual factors" (Iwasiw & Goldenberg, 2015, p.10). The study centers on analysis of internal variables of institutional size and research capacity, program admission factors, specific science curriculum as identified by course titles, and external factors of boards of nursing rules and if there is any influence on the important learning outcome measure of the criterion referenced NCLEX-RN® examination pass rate. The interpretation of influence of factors on pass rates may help identify whether there is influence of science courses within nursing curriculum as a program level learning outcome.

Research Questions

Since there is limited research available within nursing educational literature describing science course inclusion in nursing curriculum, this study addressed the following four basic research questions:

1) What differences are noted between schools in regards to science courses included in curricula at traditional, four year, pre-licensure BSN programs in the United States?
2) As identified by the call for transformation of nursing education by Benner et.al. (2010) and increasing educational focus on STEM education, what changes in science courses

have occurred between the early 1900s nursing curricula compared with modern 2018 nursing curricula?

3) Recognizing the board of nursing regulatory component of influence on nursing curriculum including science courses and content, what alignment exists between traditional, four-year, pre-licensure BSN nursing curricula and board of nursing rules?
4) How does the context of specific science course inclusion combinations (science curricula), as well as external variables such as institutional size, geographical location, program entry type, or admission GPA influence criterion referenced NCLEX-RN® examination (entry into practice examination) pass rate scores?

CHAPTER 2

LITERATURE REVIEW

History of Science Courses in Nursing Curricula

Nursing education has included natural and physical science coursework since the early 1900s (Nutting & Dock, 1907). As the medical field moved into more specialization in the hospital setting, Isabel Robb (1907) introduced a prescribed course of study which included psychology, and hospital electives which focused on areas such as biology, physiology, hygiene, bacteriology, and household chemistry. Within a short period of time, Nutting and Stewart (1918) identified that nursing education should be structured in three year periods and include more formal education in areas such as bacteriology, anatomy and physiology, applied chemistry, pathology, and Materia Medica (pharmacology). The shift to formal curriculum and inclusion of courses in natural and physical sciences continued for the next decades in nursing education.

By the 1930s, nursing education was beginning to shift to formal programs within a college or university (National League for Nursing [NLN], 1936). A recommendation of two years of study post-high school study with a more significant focus on critical thinking and understanding of concepts was encouraged, including academic work in the natural and physical sciences. By 1954, National League of Nursing (NLN) created achievement tests to measure performance in areas such as anatomy and physiology, chemistry, microbiology, and pharmacology. The achievement tests measured student academic performance and scholastic achievement (NLN, 1954). By the late 1950s, increasing demands for nurses, cost of collegiate education, and the length of the nursing curriculum (McGrath, 1959), opened discussion among nursing educators about how science coursework fits within a nursing curriculum (Russell, 1960). Although practicing nurses recognize the importance and value of natural and physical sciences content within the curriculum (Anthony & Templin, 1998; Birks, Ralph, Cant, Tie, & Hillman, 2018; McVicar, Andrew & Kemble, 2015; Taylor, Ashelford, Fell, & Goather, 2015), there appears to be limited nursing educational research related specifically to the science curriculum or its contribution to the meeting of program learning outcomes. A primary purpose of the study is to dissect the nursing curriculum to identify science courses as a significant part of curriculum and exploring potentially influencing extrinsic and internal factors on the science course inclusion is a purpose of this study.

Institutional Factors Contributing to Science Course Inclusion

As discussed by Iwasiw and Goldenberg (2015), both internal and external contextual factors influence nursing curriculum development. At the institutional level, internal contextual factors such as the mission, vision, and philosophy, organizational culture and climate, and financial resources available to a school of nursing (Iwasiw & Goldenberg, 2015) can influence the nursing curriculum. The external contextual variables that influence development of curriculum include variables from both the macro-environment of the institution, and the education sector or industry itself (Khan & Law, 2015). For example, the Carnegie classification database (Indiana University, 2018), contains educational contextual variables of geographical location, size of student body, research levels, and instructional program classification. Federal/state educational policies and accreditation organizations can also have significant contribution to curriculum development as variables coming from the higher educational industry itself (Khan & Law, 2015).

The Science, Technology, Engineering, and Math (STEM) movement within the United States has been a significant macro-environmental variable on curriculum development from K-

12 as well as higher educational levels (Breiner, Harkness, Johnson, & Koehler, 2012). As defined by Breiner et al (2012), the STEM movement has developed out of global economic need to remain competitive in a changing global market. K-12 curriculum is developing to include more integration of STEM content. The American Association of Colleges of Nursing (2008) identifies "sciences that have clinical relevance are especially important to the profession of nursing to ensure that graduates have the ability to keep pace with changes driven by research and new technologies" (p.11). Although nurses identify science as important to nursing practice, research has been limited in how biological and physical sciences contribute to success in a nursing program in either content knowledge or critical thinking skills, two important contributions of sciences identified in STEM education. There is limited discussion as to what contribution sciences make to the scaffolding of a nursing curriculum to achieve the learning outcomes expected within a curriculum (Keating, 2006).

Outside Influences on Science Course Inclusion in Nursing Curriculum

Professional standards and trends have influence on curriculum development (Iwasiw & Goldenberg, 2015). External macro-environmental factors that contribute to the context in which nursing curriculum is developed includes (a) accreditation organizations, such as the Commission on Collegiate Nursing Education (CCNE) and the National League for Nursing (NLN); (b) national and state nursing rules; and (c) the NCLEX-RN® examination developed by the National Councils on State Boards of Nursing (NCSBN). Contextual factors are important to consider in nursing curriculum development and in particular, how science courses are included or excluded from the curriculum.

AACN (2008) outlines clearly that sciences in BSN nursing curriculum include:

- physical sciences (e.g., physics and chemistry),
- life sciences (e.g., biology and genetics),
- mathematical sciences, and
- social sciences (e.g., psychology and sociology) (p. 10)

The clear outline of what types of sciences should be included in a curriculum demonstrates a significant external influence on how a nursing curriculum develops.

The National Councils on State Boards of Nursing (NCSBN, 2018) makes curriculum an important component for review of nursing program with primary focus on assuring that programs meet the criteria for maintaining the public safety. Individual boards of nursing further regulate curriculum that may include specific courses and content as well as educational hours in a curriculum. As an example, the state board of nursing in Vermont outlines in administrative rules the following specific curriculum requirement (Vermont Board of Nursing, 2015):

> "4.30 Registered Nursing Programs
>
> A registered nursing program shall include content in pharmacology and nutrition. Each program must provide no less than:
>
> (a) 180 theory hours and 400 clinical hours covering the following:
>
> (1) Adult Nursing;
>
> (2) Maternal/Infant Nursing;
>
> (3) Pediatric Nursing;
>
> (4) Psychiatric/Mental Health Nursing.
>
> (b) 80 hours in Anatomy and Physiology;
>
> (c) 40 hours in Microbiology;
>
> (d) 80 hours covering both Humanities and Social/Behavioral Science."

Other state boards of nursing give more general science course expectations within curriculum such as the state board of nursing in Virginia, which lists "3. Concepts of anatomy, physiology, chemistry, microbiology, and the behavioral sciences" (Virginia State Board of Nursing, 2018, p.11) and the Maine state board of nursing which lists "anatomy, physiology, chemistry, microbiology and physics" (Maine State Board of Nursing, 2013, p. 13). Further exploration of the differences between board specific nursing curriculum requirements and potential influences on science course requirements within curricula is of interest in this study.

Finally, the NCLEX-RN® examination result or pass rate as a measure of student success in meeting the program learning outcomes as well as board of nursing requirements for safe entry into practice contributes to the overall curriculum development including within the sciences. Annual test blueprints published by the National Councils of State Boards of Nursing outline specific topic and content areas of significance in measuring a student's ability to perform as a safe new nurse.

In the current NCLEX-RN ® test blueprint (National Council of State Boards of Nursing, 2016), 11-17% of the examination is focused on covering content including scientific principles and concepts related to anatomy and physiology, pathophysiology, fluid and electrolyte imbalances, and hemodynamics, as well as nutrition, laboratory value analysis, and safety/infection control including principles of asepsis directly related to microbiology. In combination with state requirements and accreditation standards, the test blueprint contributes to the external macro-environment for nursing science curriculum development.

Hypotheses

In conducting the study, the following hypotheses were tested as linked to the research questions and literature to help get a better understanding of the current state of science course inclusion in traditional, four-year, pre-licensure BSN programs across United States (U.S.) schools of nursing. The hypotheses in the study use the definition of physical (physics and chemical sciences) and life sciences (biological sciences) developed by the American Association of Colleges of Nursing (2008). Underlying hypothesis development is whether external factors are maintaining science curriculum with consistency to meet the anticipated program outcome as measured by the NCLEX-RN® examination pass rate.

1. There is a significant difference between physical and life science courses offered within 1918 nursing curriculum and 2018 nursing curriculum within U.S. schools of nursing.
2. There is a significant association between the physical and life sciences within curriculum of U.S. schools of nursing and NCLEX-RN® examination pass rates.
3. There is a significant difference between science course inclusion required by boards of nursing and science curriculum within schools of nursing.
4. There is a significant association between NCLEX-RN® examination pass rates and science curricula among U.S. schools of nursing and institutional type, geographical location, direct entry status, or admission GPA.

Limitations Within the Literature

There are a number of limitations in the literature search. The limitations include (a) limited research on science course inclusion in curriculum and associated program learning outcomes, and (b) sporadic research about what scientific knowledge and thinking skills are needed within a transformed curriculum (Benner et. al, 2010). Through the study, there is a hope to create opportunity for further dialogue within nursing education about scientific course contributions to the liberal education of a nurse and to transform curriculum to meet the changing demands and need for innovation within nursing practice.

CHAPTER 3

METHOD

Study Design

The study used an observational design as described by McMillan and Schumacher (2010). The design of the study allows for the identification of potential differences in the science courses offered among schools of nursing and the influence of contextual variables on science course inclusion in curriculum and NCLEX-RN® examination pass rates. Since schools of nursing have curricula in place, the design also allows for relationship identification (McMillan & Schumacher, 2010).

Distinguishing the study design is the identification of contextual factors influencing the curriculum. The specific types and number of science courses offered, geographical location , size and research level of the institution, specific science requirements regulated by boards of nursing, program specific admission requirements, and NCLEX-RN® pass rates are variables contributing to the study design and framing the analysis. The use of readily available data gives richness to the study in comparing historical and modern curricula to identify any significant change over time in science courses.

As the study was unfunded, the collection of secondary data from multiple existing public datasets contributes an efficient and cost effective design (McMillan & Schumacher, 2010). An additional benefit of using existing public datasets is that few nursing educational studies have looked at publically available datasets to analyze curricula. The use of existing datasets allows access to (a) a large sample size, (b) ability to collect data based on the specific parameters of the study, and (c) data that has clearly defined variables to ensure consistency of data among different schools of nursing.

Finally, analysis of the data will use both descriptive and general statistical analysis to help test hypotheses. Descriptive statistical analysis will help to “characterize the data” of the type and number of science courses offered by different schools of nursing (McMillan & Schumacher, 2010, p. 149). Statistical analysis including descriptive statistics and one-way ANOVA analysis provides identification of relationships between study variables and the continuous variable, NCLEX-RN® examination pass rates.

Sample and Sampling

The development of sample selection criteria contributes to the validity of the study as it limits the population of interest to the sample directly related to the research questions (Hoskins, 2004). In the study, a sample school is (a) under the jurisdiction of a United States board of nursing, (b) accredited by the Commission on Collegiate Nursing Education (CCNE), and (b) offers a traditional four-year pre-licensure baccalaureate education (BSN). The significance of selection of schools accredited by CCNE is the consistency of the mission and philosophy of a liberal education and importance of specific science inclusion in curriculum as identified within the guidance documents for baccalaureate nursing program accreditation (CCNE, 2018a). Limiting the sample to CCNE accredited schools reduces the potential confounding factor of the value of science course inclusion.

Excluding schools of nursing which provide an associate’s degree (ADN) in the study, limits inadvertent sample selection as CCNE does not provide accreditation to these programs. Schools of nursing that provide exclusively RN-BSN programs or accelerated “two plus two” ADN to BSN programs also were excluded from the study as the students in those programs have already obtained licensure as a registered nurse. Support for exclusion focuses on the lack of contribution to the school's NCLEX-RN® examination pass rate, an important dependent variable in the study.

Further characteristics for inclusion include institutional and programmatic characteristics. An included school (a) is located within a college/university that is listed within the Carnegie classification (Indiana University, 2018), (b) has publically reported NCLEX-RN® examination pass rate score, and (c) has electronically available admission grade point average (GPA) and direct entry information on the institution or program website. By clearly defining the factors for sample inclusion, classification errors will be reduced (McMillan & Schumacher, 2010).

Stratified random sampling is the selected sampling method. Stratified sampling "assures inclusion of certain characteristics of a sample" (Hoskins, 1998, p. 43). Stratification of the sample by geographical area includes (a) North Atlantic, (b) Midwest, (c) South, and (d) West as defined by the American Association of Colleges of Nursing (AACN, 2018). The assignment of a unique identifier number defines each school in the sample. A random proportional sample for each geographical area was also determined (McMillan & Schumacher, 2010). The ideal minimum sample size for each geographical region was calculated using Qualtrics (2018) sample size calculator. By using a stratified random sample, comparing different schools by geographical region permits confident representation of the full population of schools of nursing (Hoskins, 1998).

In calculating the sample size, consideration of the total number of CCNE accredited schools of nursing and regional distribution was collected (CCNE, 2018b) and is outlined in Table 3.1.

TABLE 3.1 SAMPLE SIZE BY REGION

Geographic region	Total number of schools	Ideal Sample size (90% confidence, 5% margin of error)
North Atlantic Schools	152	98
Midwest Schools	236	127
West Schools	126	86
South Schools	240	128
Total Original Schools in CCNE database	754	439

The selection of a 90% confidence level was set to manage data collection within the time and resources available while giving reasonable reliability. A 5% margin of error supports further validity through representation of the overall total schools of nursing population (McMillan & Schumacher, 2010). To select final schools for inclusion in the study and to strengthen the validity of the study, a simple online random number generator, Research Randomizer (2018) generated the random sample. A Microsoft Excel™ spreadsheet recorded the list of selected schools.

The final sample size included 533 schools of nursing which exceeded the 90% confidence level. A research decision to include additional schools in the sample due to the unequal distribution of schools across geographic regions occurred. In addition, a large sample size helped to buffer effects of unanticipated discarding of a school that did not meet all the sampling criteria during data collection. Finally, a larger sample helps to reduce the inadvertent effect of the limiting factor of CCNE accreditation sampling criteria, as the homogeneity of the schools was unknown at the start of the study.

Sample Description

The stratification of sample by geographic region occurred. A summary of the schools in each geographical region is located in Table 3.2.

TABLE 3.2 DISTRIBUTION OF SCHOOLS

	Frequency	Percent	Cumulative Percent
1-North Atlantic	106	19.9	19.9
2-South	179	33.6	53.5
3-Midwest	170	31.9	85.4
4-West	78	14.6	100.0
Total	533	100.0	

Evaluation of 681 schools occurred in the study. Excluded from the study were 148 schools. The excluded schools include (a) 63 schools which did not meet the criteria of traditional, four-year BSN nursing program, (b) 29 schools that did not have a published NCLEX-RN examination pass rate, and (c) 56 schools that did not have a readily available course of study or curriculum on the college/university website.

Specific data collection identifying the institutional type occurred. The schools were associated with either a public, private not for profit, or private for profit institution as defined by the Carnegie Classification (2018) and located in Appendix B. Upon review, 98.7% of the schools of nursing were associated with either public or private, non-profit institutions, and 1.3% associated with private, for profit institutions.

TABLE 3.3 CARNEGIE CLASSIFICATION BY TYPE OF INSTITUTION

Type of Institution	Frequency	Percent	Cumulative Percent
Public	237	44.5	44.5
Private, non-profit	289	54.2	98.7
Private, for profit	7	1.3	100.0
Total	533	100.0	

In reviewing the sample schools for Carnegie classification by institutional research level, 125 colleges (37%) of the sample were “Master's Colleges & Universities: Larger Programs”. 341 (64%) of schools of nursing are affiliated with either baccalaureate or master’s level institutions as further described in Table 3.4 Sample Institutions by Research Level.

TABLE 3.4 SAMPLE INSTITUTIONS BY RESEARCH LEVEL

Type of Research Institution-Doctoral level	**Total Schools (%of total Doctoral)**	**Type of Institution-Master’s level**	**Total Schools (% of total masters and baccalaureate)**	**Type of Institution-Baccalaureate level and Other**	**Total Schools (% of total masters and baccalaureate)**
Doctoral/Professional Universities	67 (35%)	Master's Colleges & Universities: Small Programs	35 (10%)	Associate's Colleges: Mixed Transfer/Career & Technical-High Traditional	1 (<1%)
Doctoral Universities: Moderate Research Activity	6 (3%)	Master's Colleges & Universities: Medium Programs	65 (19%)	Special Focus Two-Year: Health Professions	1 (<1%)
Doctoral Universities: High Research Activity	51 (27%)	Master's Colleges & Universities: Larger Programs	125 (37%)	Baccalaureate/Associate's Colleges: Mixed Baccalaureate/Associate's	6 (2%)
Doctoral Universities: Higher Research Activity	8 (4%)	**Total Masters and Baccalaureate programs (% total overall programs)**	341 (64%)	Baccalaureate Colleges: Diverse Fields	48 (14%)
Doctoral Universities: Very High Research Activity	56 (29%)			Baccalaureate Colleges: Arts & Sciences Focus	16 (5%)
Doctoral Universities: Highest Research Activity	4 (2%)			Special Focus Four-Year: Other Health Professions Schools	40 (12%)
Total of Doctoral programs (% overall total programs)	192 (36%)			Special Focus Four-Year: Medical Schools & Centers	2 (<1%)
Overall Total Number of programs	533 (100%)			Special Focus Four-Year: Other Special Focus Institutions	2 (<1%)

The nursing programs in the sample had similar admission processes with 408 schools (76.5%) admitting students indirectly after completion of general education and science coursework. The overall mean admission grade point average (GPA) for all schools in the study was 2.858 as outlined in Table 3.6.

TABLE 3.5 ADMISSION REQUIREMENTS IN SAMPLE SCHOOLS

Variable	**Total schools (N)**	**Mean**	**Range / Standard deviation**	**Standard Deviation**
Admission GPA	533	2.858	2.0-4.10	0.27634
Variable	**Total schools (N)**	**Percentage of total**		
Direct Entry-Yes	125	23.5%		
Direct Entry-No	408	76.5%		

In summary, the schools included in the study are primarily located in the South and Midwest regions of the U.S., affiliated with either a public or private non-profit institution, and affiliated with Carnegie classified master's level larger universities or colleges.

Data Collection

Collection of data from readily available datasets via the Internet using the World Wide Web (www.) simplified the collection. The specific datasets used in the study include:

- Commission on Collegiate Nursing Education (CCNE) listing of currently accredited schools of nursing,

- School of nursing websites for traditional four year BSN course of study or course plans specifically located in the undergraduate BSN handbook, the college/university undergraduate course catalog or college/university undergraduate bulletin,
- Carnegie Classification of Institutions of Higher Education®, and
- Board of nursing annual reports listing NCLEX-RN® examination pass rates for BSN programs (percent pass/total of students taking examination by program). Two states did not have publically available pass rates. For those sample schools, a research decision to use school or university posted pass rate was made. This research decision is supported as a school of nursing is at risk of falsification of information leading to potential accreditation or board of nursing issues if pass rates are not accurately reported.

Key factors in selection of datasets include (a) being well established, (b) providing current information, and (c) being readily available. In collecting data, high-speed internet helped to ensure efficient collection of data.

The first dataset used was the CCNE listing of accredited pre-licensure baccalaureate (BSN) programs by geographical location (CCNE, 2018b). The dataset provides detail about actively accredited nursing programs. The second dataset selected was specific websites for schools of nursing. Exploration of the school of nursing website produced specific science course data from either program curriculum sheet/course plans or undergraduate catalog/bulletins. The third dataset used is the Carnegie Classification of Institutions of Higher Education® (Indiana University Center for Postsecondary Research, 2018) to identify institutional size, setting, instructional program type, and research level. This dataset helped to distinguish each nursing program within the context of the college or university. Finally, the fourth dataset is websites of boards of nursing that include published NCLEX-RN® examination pass rates for nursing schools as well as curriculum requirements for science courses required by rules or regulations. Definitions for each variable collected using the dataset definitions are included in Appendix B. A log was maintained record of any information that contributed to study limitations and/or identification of notes of interest for study discussion.

Microsoft Excel ™ spreadsheets provided organization for collected data. The template used for data collection is located in Appendix A. A complete review of the spreadsheets for errors in alignment of data or transposition of data assisted with maintaining reliability of data collection (McMillan & Schumacher, 2010).

Ethical Considerations for Data Protection

The Chair of the Institutional Review Board determined that there was no need for review of the study as the study did not contain human subjects. (University Of Maine Office of Research Compliance, 2018). A copy of the email from the Board is included in Appendix B**.**

During the study, to protect an individual school's identity, there is no identification of college or university program names in analysis or reporting. Although not a significant concern as the majority of schools have a publically available NCLEX-RN® pass rate, assigning a unique number identifier was an important consideration in this study. NCLEX-RN® examination pass rates have potential to influence student admission decisions, marketing of nursing programs, and accreditation status so protection of data was important in the study.

Data files encryption with password protection and BitLocker access maintained data security. Data storage occurs as per guidelines of record retention after any final use for publication or presentation is completed but no later than ten years from date of publication.

Limiting discussion of specific data collected to the chair of the dissertation committee as well as dissertation committee members for clarification of questions as required to complete the study helps to maintain the protection of data.

Data Analysis

The data was analyzed using statistical methods readily available using the IBM SPSS® Statistics 24 statistical analysis platform and Microsoft Excel ™. Statistical test selection focused on the variable type and comparison required to distinguish correlation or relationships (Knapp, 2018).

The first hypothesis, "There is a significant difference between physical and life science courses offered within 1918 nursing curriculum and 2018 nursing curriculum within U.S. schools of nursing", was analyzed using descriptive statistics. To compare 1918 science curriculum with modern science curriculum, categorical coding was required to assist with data analysis of number and type of science courses within curriculum (Knapp, 2018, p.58). To distinguish different curriculum categories, assignment of the categorical code was dependent on whether the science courses in the curriculum has similar course titles as the courses in 1918 curriculum (Nutting and Stewart, 1918). The categorical codes include:

- 0=below curriculum (less science courses than 1918 curriculum),
- 1=at curriculum (same number of science courses as the 1918 science curriculum), or
- 2=above curriculum (more science courses than 1918 curriculum).

The creation of a table to identify the number of schools by frequency of each science course offered helps with data analysis.

The second hypothesis “There is a significant association between the physical and life sciences within curriculum of U.S. schools of nursing and NCLEX-RN® examination pass rates.” analysis compared the categorical variable of science curriculum with the continuous variable of the NCLEX-RN® examination pass rate. Using a one way ANOVA statistical test permitted the comparison between two or more groups to see if the type of curriculum influenced NCLEX-RN® examination pass rate scores (Knapp, 2018, p.108).

The analysis of the third hypothesis “There is a significant difference between science course inclusion required by boards of nursing and science curriculum within schools of nursing.” required use of descriptive statistics and categorical coding of the different types of rules pertaining to science course requirements by rule for nursing curriculum. Board of nursing rules were categorized as “very general requirements” with no specific science content or courses listed, “specific requirements” of which exact specific content or courses are listed, and “very specific requirements” that outline specific science courses with additional requirements for contact hours. Coding of each board of nursing rule led to calculation of the frequency and percentage of schools by geographical region.

The last hypothesis analyzed, “There is a significant association between NCLEX-RN® examination pass rates and science curricula among U.S. schools of nursing and institutional type, geographical location, direct entry status, or admission GPA”, required the use of a correlation statistic and a one-way ANOVA. To determine if there was any relationship or correlation between the type of science curriculum and the institution variables, chi-square and one-way ANOVAs were used. Multiple linear regression analysis was used to assess the variables that might be predictive of NCLEX-RN® examination pass rates. All variables were dummy coded except for the admission GPA, which did not require additional coding as GPA is a continuous variable (Knapp, 2018, p. 313). The significance level for each hypothesis was set at 0.05.

CHAPTER 4

RESULTS

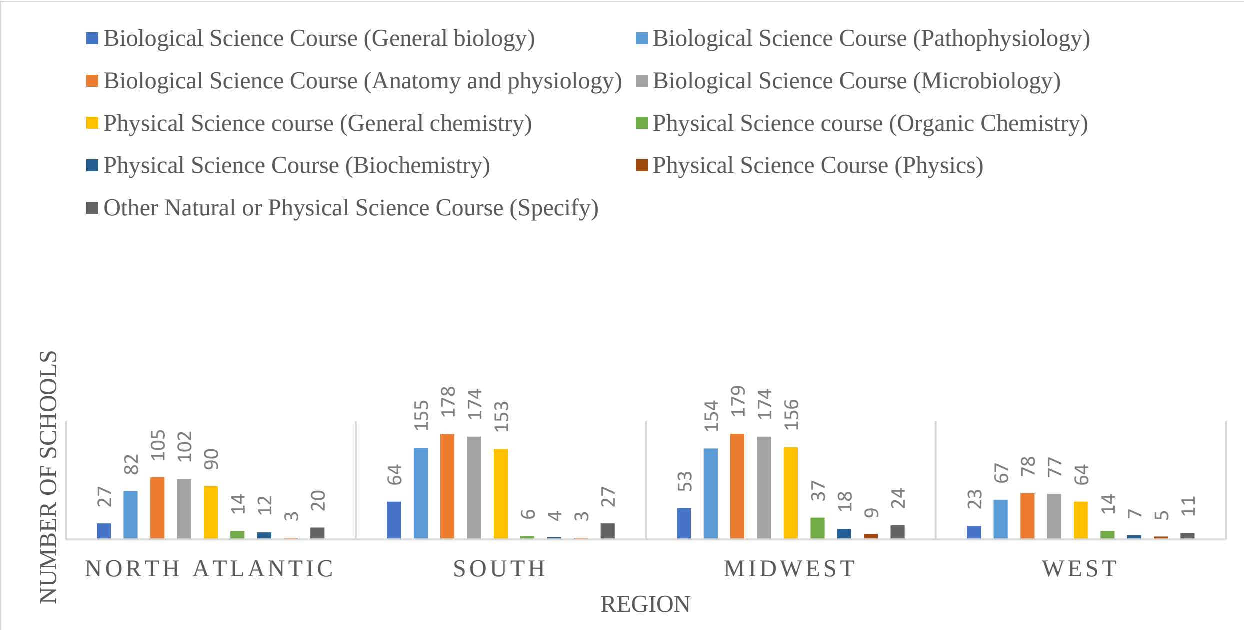
The first analysis of results is the landscape of science courses within nursing curriculum. The primary science courses offered by course name in nursing curriculum are pathophysiology, anatomy and physiology, microbiology and general chemistry as shown in Table 4.1. The science courses that are present the least amount of times in nursing curriculum include physics, biochemistry, and organic chemistry. Some schools offer additional courses such as general biology (167 schools or 31.3%) or genetics (73 schools or 13.7%). Courses with highlighting within Table 4.1 include pathophysiology, anatomy and physiology, microbiology and general chemistry, which have similar course titles found in the nursing curriculum identified by Nutting and Stewart (1918).

TABLE 4.1 INCLUDED AND EXCLUDED SCIENCE COURSES

Region	General biology	Patho-physiology	Anatomy/ physiology	Microbiology	General chemistry	Organic Chemistry	Biochemistry	Physics	Other Natural or Physical Science
North Atlantic	79	24	1	4	16	92	94	103	86
South	115	24	1	5	26	173	175	176	152
Midwest	117	25	0	5	23	142	161	170	155
West	55	11	0	1	14	64	71	73	67
Total Schools that EXCLUDE the science course	366 (68.7%)	84 (15.8%)	2 (0.4%)	15 (2.8%)	79 (14.8%)	471 (88.4%)	501 (94.0%)	522 (97.9%)	460 (86.3%)
Total Schools that INCLUDE the science course	167 (31.3%)	449 (84.2%)	531 (99.6%)	518 (97.2%)	454 (85.2%)	62 (11.6%)	32 (6.0%)	11 (2.1%)	73 (13.7%)

The distribution of courses appears to demonstrate similar distribution of pathophysiology, anatomy and physiology, microbiology, and general chemistry across regions as shown in Figure 4.1.

FIGURE 4.1-SCIENCE COURSES BY REGION



The number of schools identified in each science curriculum group presents in Table 4.2. In the study, 331 schools (62.1%) have similar matching course titles found in the 1918 science curriculum. In addition, 202 schools (37.9%) of the curricula have either more or less science courses by title than the 1918 curriculum. The hypothesis, "There is a significant difference between the type and number of physical and life science courses offered within 1918 nursing curriculum and 2018 nursing curriculum within U.S. schools of nursing" is unable to be supported or refuted by these findings as curriculum is coded by course title only, not content or syllabi. Refer to the Discussion section of the paper for more detail.

TABLE 4.2-FREQUENCY OF SCIENCE CURRICULA

Variable	Frequency	Percent
Below curriculum	132	24.8
At curriculum	331	62.1
Above curriculum	70	13.1
Total	533	100.0

Science Curriculum and NCLEX-RN® Examination Pass Rates

The NCLEX-RN® examination being at the end of a nursing program is valued as a measure of curriculum effectiveness (CCNE, 2018a) and is part of overall program outcome expectations. As shown in Table 4.3, the hypothesis, "There is a significant association between the physical and life sciences within curriculum of U.S. schools of nursing and NCLEX-RN® examination pass rates" appears to indicate no statistically significant relationship between NCLEX-RN® examination pass rates and the three different curriculum models from the study sample ($p=0.636>0.05$).

TABLE 4.3-SCIENCE CURRICULA COMPARISONS

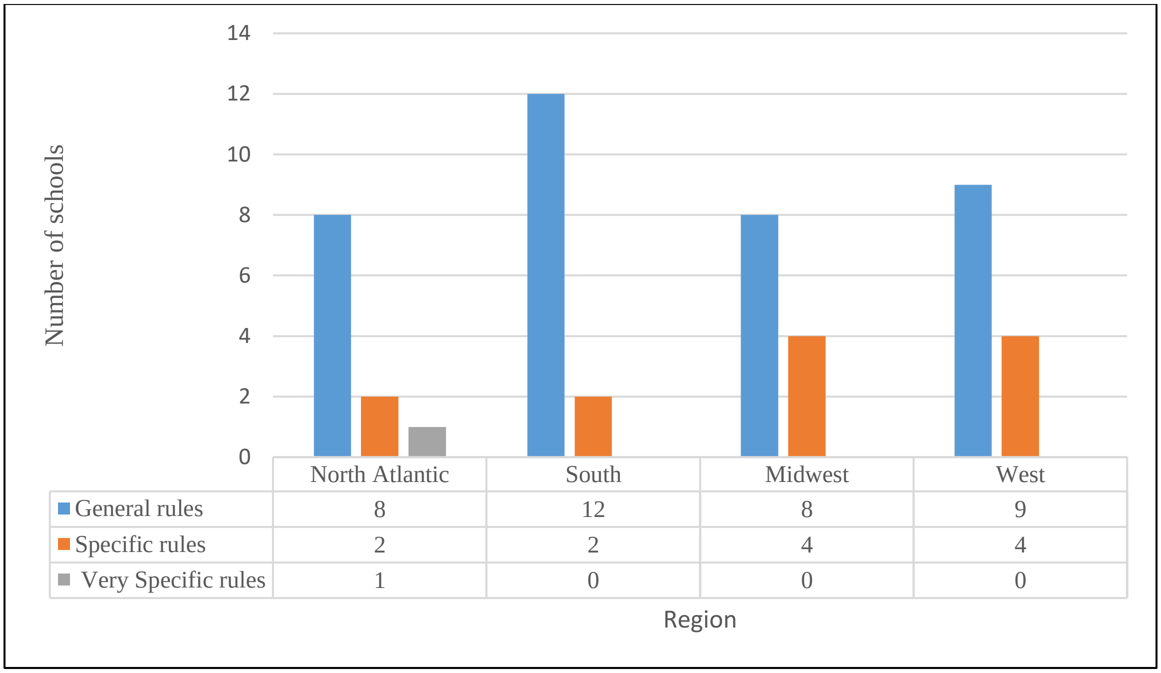
CURRICULUM	Mean	N	Standard Deviation
Below curriculum	.9099	132	.08508
At curriculum	.9008	331	.10206
Above curriculum	.9010	70	.07849
Total	.9031	533	.09517

$p=0.636$

Science Curriculum and Board of Nursing Requirements

Upon review, thirty-seven boards of nursing (74%) have general requirements for natural or physical sciences at the time of the study with only one board of nursing having very specific rules within the sample as outlined in Figure 4.2. Further comparative analysis of science courses offered and meeting board of nursing curriculum requirements, 100% of schools within the sample met the requirements for science in the curriculum. Of note, during data collection, one state was in process of reviewing rules and moving from "specific rules" to "general rules". In the analysis of the hypothesis, "There is a significant difference between science course inclusion required by boards of nursing and science curriculum within schools of nursing", the results indicate no difference noted between board of nursing requirements and school of nursing inclusion of science courses in curriculum. All schools (100%) in the sample appear to meet board of nursing requirements.

FIGURE 4.2 TYPE OF NURSING RULES FOR CURRICULUM BY STATES AND REGION



Institutional Factors Influencing Science Course Inclusion

The results of testing the association between NCLEX-RN® examination pass rates and curriculum types with the institution and program variables of (a) geographical region, (b) type of institution, (c) research level of institution, (d) admission grade point average (GPA) and (e) direct entry status present in Table 4.4. Based on the statistical results, there appears to be no significant association between NCLEX-RN® examination pass rates and geographical location of the school of nursing (p=0.187), the research level of the associated institution (p=0.390), or the direct entry status (p=0.484). There may be an association between the NCLEX-RN®

examination pass rates and the type of institution (public, private/not for profit, private/for profit) (p=0.026), or the program admission GPA (p=0.025). There appears to be no significant association noted between the different types of science curriculum and geographical region (p=0.087), research level (p=0.052), or direct entry status (p=0.234). There appears to be a statistically significant association between the type of institution and the NCLEX-RN® examination pass rate (p=0.026) and the admission GPA (p=0.025). There appears to be a significant association between the different science curriculum and admission GPA (p=0.00).

TABLE 4.4-SIGNIFICANCE OF ASSOCIATIONS

Independent Variable	**NCLEX pass rate**	**Curriculum**
Geographical Region (GEOAREA)	0.187	0.087
Type of Institution (CARNCONTROL)	0.026*	0.664
Research level (RESEARCH)	0.390	0.052
Direct Entry (DIRECTENTRY)	0.484	0.234
Admission GPA (ADMIT GPA)	0.025*	0.00*

*Statistically significant difference detected between groups ($p \leq 0.05$)

Additional Results

Some subjective results are of interest. Science courses in the study did appear to be at 100-200 survey level with the exception of pathophysiology using microbiology for comparison as described in Table 4.5.

TABLE 4.5 PATHOPHYSIOLOGY AND MICROBIOLOGY COURSE LEVELS

Course	100-200 level course (%)	300 level or above (%)
Pathophysiology (n=449)	39%	61%
Microbiology (n=518)	92%	8%

In further review of pathophysiology courses, some schools of nursing merged pathophysiology and pharmacology courses into one course. In addition, pathophysiology appears to be the only science course that may have a nursing specific course number. The course number starting with either NUR, NU or NURS prefixes implies that the teaching of the course is within the nursing program itself and not within a specific science school or department. Finally, most schools offer anatomy and physiology requiring two courses. With anatomy and physiology (AP), courses including between six to eight credits in total, AP courses top the list as the highest number of credits for a science content area within the study.

CHAPTER 5

DISCUSSION

The study is an observational study to gain further insight into the landscape of science courses included in modern nursing curricula and the potential relationships between internal and external institutional and program factors that may have influence on science courses included. The study also looks at the relationship between the inclusion of science courses and the NCLEX-RN® examination pass rates that links to program learning outcome assessment. The differences in science curriculum across schools of nursing, the influence of boards of nursing on science curriculum, and internal and external variable influences on science curriculum is the focus of discussion.

Science Courses in Nursing Curricula

Upon analysis of the sample, there is very little variability in type or number of science course offerings among U.S. schools of nursing. The majority of schools of nursing offer science courses with similar titles as science courses from the 1918 curriculum as described by Nutting and Stewart (1908). Pathophysiology, anatomy/physiology, general chemistry, and microbiology continue to persevere as core science courses listed in nursing curriculum. The lack of variation in science courses identified by name across U.S. schools of nursing may be a result of the strong influence of the NCLEX-RN® examination test blueprint in driving program learning outcomes as well as nursing education curriculum structures through rules enforced by boards of nursing.

The strong influence of these two external factors has the potential for creation of a stagnant science curriculum. The stagnation of the science curriculum has the potential to impact whether nursing curriculum can transform as suggested by Benner et.al. (2006). The shifting of paradigm as discussed by Kuhn (1962) requiring scientists to agree that the paradigm is shifting or changing is analogous to the need for nurse educators to agree to change the science curriculum. For example, the NCLEX-RN® test blueprint (NCSBN, 2016) outlines specific content such as pathophysiology which maps directly to the science course, pathophysiology. Although the blueprint updates every three years, there is a potential risk that new scientific content may miss entry into the blueprint if nurse educators do not agree that there needs to be adjustment or change.

In the sample used in this study, NCLEX-RN® examination pass rates were consistent across the schools of nursing with a mean pass rate of 90% (Table 4.3). With program consistency in NCLEX-RN® examination performance, nurse educators may see no anticipated need to shift learning outcomes measured by the examination. Combined with board of nursing rules that define generic curriculum content in natural and physical sciences to support nursing coursework, nurse educators may not see any further need for change in science curriculum. The question remains as to whether the current science curriculum will meet changing demands of (a) increasing use of technology and advances in medicine, and (b) an evolving K-12 STEM education movement that has a stronger focus on math and sciences (Breiner, Harkness, Johnson, & Koehler, 2012).

Finally, although there were periods of time in nursing educational history where science competency was assessed and evaluated independently of nursing competencies (NLN, 1954), that competency assessment has been moved out of most nursing schools. The majority of the schools in the sample (Table 3.6) are not direct entry with successful completion of science courses often a pre-requisite to entry. With a separation of sciences from the curriculum assessment process within a school of nursing, other than having a course grade for progression, how science course learning outcomes link to nursing program learning outcomes remains unknown.

The potential influence of science coursework on critical thinking skill development as well as content knowledge retention and application at a higher cognitive level through scaffolding within the nursing curriculum remains an outstanding area of research. The ultimate question posed, however, is whether nursing students have grasped the scientific knowledge and critical thinking skills offered by science courses to a level needed to develop clinical judgement further in the curriculum and into practice. Assisting students in learning how to interact collaboratively with other disciplines in solving healthcare problems is also a potential learning domain missed by limiting or stagnating science coursework engagement.

In collecting data, I subjectively noted that there does appear to be some shift in streamlining or integrating science content within both science and nursing courses. Although Dewey highlighted the pragmatic approach to learning in his work, an underlying part of the conceptual framework in this study, I do wonder whether streamlining and highlighting only key scientific concepts or knowledge undermines the thinking that is required in analysis and evaluation demanded by clinical judgement in nursing practice. The integration of courses such as pharmacology with pathophysiology as well as the reduction of credits for anatomy and physiology courses in some schools are notable examples of potential areas of concern in streamlining scientific study. Combined with the information that most science courses offered within nursing curricula are at the 100-200 (survey) course level or factual/procedural knowledge level as per Bloom's taxonomy (Keating, 2006. P. 69) with the exception of pathophysiology or microbiology that may be 300 level courses, higher levels of metacognitive learning and movement toward clinical judgement and clinical reasoning may be lacking. Whether this type of integration of content and concepts better meets the learning needs of nursing students and program learning outcomes is for future study and research.

Comparison of historic and current science curricula

In the study, schools of nursing appeared to have similar science course titles or names compared to science courses offered in 1918 (Nutting & Stewart, 1918). The science course titles offered in natural and physical sciences appear to be consistent within the history of science education over the past one hundred years. The consistency appears to reflect the ongoing struggle within nursing education to ensure a liberal yet relevant science education for nurses with focus on content and not necessarily critical thinking skill development. For example, in the 1930s, the recognized shift from home based healthcare to hospital based care (Committee on the Grading of Nursing Schools, 1932) mirroring the shift from farm to urban lifestyles, affected the development of nursing curricula into more structured programs which included the same science courses which were offered within the early nursing programs from 1908-1918. What appears to have changed within the science curriculum however, is the specific course content. For example in the 1940s with World War II requiring more nurses in demand, the streamlining of nursing curriculum occurred and more structure given to which sciences were offered and in which content areas. Nursing programs shifted to two-year programs and adjusted content focus of the science courses to streamline education process. The discovery of the antibiotic, penicillin, as well as medical advances in care, exploded scientific knowledge, and nursing programs mirrored the changes with science content shifts. A similar content explosion in sciences and math occurred within the late 1940s and 1950s, with the U.S. move to space exploration and rapid scientific content expansion.

As per Chayer (1947),

> Activity analyses of nursing practice have been made from time to time, which serve a useful purpose as a background for the identification of the scientific principles underlying them but since the field of science is constantly expanding and changing nursing practice, the profession of nursing must work toward a continuous analysis of practices. The next step is to isolate the basic principles of science that are inherent in desirable practice. (p.75)

The shift to thinking about sciences as contributing to critical thinking development within education started to reveal itself in the 1960s with the example given by Russell (1960) was to avoid courses such as "microbiology for nurses" and viewed "scientific study should also include societal component to help support inductive reasoning (using) strategies and tactics of science" (p. 127). Russell also presented the idea that

> (The) horizontal split between liberal arts and professional courses creates the impression that liberal education is over and done with when professional study begins...if all liberal arts courses are concentrated in the first two years students are necessarily limited to introductory subjects and consequently are unable to penetrate any field in depth. (p. 131)

Although there was discussion of sciences as contributing to thinking as early as the 1960s, there appears to be no significant shift in keeping sciences intact as independent opportunities for learning as evidenced by the continued maintenance of survey level courses in the sciences even today.

Although general knowledge of the content of the science discipline presents in survey courses, skills development in scientific critical thinking within the course may be limited (Talavera, 2018). With unchanging science curriculum, Benner's call for educational transformation (2010) may not be addressed in significant manner to reflect the scientific knowledge, skills, and scientific critical thinking ability which nurse educators assume.

Although science coursework could have the potential to help in the development of critical thinking skills leading to clinical judgement, from the study, it does not appear that nurse educators have seen the opportunity to leverage science coursework in that manner. A study conducted by Huber and Kuncel (2016) analyzed critical thinking effectiveness across college through meta-analysis of multiple studies. What was determined from the analysis is that domain specific critical thinking enhances in short term within a discipline such as nursing which focuses highly on critical thinking skill development within the discipline. However, findings were inconclusive as to whether there is a long-term effect even with focused critical thinking skill activities. The general college experience may be what develops critical thinking skills and more study is needed to see whether domain generic critical thinking skills contribute to enhancement of skill over the longer term. Although domain specific critical thinking skill development might be expected by nurse educators, there is need for further research to identify specifically what components of critical thinking might be enhanced through the liberal education components of the curriculum, including natural and physical sciences.

Influence of Boards of Nursing on Science Curricula

The study revealed that current board of nursing rules are mostly general to content area in outlining requirements for science course inclusion in nursing curriculum (Figure 4.1). By outlining general rules for science coursework, the ownership for nursing educational decisions remains with the schools of nursing to ensure that scientific content and skills match the needs of nursing practice for safety. With the Institutes of Medicine (2011) outlining the need for nurses to perform to the highest educational level, and accrediting bodies such as CCNE (2018) identifying preparation in natural sciences as essential to the function of a baccalaureate nurse, consideration of science curriculum as contributing to patient safety seems an ongoing educational endeavor.

External and Internal Variables Effects on Curriculum and Pass Rates

The study attempted to review a variety of variables that may have specific impact on development of science curriculum as suggested by Iwasiw and Goldenberg, (2018). Upon analysis of results from the sample, there did not appear to be any significant association between geographical location of the school of nursing, the institutional type or research level or program admission requirements and NCLEX-RN® examination pass rates or type of science curriculum. Prior to start of the study, I had an underlying thought that perhaps schools of nursing affiliated with high research activity institutions would offer more science courses within curricula; this was not the reality. The interface between admission GPA and direct entry did identify that the schools of nursing within the sample do appear to be using science courses as a gatekeeper function for entry into nursing programs. Although there is specific research on the science content knowledge needed for a practicing nurse today, the educational research centers on the biological sciences (Birks et.al, 2018; McVicar et.al, 2015). The specific skills a nursing student needs to obtain in the sciences, particularly in critical scientific thinking, has been absent from research. The gatekeeper nature of the science courses within a nursing program has the potential to promote students who are strong academically in the scientific content knowledge without having the problem solving skills and scaffolding of scientific knowledge and thinking needed to scaffold learning through the nursing curriculum.

Limitations of Study

There are limitations of the study in method and design. First, although easily accessible, the published databases used in the study may have missing variables of interest based on the availability of data from institutions or may be limited by the reporting period. In the middle of data collection (December 2018), the Carnegie Classification database was updated, so as a result, some data may not be current, which may have affected results. Secondly, Iwasiw and Goldenberg (2018) had identified the importance of the university mission and vision statements as influential on curriculum development, but there was no efficient way to collect mission and vision statements for this study. As a result, the variable of institutional lens related to science education remains absent in this study. Thirdly, the study design focuses on aggregate data, particularly for NCLEX-RN® examination pass rates, which may have led to skewed results. A future study designed on individual student data could give a very different outcome.

The sample selection was exclusive to a very specific range of nursing schools. Of note, although not included in the variables of the study, most of the schools in the study were selective or highly selective, with most residential schools. This may have skewed the sample to the highest performing nursing schools that had received accreditation. As all the schools in the sample were traditional four-year programs, the exclusion of associate degree programs, the newest innovative nursing programs, including two plus two and master level entry into practice programs from the study may have also skewed results. The influence of innovative programs remains unknown but certainly have effect on the generalizability of the study.

The selective nature of admissions to the programs in the sample may have affected the study outcomes. as the science coursework is completed prior to admission to the nursing program. Combined with high admission GPA requirements, the potential to affect the findings in the study exists. A future study that compares direct entry programs to non-direct entry programs has potential to reveal different results.

In designing the study, the institutional variables selected did not appear to have relationship with NCLEX-RN® examination pass rates. Although science content knowledge may be part of the test blueprint, a better measure of science course knowledge would have been to use a specific competency examination. Also, the underlying premise that science coursework offers both content and critical thinking skills, would demand use of a critical thinking inventory or assessment in order to measure more accurately the learning outcomes. Caution in interpreting the results as to nurse educators' values on sciences in nursing education is required for that reason. The results are more relevant to future study needs related to how nurse educators assess learning outcomes and assessments for science content and critical thinking skill development.

McMillan and Schumacher (2010) identify the importance of recognition of unknown relationships of variables outside of a study that may have influences on findings. During data collection, I did note a difference in how schools code course names, course numbers and credits. Some schools used a contact hour for example that did not match traditional course credit hours. As the researcher, I did make some judgements for study inclusion based on course descriptions and overall nursing program credits. I also interpreted course titles as equivalent to course names listed in early 1900s curricula and developed the study based on course titles only. Further study in the course descriptions or ultimately the course syllabi, would gain much greater insight into the focus of the curriculum and learning outcomes specific to science coursework.

A few other considerations of limitations are evident. There may be an unknown or confounding relationship between the specific science course hours and relationship between science curriculum or pass rate outcomes. One other unknown and expected confounding variable in this study is the knowledge of faculty about curriculum decision process. Faculty views on decision making could have strengthened which variables would actually have more influence on science course decisions, particularly as related to admission to program GPA and direct entry status. How a faculty team makes the decision to include or exclude a specific science course as part of admissions or within curriculum remains absent from this study and may be a significant confounding variable.

Finally, the study was limited on scope based on time and funding. For example, including schools accredited by the National League of Nursing, may have given different results. Data entry performed directly by the researcher may have affected interpretation of statistical significance based on entry of variables and data into the statistical software. To mitigate this effect, I obtained feedback on statistical analysis from committee members and corrections made. With a funded study, a more robust statistical analysis plan would help improve validity and reliability of data as suggested by McMillan and Schumacher (2010).

Implications for Nursing Education

The implication for nursing education from this study is that more collaborative evaluation and assessment of science courses be included in nursing curricula decisions to meet the expected learning outcomes of both science content and critical thinking skill development. Of most concern, is that the level of science education given to nursing students in the first two years of a nursing program or pre-nursing program, may not meet the nursing program expectations due to the survey nature of many of the required science courses. With increasing demand on nursing programs to produce more entry-level nurses, there is a significant risk of reducing the number and type of science courses as part of the liberal education. By reducing the partnership with science educators, the requirement to remain current in scientific practice and science education rests with the nurse educator. With an ever-increasing complexity of scientific advances in healthcare, this would appear to be a significant risk to nursing practice development into the future.

Although not the specific subject of this study, exploration of STEM literature may be useful to nurse educators to help improve retention and student success in science, coursework so that nursing students can obtain entry into nursing programs. Gender, minority, and philosophical views on science all may have hidden impact on science education in nursing curriculum. To achieve improved integration of sciences into nursing curricula, further collaboration with STEM educators may be required into the future.

Conclusions

The study did uncover the remarkable consistency among nursing curricula in science course inclusion. As Benner (2010) had suggested earlier in the decade of the importance of transforming nursing education to meet the demands of a changing healthcare environment, the change appears to be slow in reaching science education within nursing curricula. The potential for enhancement of scientific thinking and critical thinking skill development within science coursework should encourage nursing educators to develop partnership with science faculty colleagues to support advancement of sciences in nursing. The hope of the study is to spark discussion among nurse educators to uncover what has "always been done" since 1918 with science education and move toward advancing science education to ensure the healthcare environments of the future can be led by nurses who are scientifically prepared and innovative.

REFERENCES

American Association of Colleges of Nursing (2008). *Baccalaureate Essentials for Nursing Practice for the Professional Nurse*. Retrieved from http://www.aacnnursing.org/Education-Resources/Tool-Kits/Baccalaureate-Essentials-Tool-Kit

American Association of Colleges of Nursing. (2017, March 20). *Diversity, Inclusion, & Equity in Academic Nursing*. Retrieved from http://www.aacnnursing.org/News-Information/Position-Statements-White-Papers/Diversity

Anthony, M., & Templin, T. (1998). Nursing faculty teaching in the general education sequence: The value of liberal arts as a component of professional nursing practice. *Journal of Nursing Education*, 37(7), 321-323.

Benner, P., Sutphen, M., Leonard, V., & Day, L. (2010). *Educating Nurses: A Call for Radical Transformation*. Stanford, CA: Jossey-Bass.

Birks, M., Ralph, N., Cant, R., Tie, Y. C., & Hillman, E. (2018). Science knowledge needed for nursing practice: A cross-sectional survey of Australian Registered Nurses. *Collegian, 25*(2), 209-215. doi:10.1016/j.colegn.2017.05.005

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics, 112*(1), 3-11. doi:http://dx.doi.org.prxy4.ursus.maine.edu/10.1111/j.1949-8594.2011.00109.x

Brown, C. E., Hyslop, R. M., & Barbera, J. (2015). Development and analysis of an instrument to assess student understanding of GOB chemistry knowledge relevant to clinical nursing practice. *Biochemistry and Molecular Biology Education, 43*(1), 13-19. doi:10.1002/bmb.20834

Byrnes, J., Dunbar, K. (2014). The nature and development of critical-analytic thinking. *Education Psychology Review, 26*:477-493.

Chayer, M. E. (1947.). Catalog Record: Nursing in modern society | Hathi Trust Digital Library [Digital image]. Retrieved February 13, 2017, from http://catalog.hathitrust.org/Record/001574671

Coladarci, T., & Cobb, C. (2014). *Fundamentals of Statistical Reasoning in Education.* Hoboken, N.J.: John Wiley & Sons, Inc.

Commission on Collegiate Nursing Education (2018a). *CCNE Standards & Professional Nursing Guidelines*. Retrieved from http://www.aacnnursing.org/CCNE-Accreditation/Resource-Documents/CCNE-Standards-Professional-Nursing-Guidelines

Commission on Collegiate Nursing Education (2018b). *Accredited Baccalaureate and Graduate Nursing Programs.* Retrieved from https://directory.ccnecommunity.org/reports/accprog.asp

Dewey, J. (1910) *How we think*. Boston, MA: D.C. Heath & Co.

Committee on the Grading of Nursing Schools. (1934). Catalog Record: Nursing schools today and tomorrow; final report of the Committee on the Grading of Nursing Schools | Hathi Trust Digital Library [Digital image]. Retrieved February 13, 2017, from http://catalog.hathitrust.org/Record/001574517

Finkelman, A., & Kenner, C. (2012). *Learning IOM: Implications of the Institute of Medicine Reports for Nursing Education*. Silver Spring, MD: American Nurses Association.

Hermann, M. (2004). Linking liberal and professional learning in nursing education. *Liberal Education, Fall 2004*: 42-47.

Hoskins, C. N. (1998). *Developing research in nursing and health: Quantitative and qualitative methods*. New York, NY: Springer Publishing Co.

Huber, C., Kuncel, N. (2016). Does college teach critical thinking? A meta-analysis. *Review of Educational Research, 86* (2):431-486.

Indiana University Center for Postsecondary Research (2018). *The Carnegie Classification of Institutions of Higher Education®*. [Data file] Retrieved from http://carnegieclassifications.iu.edu/

Institute of Medicine (US) Committee on the Robert Wood Johnson Foundation Initiative on the Future of Nursing, at the Institute of Medicine (2011). *The Future of Nursing: Leading Change, Advancing Health*. Washington, D.C.: National Academies Press. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK209880/ doi: 10.17226/12956

Iwasiw, C. L., & Goldenberg, D. (2015). *Curriculum Development in Nursing Education*. Burlington, MA: Jones and Bartlett Learning.

Keating, S. (2006). *Curriculum Development and Evaluation in Nursing*. Philadelphia, PA: Lippincott, Williams, & Wilkins.

Khan, M. & Law, L. (2015). An integrative approach to curriculum development in higher education in the USA: A theoretical framework. *International Education Studies, 8* (3), 66-76.

Knapp, H. (2018). *Intermediate Statistics Using SPSS®*. Thousand Oaks, CA: Sage Publications, Inc.

Kuhn, T. (1962). The structure of scientific revolutions. *International Encyclopedia of Unified Science (2)* 2: 1-210.

Maddux, H., Donnett, D. (2015). John Dewey's pragmatism: Implications for reflection in service learning. *Michigan Journal of Community Service Learning, Spring 2015*, 64-73.

Maine State Board of Nursing (2013). *Chapter 7-Standards for Educational Programs in Nursing*, ME State Rule §§ 2-280- Chapter 7. Retrieved from https://www.maine.gov/boardofnursing/docs/Chapter%207.pdf

McCarthy, M., Harris, D., & Tracz, S. (2014). Academic and nursing aptitude and the NCLEX RN in baccalaureate programs. *Journal of Nursing Education*, *53*(3), 151-160.

McGrath, E. J. (1959). Catalog Record: Liberal education in the professions | Hathi Trust Digital Library [Digital image]. Retrieved from http://catalog.hathitrust.org/Record/001449991

McMillan, J., Schumacher, S. (2010). *Research in Education-Evidence Based Inquiry. Seventh Edition*. Upper Saddle River, NJ: Pearson Education Inc.

McVicar, A., Andrew, S., & Kemble, R. (2015). The bioscience problem for nursing students: An integrative review of published evaluations of Year 1 bioscience, and proposed directions for curriculum development. *Nurse Education Today, 35*(3), 500-509. doi:10.1016/j.nedt.2014.11.003

National Council of State Boards of Nursing (2016). NCLEX-RN® Examination Detailed Test Plan for the National Council Licensure Examination for Registered Nurses Effective April 2016, Item Writer/Item Reviewer/Nurse Educator Version. Retrieved from https://www.ncsbn.org/2016_RN_DetTestPlan_Educator.pdf

National League of Nursing Education. (1936). Catalog Record: Essentials of a good school of nursing | Hathi Trust Digital Library [Committee on Standards]. Retrieved from http://catalog.hathitrust.org/Record/001574544

National League for Nursing. (1954). Catalog Record: The NLN achievement tests in professional nursing | Hathi Trust Digital Library [Digital image]. Retrieved from http://catalog.hathitrust.org/Record/005686295

Norman-McKay, L., & ASM MINAH Undergraduate Curriculum Guidelines Committee, & the ASM MINAH Undergraduate Curriculum Guidelines Committee. (2018). Microbiology in nursing and allied health (MINAH) undergraduate curriculum guidelines: A call to retain microbiology lecture and laboratory courses in nursing and allied health programs. *Journal of Microbiology & Biology Education, 19*(1) doi:10.1128/jmbe.v19i1.1524

Nutting, M., & Dock, L. L. (1907). Catalog Record: A history of nursing; the evolution of nursing systems from the earliest times to the foundations of the first English and American training schools for nurses | Hathi Trust Digital Library [A history of nursing; the evolution of nursing systems from the earliest times to the foundations of the first English and American training schools for nurses.]. Retrieved from http://catalog.hathitrust.org/Record/00859522

Nutting, M. A., & Stewart, I. M. (1918). Catalog Record: Standard curriculum for schools of nursing | Hathi Trust Digital Library [Curriculum document prepared by the Committee on Education of the National League of Nursing Education]. Retrieved from http://catalog.hathitrust.org/Record/002072165

Okasha, S. (2016). *Philosophy of science: A very short introduction*. New York, NY: Oxford University Press.

Qualtrics (2018). *Calculating sample size*. Retrieved from https://www.qualtrics.com/blog/calculating-sample-size/

Rega, M. L., Telaretti, F., Alvaro, R., & Kangasniemi, M. (2017). Philosophical and theoretical content of the nursing discipline in academic education: A critical interpretive synthesis. *Nurse Education Today, 57*, 74-81. doi:10.1016/j.nedt.2017.07.001

Robb, I. H. (1907). Catalog Record: Educational standards for nurses: With other addresses on nursing subjects | Hathi Trust Digital Library [1859-1910]. Retrieved from http://catalog.hathitrust.org/Record/009785533

Rodgers, B. L. (2005). *Developing nursing knowledge: Philosophical traditions and influences*. New York, NY:Lippincott Williams & Wilkins.

Russell, C. H. (1960). Catalog Record: Liberal education and nursing | Hathi Trust Digital Library [Digital image]. Retrieved from http://catalog.hathitrust.org/Record/000384352

Simon, E., McGinniss, S., & Krauss, B. (2013). Predictor variables for NCLEX-RN® readiness exam performance. *Nursing Education Perspectives. 34* (1) 18-35.

Spohn, R. (1962). Spohn, R. R. (1962). Catalog Record: The future of education for professional practice; a guide for the study of ANA's proposed goal on nursing education and principles of nursing education | Hathi Trust Digital Library. Retrieved from http://catalog.hathitrust.org/Record/002072190

Talavera, I. (2016). The acquisition of scientific knowledge via critical thinking: a philosophical approach to science education. *Forum on Public Policy: A Journal of the Oxford Round Table*. Retrieved from http://link.galegroup.com.prxy4.ursus.maine.edu/apps/doc/A497796667/AONE?u=maine_orono&sid=AONE&xid=c370ba12

Taylor, V., Ashelford, S., Fell, P., & Goacher, P. J. (2015). Biosciences in nurse education: Is the curriculum fit for practice? Lecturers' views and recommendations from across the UK. *Journal of Clinical Nursing, 24*(19-20), 2797-2806. doi:10.1111/jocn.12880

Tirunch, D., DeCock,M., Weldeslassie, A., Elen, J.,Janssen,R. (2017). Measuring critical thinking in physics: Development and validation of a critical thinking test in electricity and magnetism. *International Journal of Science and Math Education,15*(2017) 663-682.

University of Maine Office of Research Compliance (2018). *Exemption categories*. Retrieved from https://umaine.edu/research-compliance/human-subjects/exemption-categories/

Virginia State Board of Nursing (2018). *Regulations for Nursing Education Programs*. Virginia VAC 90-27-10 et seq. §§ 54.1-2400 and Chapter 30 of Title 54.1 of the *Code of Virginia*. Retrieved from https://www.dhp.virginia.gov/nursing/nursing_laws_regs.htm#reg

APPENDIX A

SAMPLE COLLECTION DATA SHEET

ID number	Institution /School Name	Location	AACN Geographic region	Carnegie Classification (Control)	Carnegie Classification (Student population)	CarnegieClassification (Basic Classification)	Carnegie Classification (Size and Setting)	Carnegie Classification (Undergraduate Profile)	Direct entry?	Nursing Admission GPA

Biological Science Course (General biology)	Biological Science Course (Pathophysiology)	Biological Science Course (Anatomy and physiology)(1907=4 credits)	Biological Science Course (Microbiology)	Physical Science course (General chemistry)	Physical Science course (Organic Chemistry)	Physical Science Course (Biochemistry)	Physical Science Course (Physics)	Other Natural or Physical Science Course (Specify)	Most recent NCLEX-RN ® pass rate (Anticipate published in October/November 2018)	NCLEX number	curriculum progression?

Fit with 1907 curriculum?(A and P (60 hours=15weeks*4 credits), microbiology (20 hours=15 weeks*1.3 credits), applied chemistry (20 hours=15 weeks*1.3 credits), pathology (10 hours=15 weeks *.67 hours)	CODING 1-Science curriculum Code (mixed, above)	RECODING 2-science curriculum codes(below, at, mixed or above)_Assume all schools have APII course, removed APII as criteria	RECODING 3-Science Curriculum codes (excluding APII and gen. bio)	Codes for 3	Notes

APPENDIX B

DATASET DEFINITIONS OF VARIABLES

Dataset 1: Carnegie Classification of Institutions of Higher Education®

Retrieved from http://carnegieclassifications.iu.edu/classification_descriptions/size_setting.php

Basic Classification Description

Doctoral Universities

Includes institutions that awarded at least 20 research/scholarship doctoral degrees during the update year (this does not include professional practice doctoral-level degrees, such as the JD, MD, PharmD, DPT, etc.). Excludes Special Focus Institutions and Tribal Colleges.

- R1: Doctoral Universities – Highest research activity
- R2: Doctoral Universities – Higher research activity
- R3: Doctoral Universities – Moderate research activity

Master's Colleges and Universities

Generally includes institutions that awarded at least 50 master's degrees and fewer than 20 doctoral degrees during the update year (with occasional exceptions – see Methodology). Excludes Special Focus Institutions and Tribal Colleges.

- M1: Master's Colleges and Universities – Larger programs
- M2: Master's Colleges and Universities – Medium programs
- M3: Master's Colleges and Universities – Smaller programs

Baccalaureate Colleges

Includes institutions where baccalaureate or higher degrees represent at least 50 percent of all degrees but where fewer than 50 master's degrees or 20 doctoral degrees were awarded during the update year. (Some institutions above the master's degree threshold are also included; see Methodology.) Excludes Special Focus Institutions and Tribal Colleges.

- Baccalaureate Colleges: Arts & Sciences Focus
- Baccalaureate Colleges: Diverse Fields

Baccalaureate/Associate's Colleges

. Includes four-year colleges (by virtue of having at least one baccalaureate degree program) that conferred more than 50 percent of degrees at the associate's level. Excludes Special Focus Institutions, Tribal Colleges, and institutions that have sufficient masters or doctoral degrees to fall into those categories

- Baccalaureate/Associate's Colleges: Mixed Baccalaureate/Associate's Colleges
- Baccalaureate/Associate's Colleges: Associate's Dominant

Associate's Colleges

Institutions at which the highest level degree awarded is an associate's degree. The institutions are sorted into nine categories based on the intersection of two factors: disciplinary focus (transfer, career & technical or mixed) and dominant student type (traditional, nontraditional or mixed). Excludes Special Focus Institutions and Tribal Colleges.

- Associate's Colleges: High Transfer-High Traditional
- Associate's Colleges: High Transfer-Mixed Traditional/Nontraditional
- Associate's Colleges: High Transfer-High Nontraditional
- Associate's Colleges: Mixed Transfer/Career & Technical-High Traditional
- Associate's Colleges: Mixed Transfer/Career & Technical-Mixed Traditional/Nontraditional
- Associate's Colleges: Mixed Transfer/Career & Technical-High Nontraditional
- Associate's Colleges: High Career & Technical-High Traditional
- Associate's Colleges: High Career & Technical-Mixed Traditional/Nontraditional
- Associate's Colleges: High Career & Technical-High Nontraditional

Special Focus Institutions

Institutions where a high concentration of degrees is in a single field or set of related fields. Excludes Tribal Colleges.

- Two-Year Special Focus Two-Year: Health Professions
- Special Focus Two-Year: Technical Professions
- Special Focus Two-Year: Arts & Design
- Special Focus Two-Year: Other Fields
- Four-Year Special Focus Four-Year: Faith-Related Institutions
- Special Focus Four-Year: Medical Schools & Centers
- Special Focus Four-Year: Other Health Professions Schools
- Special Focus Four-Year: Engineering Schools
- Special Focus Four-Year: Other Technology-Related Schools
- Special Focus Four-Year: Business & Management Schools
- Special Focus Four-Year: Arts, Music & Design Schools
- Special Focus Four-Year: Law Schools
- Special Focus Four-Year: Other Special Focus Institutions

Tribal Colleges

Colleges and universities that are members of the American Indian Higher Education Consortium, as identified in IPEDS Institutional Characteristics.

Classifications are time-specific snapshots of institutional attributes and behavior based on 2013-14 data.

Size & Setting Classification Description

The Size and Setting Classification describes institutions' size (student population) and residential character. Because residential character applies to the undergraduate student body, exclusively graduate institutions are not included. For detailed information regarding how this classification is calculated, please see the Size and Setting Methodology.

Size matters. It is related to institutional structure, complexity, culture, finances, and other factors. Residential or nonresidential character reflects aspects of the campus environment, student population served, and the mix of programs and services that an institution provides.

Four-year institutions are divided into four categories of full-time equivalent (FTE*) enrollment and three categories of residential character. Neither characteristic implies differences in the quality of undergraduate education, but an institution's location along the two continua generally corresponds to a distinctive mix of educational challenges and opportunities. Because few two-year institutions serve a residential population, these institutions are classified solely based on FTE enrollment.

The residential character measure is based on two attributes: the proportion of degree-seeking undergraduates who attend full-time and the proportion living in institutionally-owned, -operated, or -affiliated housing. It is important to note the variety of situations of students who do not live in college or university housing. Some are true "commuting" students, while others may live with other students in rental housing on the periphery of campus, and still others are distance education students who rarely or never set foot on a campus. A chart illustrating the residential character categories can be found here.

The categories are as follows:

Two-year, very small
Fall enrollment data indicate FTE* enrollment of fewer than 500 students at these associate's degree granting institutions.

Two-year, small
Fall enrollment data indicate FTE* enrollment of 500–1,999 students at these associate's degree granting institutions.

Two-year, medium
Fall enrollment data indicate FTE* enrollment of 2,000–4,999 students at these associate's degree granting institutions.

Two-year, large
Fall enrollment data indicate FTE* enrollment of 5,000–9,999 students at these associate's degree granting institutions.

Two-year, very large
Fall enrollment data indicate FTE* enrollment of at least 10,000 students at these associate's degree granting institutions.

Four-year, very small, primarily nonresidential

Fall enrollment data indicate FTE* enrollment of fewer than 1,000 degree-seeking students at these bachelor's or higher degree granting institutions. Fewer than 25 percent of degree-seeking undergraduates live on campus** and/or fewer than 50 percent attend full time (includes exclusively distance education institutions).

Four-year, very small, primarily residential

Fall enrollment data indicate FTE enrollment of fewer than 1,000 degree-seeking students at these bachelor's or higher degree granting institutions. 25-49 percent of degree-seeking undergraduates live on campus** and at least 50 percent attend full time.

Four-year, very small, highly residential

Fall enrollment data indicate FTE enrollment of fewer than 1,000 degree-seeking students at these bachelor's or higher degree granting institutions. At least half of degree-seeking undergraduates live on campus** and at least 80 percent attend full time.

Four-year, small, primarily nonresidential

Fall enrollment data indicate FTE enrollment of 1,000–2,999 degree-seeking students at these bachelor's or higher degree granting institutions. Fewer than 25 percent of degree-seeking undergraduates live on campus** and/or fewer than 50 percent attend full time (includes exclusively distance education institutions).

Four-year, small, primarily residential

Fall enrollment data indicate FTE enrollment of 1,000–2,999 degree-seeking students at these bachelor's or higher degree granting institutions. 25-49 percent of degree-seeking undergraduates live on campus** and at least 50 percent attend full time.

Four-year, small, highly residential

Fall enrollment data indicate FTE enrollment of 1,000–2,999 degree-seeking students at these bachelor's or higher degree granting institutions. At least half of degree-seeking undergraduates live on campus** and at least 80 percent attend full time.

Four-year, medium, primarily nonresidential

Fall enrollment data indicate FTE enrollment of 3,000–9,999 degree-seeking students at these bachelor's or higher degree granting institutions. Fewer than 25 percent of degree-seeking undergraduates live on campus** and/or fewer than 50 percent attend full time (includes exclusively distance education institutions).

Four-year, medium, primarily residential

Fall enrollment data indicate FTE enrollment of 3,000–9,999 degree-seeking students at these bachelor's or higher degree granting institutions. 25-49 percent of degree-seeking undergraduates live on campus** and at least 50 percent attend full time.

Four-year, medium, highly residential

Fall enrollment data indicate FTE enrollment of 3,000–9,999 degree-seeking students at these bachelor's or higher degree granting institutions. At least half of degree-seeking undergraduates live on campus** and at least 80 percent attend full time.

Four-year, large, primarily nonresidential

Fall enrollment data indicate FTE enrollment of at least 10,000 degree-seeking students at these bachelor's or higher degree granting institutions. Fewer than 25 percent of degree-seeking undergraduates live on campus** and/or fewer than 50 percent attend full time (includes exclusively distance education institutions).

Four-year, large, primarily residential

Fall enrollment data indicate FTE enrollment of at least 10,000 degree-seeking students at these bachelor's or higher degree granting institutions. 25-49 percent of degree-seeking undergraduates live on campus** and at least 50 percent attend full time.

Four-year, large, highly residential

Fall enrollment data indicate FTE enrollment of at least 10,000 degree-seeking students at these bachelor's or higher degree granting institutions. At least half of degree-seeking undergraduates live on campus** and at least 80 percent attend full time.

Exclusively graduate/professional

Fall enrollment data indicate that there are no undergraduates enrolled at these institutions. All enrolled students are in graduate-level programs.

* FTE: Full-time equivalent enrollment was calculated as full-time plus one-third part-time.

** On campus is defined as institutionally-owned, -controlled, or -affiliated housing.

Classifications are time-specific snapshots of institutional attributes and behavior based on 2013-14 data.

Dataset 2: Sample website example for school of nursing curriculum/program of study Retrieved from the University of Maine School of Nursing https://umaine.edu/nursing/wp-content/uploads/sites/223/2016/09/new-4-yr-program-planlogo.pdf

1865 THE UNIVERSITY OF MAINE

University of Maine School of Nursing
BSN Program of Study

FIRST YEAR

FALL SEMESTER		SPRING SEMESTER	
BMB 207 Fundamentals of Chemistry	3 cr	BMB 240 Microbiology	3 cr
BMB 209 Fund. Chem. Lab	1 cr	BMB 241 Microbiology Lab	2 cr
BIO 100 Basic Biology (GESCI)	4 cr	BIO 208 Anatomy & Physiology (GESCI)	4 cr
FSN 101 Intro to Nutrition	3 cr	PSY 100 General Psychology (GESI)	3 cr
ENG 101 English Composition (GEWR)	3 cr	Math (if needed) or Gen Ed	3 cr
NUR 101 Iss & Opp in Nsg	1 cr	NUR 102 Foundations of Nsg Practice I	1 cr
TOTAL	15 cr	TOTAL	16 cr

SECOND YEAR

FALL SEMESTER		SPRING SEMESTER	
PHI (GEWC)	3 cr	NUR 200 Care of Adults I (GEMA)	3 cr
Growth & Development	3 cr	NUR 202 App Theory to Nsg Pract I	1 cr
MAT 232 Statistics (GEMA)	3 cr	NUR 201 Care of Adults I Clinical	1 cr
*NUR 165 Intro. To Care of the Older Adults	1 cr	NUR 300 Health Assessment	4 cr
*NUR 103 Foundations of Nsg Practice II	3 cr	**NUR 303 Pathophysiology	3 cr
SOC 101 Intro to Sociology (GESI)	3 cr	*NUR 265 Human Genetics/Genomics for Nsg. Practice	1 cr
		General Education (GEWRI)	3 cr
TOTAL	16 cr	TOTAL	16 cr

THIRD YEAR

FALL SEMESTER		SPRING SEMESTER	
NUR 301 Care of Adults II (GEMA)	3 cr	NUR 334 Care of Adults III	3 cr
NUR 302 App Theory to Nsg Pract II	1 cr	NUR 335 Care of Adults III Clinical	2 cr
NUR 306 Care of Adults II Clinical	2 cr	NUR 340 Psych/Mental Hlth Nsg.	3 cr
*NUR 316 Pharmacology	3 cr	NUR 341 Psych/Mental Hlth Clinical	2 cr
*NUR415 Sociocultural Issues	3 cr	NUR 310 Hlth Related Research	3 cr
Gen Ed. (GEART)	3 cr	*NUR 365 Health Care Informatics	1 cr
TOTAL	15 cr	TOTAL	14 cr

FOURTH YEAR

FALL SEMESTER		SPRING SEMESTER	
NUR 413 Family Centered Care OB	3 cr	NUR 456 Prof. Nsg. Pract Through Lifespan	4 cr
NUR 416 Family Centered Care Peds	3 cr	NUR 444 Management & Ldrsp in Nsg	3 cr
NUR 414 OB Clinical	1cr	NUR 455 Sr Clinical Practicum	4 cr
NUR 417 PEDS Clinical	1cr	NUR 447 Clinical Reflections Seminar	1 cr
NUR 452 Comm & Pop Health (GEPOP)	3cr	Gen Elective	3 cr
NUR 453 Clinical Care of Communities	2cr		
*NUR 435 End-of-Life- Care	1 cr		
TOTAL	14 cr	TOTAL	15 cr

Total Credits: 121 cr

Nsg Mjr: 71 cr

Pre-reqs/Gen eds: 50 cr

PROGRESSION TO THE 200 LEVEL NURSING COURSES IS CONTINGENT UPON SUCCESSFUL COMPLETION OF 47 HOURS, WHICH INCLUDES ALL SCIENCES, MATH AND SOCIAL SCIENCE PREREQUISITE COURSES FOR THE NURSING MAJOR, WITH "C" OR BETTER, A SCIENCE GRADE POINT AVERAGE OF 3.00, AND A CUMULATIVE GRADE POINT AVERAGE OF 3.00.

*-denotes online NUR course

**-denotes NUR course with classroom and online sections

Non-Discrimination Notice:

The University of Maine does not discriminate on the grounds of race, color, religion, sex, sexual orientation, including transgender status and gender expression, national origin, citizenship status, age, disability, genetic information or veteran's status in employment, education, and all other programs and activities. The following person has been designated to handle inquiries regarding non-discrimination policies: Director, Office of Equal Opportunity, 101 North Stevens Hall, 581-1226.

Approved 1/16/13

Dataset 3-Sample of NCLEX-RN® pass rates from a state board of nursing

Retrieved from https://www.rn.ca.gov/education/passrates.shtml

NCLEX Pass Rates

The table below is categorized by academic year (e.g., July 1st - June 30th) and reflects the results of all graduates who have taken the NCLEX examination for the first time within the last five years (including those students who graduated more than five years ago). Due to possible changes in this data, the BRN asks that you contact the individual programs directly for the most accurate and up-to-date information. Please refer to RN Programs for a contact list of all BRN accredited programs.

School	2012/2013		2013/2014		2014/2015		2015/2016		2016/2017	
	# Taken	% Pass	# Taken	% Pass	# Taken	% Pass	# Taken	% Pass	# Taken	% Pass
Allan Hancock College	35	82.86%	34	79.41%	36	80.56%	32	84.38%	33	78.79%
American Career College	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	43	79.07%
American River College	55	94.55%	49	85.71%	67	94.03%	62	93.55%	101	98.02%
American University of Health Sciences	36	50%	60	80%	39	84.62%	62	91.94%	79	87.34%
Antelope Valley College	112	91.96%	100	81%	99	82.83%	86	89.53%	129	79.84%
Azusa Pacific University - BSN	273	87.18%	248	83.46%	276	84.06%	287	82.23%	346	86.42%
Azusa Pacific University - MSN	18	94.44%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bakersfield College	99	97.98%	93	91.4%	125	91.20%	133	92.48%	104	91.35%
Biola University	23	82.61%	29	79.31%	44	77.27%	27	88.89%	38	81.58%
Brightwood College	171	75.44%	169	63.91%	134	78.36%	151	73.51%	160	74.38%
Butte College	122	86.07%	59	83.05%	83	81.93%	76	81.58%	102	84.31%
Cabrillo College	58	86.21%	56	75%	49	69.39%	66	78.79%	56	80.36%
California Baptist University - BSN	71	78.87%	76	72.37$	130	83.85%	134	81.34%	141	87.94%
California Baptist University - MSN	19	84.21%	22	86.36%	31	80.65%	35	74.29%	36	94.44%
CSU Bakersfield - BSN	78	97.44%	N/A	N/A	49	83.67%	59	96.61%	51	96.08%
CSU Bakersfield - MSN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CSU Channel Islands	25	96%	32	100%	47	93.62%	40	100%	41	92.68%
CSU Chico	80	92.5%	71	91.55%	69	95.65%	76	94.74%	64	96.88%

APPENDIX C

COPY OF IRB EMAIL

On Mon, Aug 20, 2018 at 1:46 PM, Patricia Poirier <patricia.poirier@maine.edu> wrote:

Thanks Gayle,

I know we talked briefly about this before but I cannot remember how we left it!!

My IPhD advisee is ready to submit her proposal for her dissertation. In my interpretation, it does not involve human subjects. She is going to correlate the curricula of schools of nursing with their licensure pass rates.

She will obtain the curricula of the schools from their publicly available websites. She has no plans to contact anyone at any of the schools. She will then code the curriculum on the basis of high, medium or low in the sciences. She will them obtain licensure pass rates for the schools, again available from publicly accessible websites.

Should she submit an IRB application anyway so that the IRB can then say it does not involve human subjects? Or can she send you a description of the procedure via email? We want to be sure we cover all bases so that she does not run into any issues with publication.

Thanks Pat

Patricia Poirier PhD, RN

Associate Professor, University of Maine

email: patricia.poirier@maine.edu

telephone (207) 581-3009 (W) (207) 460-2055 (C)

Email Response from IRB from Dr. Poirier to me:

---------- Forwarded message ----------

From: Gayle Jones <gayle.jones@maine.edu>

Date: Mon, Aug 20, 2018 at 1:56 PM

Subject: Re: August 29th IRB

To: Patricia Poirier <patricia.poirier@maine.edu>, Cindy Erdley <erdley@maine.edu>

With your description, I don't see how this could have any confusion of being human subjects research. Curricula is definitely not, and as long as the licensure pass rates are not identifiable by individual, that part is not "human subjects" either. I've copied Cindy, but I don't feel your student needs to submit an IRB application -- more work for her and for the IRB.

Thanks, Gayle

BIOGRAPHY OF THE AUTHOR

Valerie C. Sauda was born April 23, 1965 in Brunswick, ME, USA, and adopted by Albert C. and Lucille P. Caron. She graduated in 1983 from Brunswick High School, in the top 10% of the graduating class and received an American Association of University Women chapter scholarship for excellence in mathematics. With strong encouragement to pursue a college degree by both of her parents, she entered the University of Southern Maine, Portland, ME, USA, and received a B.A. in Biology in 1987. Her first employment was with an environmental science firm as a laboratory assistant. Missing contact with people, and encouraged by her mother who was a nurse, Valerie entered the first cohort within the M.S.N. option for non-nurses program at the University of Southern Maine. She graduated in December, 1992, with an M.S.N. with concentration in community health. She was inducted into Sigma Theta Tau International, the international nursing honor society, upon graduation. Valerie married Michael Sauda on May 15, 1993, before moving to Bangor, ME USA, to start her first staff nurse position at Eastern Maine Medical Center. Valerie has held various nursing positions in practice, education and leadership over the past twenty-five years as a nurse in rural Maine. She has practiced as a staff nurse in acute care, provided supervision at a local home health care agency, was the regional director for a community based long-term care case management organization, and was the Community Services program director at Eastern Area Agency on Aging (EAAA), the first nurse to hold that position. During her time at EAAA, Valerie provided leadership for the agency in the first outreach effort for the new federal Medicare Part D prescription drug benefit, with the agency receiving national recognition for its substantial outreach collaborative effort with community partners.

Throughout her career, Valerie has been interested in teaching nursing. Her first experiences teaching experiences were at the University of Maine in medical-surgical nursing. Through an innovative gerontological teaching position created through a collaboration with Eastern Maine Community College, Eastern Maine HealthCare System, Rosscare and First Atlantic HealthCare, she cemented her passion for teaching as a career. Valerie started her position at Husson University in Fall, 2014 as an Assistant Professor in nursing and was promoted in 2018 to Undergraduate Coordinator. She has received a leadership award from the local chapter of Sigma Theta Tau International, and has received recognition for academic achievement during her doctoral studies at the University of Maine through Golden Key and Phi Kappa Phi honor societies. Valerie has maintained active engagement as a certified gerontological nurse through the American Nurses Credentialing Center (ANCC) and is a fellow with the Maine Gerontological Society. Valerie is a candidate for the Doctor of Philosophy degree in Interdisciplinary in Nursing and Education from the University of Maine in May 2019.