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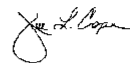
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Doctor of Education in Organizational Leadership



Dr. Joey Cope, Dean of the
College of Graduate and
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Date July 24, 2020

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Academic Success and Curricular Structure: Exploring the Relationship Between
Prerequisite Course Sequence and Grade Point Average in Community
College Health Science Students

A dissertation submitted in partial satisfaction
of the requirements for the degree of
Doctor of Education in Organizational Leadership

by
Patrick Carl Dupont

July 2020

Dedication

I would like to dedicate this dissertation to my family, for their prayers and support. To my wife Linda for her prayers and patience, and to the memories of my mother and my grandfather, both educators who inspired me with their dedication and devotion to their students and their families. To our church family for their prayers and encouragement, and to Petra S. for her friendship, prayers, and counsel.

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Abstract

The current and ongoing shortage of healthcare professionals in the United States challenges educators and institutions to produce graduates of health professions programs in ever-increasing numbers. However, the current process typically used in community colleges is a cafeteria-style system of open enrollment, a model in which students pick courses from many choices without guidance or counseling. As a result, students often enroll in more advanced courses before taking the fundamental science courses. This may lead to poor performance, dropout, or failure. One potentially important variable in student success at a community college in the southwestern United States is student performance in the prerequisite course sequence in the health science curriculum. In this study, a prerequisite course is a course in the health sciences curriculum required for application to one of the health professions programs at South Community College; prerequisite grade point average (PGPA) is a student's grade point average in the health professions related science (HPRS) courses. PGPA is a commonly used criterion for admission to health professions programs. This study was therefore designed as a quantitative retrospective analysis of health professions related science prerequisite course sequence and PGPA. This study was designed to produce empirical data to support proposed curricular innovations and strategies at the study site. The study findings demonstrated statistically significant relationships between course sequence and PGPA. These data may be applied to formulate strategies directed at resolving issues that negatively affect enrollment, academic success, and graduation rates of students in the health sciences at South Community College.

Keywords: Prerequisite Grade Point Average (PGPA), Health Professions Related Science (HPRS), course sequence

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Chapter 1: Introduction

Students applying to one of the health professions programs at a community college in the southwestern United States must take prerequisite courses in the health science curriculum. South Community College's (pseudonym) Health Professions Related Science (HPRS) courses begin at the first-year level and include Anatomy and Physiology I, Anatomy and Physiology II, Microbiology, and Medical Terminology. Second-year classes including Pathophysiology and Pharmacology are advanced courses that build on the understanding gained in prerequisites and are intended to be taken after the introductory HPRS courses have been completed.

For the purposes of this study, course sequence was defined as the order in which the required prerequisites were taken by students at South Community College (Betancur et al., 2019; Claypool, 2018). However, the courses in this specific college are open to enrollment without restriction and are not always taken in sequence. Often, new and returning students are wrongly advised, or not advised at all, and enroll in the second-year courses before having completed the first-year courses, often resulting in withdrawal or failing the courses. This is important because success in the first postsecondary academic year is key to continued success; students who earn passing grades in prerequisite courses in their first year have demonstrated higher graduation rates than students who do not earn passing grades (Heileman et al., 2017).

The significance of preadmission academic criteria such as grade point average (GPA) as a predictor of academic success in health professions programs is well documented (Ari et al., 2008; Austin, 2011; Barfield et al., 2011; Bennett et al., 2016; Calisir et al., 2016; Eiland et al., 2018; Ingrassia, 2016; Mancuso & Udalis, 2012; Sanderson, 2014; Wambuguh et al., 2016; Wilson et al., 2015). At South Community College, an open admissions policy exists for entering students, meaning that any applicant holding a high school diploma or General Educational

Development (GED) certification is eligible for enrollment: therefore, GPA is not considered during admissions to the school itself.

The admissions policy for health professions programs is selective, and students must meet a minimum prerequisite grade point average (PGPA) of 2.5 to apply to the programs. Unsystematic, *cafeteria-style* enrollment of students in prerequisite HPRS courses allows students to take advanced courses before basic prerequisite courses. This approach often results in students failing, dropping out, or not achieving a PGPA sufficient for acceptance into the health professions programs.

Enrollment in courses with attention to the organized and sequential order of progression is well documented in the literature (Dolder et al., 2012; Lim, 2016; Wigdahl et al., 2014). Students encounter many options in course selection and frequently express confusion and frustration regarding the order in which to take prerequisite courses. This problem is exacerbated by a lack of understanding of the relationship between curricular structure and sequential progression through prerequisite courses specific to health sciences and preadmission GPA. This study directs inquiry into the relationships between curricular structure and academic success, focusing on prerequisite curricula specific to the health professions programs at South Community College.

Addressing the issue of open enrollment is essential in the context of the local problem of healthcare worker supply. Demographic shifts in the U.S. population in general and in the healthcare professions workforce, in particular, contribute to current nationwide shortages of healthcare providers with sustained deficits projected into the future (Jurashek et al., 2012). In addition to increasing demand for care for the aging population, many healthcare professionals are approaching retirement age, exacerbating shortages of nurses, physicians, and allied health

professionals (Dickson, 2015). Demand for healthcare has increased not only with the aging population but also with increasing incidence of diseases such as cancer (Levit et al., 2010).

The increasing societal demand for healthcare combined with the shortage of providers encourages a reassessment of the supply dynamics involved in producing more healthcare professionals. A part of this dynamic is evaluating and implementing strategies directed at enrolling more students. Refining of admission criteria for the healthcare professions is needed to address student and community needs (Burns, 2011).

Kaufman and Guerra-Lopez (2013) defined need as “a gap between current results and desired results” (p. 6). Stakeholders at South Community College have acknowledged an ongoing demand for increased enrollment in and graduation from the health professions programs to meet community needs for healthcare professionals. The proposed research is consistent with one of the goals of South Community College to continue to provide well-trained healthcare workers to the community and meet the increasing demand in that industry both at local and national levels (Carnevale & Smith, 2013).

Currently, student enrollment in the healthcare professions programs at South Community College falls short of supplying enough graduates to meet the increasing demand for healthcare practitioners in the community served by the college. This phenomenon is reflective of the problem identified at the national level (Zimbelman et al., 2010). Increasing enrollment in healthcare professions programs can help address the problem of supply and demand in the community. In addressing this problem, the population targeted by this study was incoming students taking HPRS courses with the goal of admission to one of the health professions programs. In facilitating the eligibility of students applying for admission to the healthcare professions programs, specific methods may be explored to help students optimize prerequisite

grade point average (PGPA) in the HPRS courses. The literature documents the significance of prerequisite preparation as a determinant of academic success (Kelsch & Sylvester 2016; Ortega et al., 2013). In this context, PGPA at the study site is the average of an individual's final grade scores for HPRS courses. PGPA is a predictor of academic success and a vital admission criterion for allied health education programs (Bennet et al., 2016). Students with lower PGPA's have less chance at admission to the healthcare professions and are faced with the choices of changing majors, retaking courses, or dropping out altogether.

Empirical research supports the importance of structured curricula and prerequisite course pathways in promoting optimal academic success, including higher student retention and GPA. A large number of studies have shown that these pathways are essential across a wide range of academic disciplines including psychology, business, and science, technology, engineering, and mathematics (STEM) programs (Betancur et al., 2019; Dunn et al., 2010; Hines & Henderson, 2017; Scrivener et al., 2015; Slim et al., 2016; Slim et al., 2014).

The stakeholders at South Community College have identified open enrollment of students in prerequisite HPRS courses as a problem. Lower admission and graduation numbers result in a diminished supply of healthcare professionals, affecting community medical facilities' staffing needs. Students may encounter obstacles to academic success that are outside their control or that of the institution. Socioeconomic status and demographic traits such as student age may influence academic success. At the study site however, many students take advanced courses before basic courses, resulting in students not achieving a PGPA sufficient for acceptance into the health professions programs. The resultant decreased admission rates to health professions programs affect the study site stakeholders because students have less opportunity to attain degrees and needed qualifications in healthcare professions programs. In a

local context, this problem is exacerbated by a lack of understanding of the relationship between curricular structure and sequential progression through prerequisite courses specific to health sciences and PGPA.

This study is particularly relevant in the context of South Community College since the focus is on curricular sequence and PGPA because the curricular sequence is a variable that is subject to manipulation by the institution. If this study demonstrates significant relationships between curricular sequence and PGPA, educators, administrators, and leaders will have the evidence needed to propose interventions in curricular planning at South Community College to optimize student success.

Proposing and implementing changes in curricular structure will entail changes in policy strategies made possible by robust and effective leadership in both faculty and administrative strata. A laissez-faire leadership approach runs the risk of falling short of promoting and sustaining high standards of scholarship and academic success. The processes of change in higher education are dependent on and concurrent with leadership that demonstrates increased awareness of the importance of specific goals and motivating others to address the identified problems and potential solutions. These dynamics are consistent with the principles of transformational leadership (Northouse, 2016).

Practice problems in the sophisticated setting of higher education often evolve from the simple to the complex and may not be resolved from a singular approach. Considering the context, problems, and potential solutions applicable in this setting, more than one leadership theory may be relevant in providing a framework for strategies directed at the resolution of identified problems. Principles of transformational leadership theory are undoubtedly relevant in

the context of this study; however, adaptive principles across the spectrum of leadership theories should be considered as well.

Theoretical Framework

The framework for this study is a combination of theories based on Tinto's interactionist theory (1975) regarding postsecondary student retention and attrition. This theory, as originally described (Tinto, 1975) stated that students who socially integrated into the campus community demonstrated higher retention and graduation rates. This theoretical framework expands to include extensions and modifications of Tinto's (1975) theory, as described in studies undertaken by Bean (1980), Astin (1984), and Harris (2006). These theories focused on a didactic perspective that academic performance and success are related to increased student sense of development and formation of supportive peer relationships resulting in higher retention rates.

Seidman's retention model (2005) held that early institutional identification of student needs and early intervention improved student retention. Seidman built on Tinto's (1993) revised retention model centering on the concept that early and effective course interventions lead to improved academic performance. Braxton (2008) focused on academic attainment, assessed by course-level learning, as reflective of Tinto's modified theory on student retention. Braxton's (2008) construct extended Tinto's interactionist theory, observing the influence of faculty behaviors on student retention and departure decisions in promoting active learning in the classroom. Scott-Clayton's (2011) structure hypothesis also extended Tinto's (1993) theory from a different perspective. The structure hypothesis described the importance of curricular programs that are designed in such a way as to allow little or no deviation from the prescribed course sequence, effectively keeping students on the pathway to academic success. The theories of

Braxton (2008) and Scott-Clayton (2011) both addressed the problem of student retention from the basis of the social integration model of Tinto. Braxton's approach was from inside the classroom with the engagement of faculty in promoting academic achievement through active learning. Scott-Clayton approached retention from outside the classroom in the curricular framework.

The combined theoretical framework emphasizes the multifaceted dynamics influencing student retention and performance. According to this framework, social interaction, course-level interventions, active learning strategies, and attention to curricular structure are integral components of promoting postsecondary student retention and academic success.

In the South Community College context, the development of communities of learning may be achieved by scheduling courses in such a way that the same student cohorts take courses together in a structured curriculum. This curricular structure is a method of promoting psychosocial engagement and interaction, allowing for timely and consistent evaluation and intervention in community colleges already integrated into the residential institution setting (Seidman, 2005). Seidman's retention model of academic and social integration also extended and modified Tinto's retention theory, centered on the concept that early and effective course interventions for at-risk students can lead to improved academic performance. A key concept presented by the author is early identification of student needs followed by intensive and continuous interventions directed at improving academic performance and retention.

Statement of the Problem

The increasing unmet demand for healthcare workers in the United States is a significant problem for stakeholders and consumers (Dickson, 2015; Harahan, 2010). The source of this problem in the context of postsecondary education in the health sciences is related to the supply

and demand of workers in healthcare professions (Zimbelman et al., 2010). The shortage of healthcare workers is expected to grow 18% by 2026. Although approximately 2.4 million new healthcare jobs will be added, there are also predicted shortages of a half-million to one million in the nursing profession and unfilled openings for 159,000 occupational therapists (Bureau of Labor Statistics, 2019; Dickson, 2015; Juraschek et al., 2012). For example, Carnevale and Smith (2013) noted that by 2020 “there will be 1.2 million job openings for registered nurses (RNs) with associate degrees” (p. 22) and that the need for allied health professionals requiring an associate degree will increase. Therefore, increased enrollment in HPRS courses becomes a significant factor in subsequent increased application and acceptance to the health professions programs at South Community College.

As the need for health professions graduates expands, so does the need to recruit, educate, and train students to address both existing and projected demands (Hinderer et al., 2014; Lin et al., 2015; Trofino, 2013). Community colleges train more than half the nation’s healthcare workforce and are increasing healthcare professions’ enrollment in response to increasing demand at national and community levels (Carnevale & Smith, 2013; Raman, 2013; Rogers, 2010). However, in nursing programs, the attrition rate for students is estimated at 20%, with the dropout rate highest in the first semester (Pence, 2011). As a result, educators in the healthcare professions face both the problems of supplying the workforce with new professionals and addressing attrition rates.

Student retention in the healthcare professions is needed to increase graduation rates and supply medical facilities with healthcare professionals in the community (Carnevale et al., 2010). This phenomenon is reflected at South Community College where active recruitment of students in the healthcare professions programs is ongoing. South Community College recently added six

new health professions programs with enrollment expected to increase. Measures to identify, assess, and address contributory problems are aimed at improving student retention and increasing graduation rates.

The complexity of course choices results in student enrollment mistakes (Jaggars & Fletcher, 2014). The *cafeteria-style* enrollment paradigm used at South Community College may result in unclear guidelines for students and obscure their perceptions of objectives and progress through the curriculum. In the case of the environment, problems, and potential solutions applicable in this context, concepts of transformational and adaptive leadership theories may apply in providing a framework for strategies directed at resolution.

Principles of transformational leadership theory are undoubtedly relevant in the context of this study; however, principles of adaptive leadership theory may be applicable as well. Traits emphasized in the adaptive leadership model that are relevant to this study include (a) identifying the adaptive challenge, (b) regulating distress, and (c) maintaining disciplined attention (Northouse, 2016, p. 261). A subset of path-goal theory relevant to this problem is expectancy theory, which posits that individuals are more motivated when they believe their efforts will result in positive outcomes consistent with their perceptions of the goal (Northouse, 2016).

Enrollment in courses with attention to the organized and sequential order of progression is well documented in the literature (Dolder et al., 2012; Lim, 2016; Wigdahl et al., 2014). This study directs inquiry into the relationships between curricular structure and academic success, focusing on prerequisite curricula specific to the health professions programs.

Purpose of the Study

The purpose of the quantitative causal-comparative and correlational study was to investigate differences in course sequence and PGPA and the extent to which course sequence

predicted PGPA after controlling for age and gender. This research analyzed archival data using regression and between-groups comparisons to determine relationship between the independent variable of course sequence and the dependent variable of PGPA of health professions students at South Community College. The study findings can be applied to support proposed curricular innovations and strategies at the study site to resolve issues that negatively affect enrollment, academic success, and graduation of students in the health sciences.

Research Questions

RQ1: What are the differences between mean PGPA scores for students taking HPRS courses in a prescribed curricular sequence and those students taking HPRS courses out of sequence?

RQ2: Is there a significant relationship between HPRS course sequence and PGPA, after controlling for age and gender, among health science students at South Community College?

Definition of Key Terms

Course sequence. The order in which the required prerequisites were taken by students at South Community College (Betancur et al., 2019; Claypool, 2018).

Health professions programs. Associate degree programs providing education and clinical training in health care specialties such as surgical technology, respiratory therapy, and radiologic technology. In addition to two programs for nursing, South Community College offers over 12 allied health professions programs.

Health professions related sciences (HPRS). A set of courses specific to and required in health science professions programs.

Open enrollment. Enrollment in general education courses is open to all students, regardless of prior academic performance.

Prerequisite grade point average (PGPA). In this study, a student's grade point average in the health professions related science courses taken as prerequisites for applying to a health professions program.

Transformational leadership. In this study, "the process whereby a person engages with others and creates a connection that raises the level of motivation and morality in both the leader and the follower" (Northouse, 2016, p. 162).

Summary

In response to the increasing demand for health care providers, community colleges are showing increased interest in recruiting students for health care professions programs. This study investigated the relationships between admission criteria and academic success in health professions prerequisite courses at a large community college in the Southwestern United States. The literature documents correlations between various admission criteria and academic outcomes. This study was specific to the relationship between prerequisite GPA (PGPA) as the dependent variable, and Health Professions Related Science (HPRS) prerequisite course sequence as the independent variable. Student age and gender were included as covariates.

The theoretical framework described theories of social interaction beginning with Tinto (1975). These theories were expanded by Bean (1980), Astin (1984), and Harris (2006). Later theories posited by Seidman (2005) and Braxton (2008) extended and expanded the social interaction theories to include a combination of academic with social factors as influencing student retention and academic success. The *structure hypothesis* of Scott-Clayton (2011) served as the theoretical model for examination of the research problem.

The problem of practice was identified as the increasing need and decreasing supply of healthcare professionals in the United States. In addressing the national need, the response at the

local level is directed at increasing enrollment in the healthcare professions programs at South Community College. Student retention and academic success are critical components to resolution of the problem. To this end, this study examined the relationships between HPRS course sequence and PGPA at South Community College. Quantitative correlational and causal-comparative designs were proposed, with the purpose of application of the findings in support of innovations and strategies aimed at increasing enrollment, retention, and graduation of students from the healthcare professions programs at South Community College.

Chapter 2: Literature Review

This literature review provides an assessment and critical analysis of research on growing healthcare workforce shortages and on variables about the education and training of direct-care workers who provide the bulk of regular patient care (Carnevale & Smith, 2013; Harahan, 2010; Lin et al., 2015). The literature contains many studies regarding variables affecting academic outcomes such as student age, gender, ethnicity, socioeconomic status (SES), and preadmission testing (Burns, 2011; Raman, 2013; Wilson et al., 2015). However, none of these variables are subject to modification in the enrollment process at South Community College. There also exists an abundance of extensive evidence of the significance of the relationships between prerequisite preparation, admission criteria, and academic success across a broad spectrum of healthcare professions programs. To illustrate the interrelationship of these variables, an extensive search and review of peer-reviewed studies examining the correlation between prerequisite course structure and academic success was conducted.

Community colleges play an important role in supplying the healthcare workforce with trained professionals; however, even though community colleges enroll a greater percentage of undergraduate students, attrition rates are higher for community college students than for four-year university students (Silverman & Seidman, 2011). This study documents supply and demand dynamics pertaining to healthcare providers in the United States. To meet the demands for healthcare professionals, enrollment, acceptance to, and graduation from health professions programs, a greater understanding of phenomena that lead to student retention and attrition needs to be addressed. By identifying the relationships between specific variables of course sequence and academic performance, future research may focus more specifically on the modification of these relationships to promote academic success.

Retention of students in health professions programs is an essential component of increasing graduation rates and the supply of healthcare workers to the community. Increasing program acceptance rates facilitates increasing program graduation rates. To apply for admission to health professions programs, students at South Community College must complete HPRS prerequisite courses. Prerequisite grade point average is the primary admission criterion for health professions programs.

Problems with student retention have contributed to decreasing enrollment in and graduation from health professions programs at South Community College. This review examines theories addressing the issue of student retention. This review focuses on theories and studies by Astin (1984), Bean (1980), Braxton (2008), Harris (2006), Scott-Clayton (2011), Seidman (2005), and Tinto (1975, 1993, 2006) and how extensions and expansions of the nascent theories of student retention have opened inquiry into how these theories apply in a community college context.

Literature Search Methods

Database searches used in this review include CINAHL Complete, EBSCO Academic Databases, eBook Collection (EBSCO), EbscoHost, Education Source (EBSCO), ERIC (EBSCO), ERIC (Government), Health Source: Nursing/Academic Edition, IEEE Xplore Digital Library, Lexis-Nexis Universe, Lynda.com, MEDLINE/PubMed, PsycInfo, Proquest Nursing and Allied Health Source, Sage Research Methods Online, and ScienceDirect. Keywords used in searches include *academic success/progression, admission/preadmission criteria, course enrollment sequence/student success, curricular structure, healthcare professions/college student attrition/retention, healthcare worker shortage, nursing shortage healthcare workforce, predictors of academic success, retention formula, and structure hypothesis.*

Information gathered from these sources was used separately within the context of the topics addressed in the studies. Additional keywords noted in the articles linked to complementary sources relevant to this study. Materials gathered were analyzed for content relevance and scientific validity and presented in the following discussion. An ongoing search is underway for new material. This study focuses on research published between 2014 and 2019; earlier publications were included when relevant.

Theoretical Framework Discussion

The theoretical framework selected for this study is based on the student retention theories of Tinto (1975, 1993, 2006), as well as those of Astin (1984), Bean (1980), Braxton (1999, 2008), Harris (2006), Scott-Clayton (2011), and Seidman (2005). The seminal work on student retention theory was posited by Tinto (1975), who conceptualized college student departure as a social process based on the student's interaction with academic and social systems of the institution. Tinto's interactionalist theory, developed from a theoretical model of suicide, gained paradigmatic status as a basis for understanding college student departure. Tinto noted that in addition to social interaction, an individual student's characteristics, background, and experiences might influence departure.

Astin (1984) described the student involvement theory of development based on physical and psychological involvement in the academic experience. In contrast with traditional pedagogical approaches of subject matter, resource, and individualized eclectic theories, the author proposed that the more a student became involved in campus activities, organizations, and interactions with other students, the higher degree of individual development and learning. Astin's (1984) theory is congruent with Tinto's interactionalist theory that social interaction and integration are fundamental principles of the overall academic experience.

In later work, Tinto (1993, 2006) encouraged an emphasis on the social and academic involvement of students with school staff, officials, and other students. Integrating interactionist theory with academic factors, Bean (1980) adapted a causal model of employee turnover in work organizations to examine relationships between variables related to student attrition in institutions of higher education. This study identified a predictive relationship between GPA and higher student retention rates. The author concluded that students not achieving academic success, as illustrated by GPA, demonstrated lower levels of institutional commitment and a greater tendency to drop out.

Harris (2006) noted the congruence of interactionist theory with academic factors. The author observed that academic performance and success were related to increased student sense of development and formation of personal bonds and supportive peer relationships or cohorts, resulting in higher retention rates. Research on curricular structure and course sequencing demonstrated an association between a cohort format with closed admission, where students remain together for their courses, and group cohesiveness. The resultant interpersonal support among students was associated with retention and degree completion (Harris, 2006). This dynamic is consistent with Tinto's (1993, 2006) revisions of interactionist theory to include the integration of basic courses as a means of promoting academic success.

Braxton (2008) described academic attainment, assessed by course-level learning, as an indicator of college success that contributed to student retention. Braxton's findings supported Tinto's (2006) assertion, which promoted the use of the classroom as an environment for translating theory into practice with the goals of higher student retention and academic success. Revising Tinto's (1993) and Braxton's (1999) theories of student departure and social interaction, Braxton et al. (2000) identified student levels of commitment to the institution as

being reflective of the level of student social integration into the college community. Student levels of commitment, in turn, were found to be associated with student persistence, retention, and success.

Taking the concept of course structure and social integration a step further into practice, Silverman and Seidman (2011) designed a curriculum integrating arithmetic and algebra courses into “10 hierarchical and sequential modules, with the first module covering basic arithmetic of whole numbers” (Silverman & Seidman, 2011, p. 270). This curriculum structure model stems from Seidman’s (2005) retention theory focused on early identification of and intervention for at-risk students. Students enrolled in the Math My Way (MMW) program, a sequential pathway of math courses arranged in a hierarchical framework, “showed improved progression in their math courses relative to the control group” (Silverman & Seidman, 2011, p. 275). Quantitative analysis of data from the MMW treatment group and the control group revealed that students in the MMW treatment group were more likely to progress to college-level math courses and also demonstrated a higher cumulative math GPA than those in the control group. This example combines the concepts of academic success and curricular sequence and structure, demonstrating congruence with Seidman’s (2005) retention theory, and expanded the persistence theory of Braxton et al. (2014, as cited in Hepworth et al., 2018).

The persistence theory of Braxton et al. (2014) reflected, revised, and extended Tinto’s interactionist theory. In addition to student social interaction and integration, other variables found to be significant in student persistence and success included first-year GPA and student perceptions of institutional integrity and commitment to student success. The retention theories of Tinto, Seidman, and Braxton were supported in research by Scott-Clayton (2011). The author described a *structure hypothesis* that related student retention and success to structured curricula.

Numerous studies carried out worldwide indicate the ongoing problem of attrition and the significance of understanding student retention in institutions of higher education (Beauvais et al., 2014; Dewberry & Jackson, 2018; Kinzie & Kuh, 2017). Tinto (1993) called for research that “sheds light on the types of programs and institutional practices that lead to successful implementation of programs...” (p. 10). Future inquiry into course structure and academic success that focuses on identifying the effects of specific institutional practices is needed (Dewberry & Jackson, 2018; Seidman, 2005). Therefore, examining these variables in this study is consistent with Tinto’s recommendation that program improvement and validation be assessed by formative, and in the future, longitudinal and summative evaluations.

Student retention and success are critical objectives of health professions programs and issues of concern for educators, students, and parents. Successful graduates of these programs are essential assets to healthcare service employers in the community, as well as the community at large. Although students taking community college HPRS courses have the same goals of graduating from health professions programs, the wide variations in the effectiveness of prerequisite preparation can compromise their likelihood of retention, acceptance, and admission to the programs.

Education requirements for healthcare professionals vary. Certificate, diploma, associate degree, bachelor’s degree, and master’s and doctoral-level degree programs are present in a range of professions and services related to the specialty of each discipline (Bureau of Labor Statistics, 2019). Standards required by each area of specialization determine the curricula provided by the educational and training programs. Curricula vary in each discipline related to the level of expertise required but typically consist of didactic content combined with laboratory and skills acquisition evaluations based on guidelines and standards required by national

accrediting agencies (American Medical Association, 2012; Commission on Accreditation of Allied Health Education Programs, 2018). Graduates of the programs are then eligible to obtain certification or licensure by completing state or national examinations. The increasing demand for trained healthcare professionals calls for increasing supply by increasing enrollment in health professions programs and ensuring that students who enter health professions programs succeed in completing the programs and in passing the national certification examinations in each discipline.

In response to the summative objectives of institutions to educate and train healthcare professionals, an increased inquiry is underway to identify and understand the retention, attrition, and academic success of students in health science programs. Increased pressure on health professions programs to raise enrollment brings up the problem of increasing retention. Concepts and observations related to college student departure have been topics of research and prompted the formulation of theories addressing student retention. The theories and models cited in this study apply to address the ongoing problem of student retention at institutions of higher education. Beginning with Tinto's 1975 interactionist theory, works of other authors cited provide a literature-informed examination of how theories and models of student retention and academic success have undergone revision and extension.

Increasing Need for Healthcare Workers in the United States

As the U.S. baby boomer generation ages, the national need for care for the aging increases, as does the demand for caregivers (Juraschek et al., 2012; Marquand & York, 2016). As a result, the U.S. Bureau of Labor Statistics (2019) projected employment in healthcare occupations to grow 14% between 2018 and 2028, adding approximately 1.9 million new jobs: more jobs than any other occupational group. This trend is exacerbated by increasing numbers of

aging healthcare professionals retiring, contributing to the need for replacement and supplementation of the supply of healthcare workers, particularly licensed professionals practicing with credentials such as a certificate or a degree. Studies predict shortages of a half-million to one million registered nurses (RNs) across the United States by 2030, which significantly exceeds the current shortage (Dickson, 2015; Juraschek et al., 2012; Zhang et al., 2018).

Increasing the number of graduates from community college nursing programs who pass national licensing exams is a means of addressing projected shortages (Khan, 2015). The role of community colleges in supplying graduates in the nursing profession workforce is significant. The increasing shortage of RNs reflects the problems of supply and demand across the spectrum of healthcare professionals. The nursing profession is unique in that several levels of credentialing exist; RNs undergo education and training at the associate's or bachelor's degree levels, though graduates at both levels are required to take the National Council Licensure Examination for Registered Nurses (NCLEX-RN). Attrition rates in two-year associate and four-year baccalaureate nursing programs range from 20% to 50%, exacerbating the significant shortage (Beauvais et al., 2014). Associate degree nursing (ADN) programs at community colleges are a "significant factor for balancing the demand and supply of the healthcare workforce" (Staykova, 2012, p. 93). Because the demand for graduates is very high, open spots in nursing programs are minimal, and attrition rates exceed 20%, admission criteria for these programs have come under increased scrutiny concerning student retention and academic success (Pence, 2011).

The demand for nurses has resulted in pressure on nursing schools across the United States to decrease attrition and to increase graduation rates. The problems of supply and demand

in the nursing education paradigm include graduating qualified students on time (progress at the expected length of time), who achieve first-time success on the NCLEX-RN examination. This issue is significant relative to the large number and percentage of NCLEX-RN applicants holding an Associate Degree in Nursing (ADN; Staykova, 2012).

Problems with the supply of students and demand for qualified graduates and success in first-time certification examinations in the nursing profession are relevant across the spectrum of the allied health professions as well. Adding to the complexity of the overall supply and demand problem for nurses and allied health professionals, the increased pressure to optimize national certification examination pass rates has prompted inquiries into admission policies and processes. This problem has resulted in more emphasis on the application of evidence-based admission criteria for health professions programs (Hinderer et al., 2014).

Allied health professions currently comprise a large percentage of healthcare jobs and are expected to occupy approximately over three million jobs by the year 2020 (Carnevale & Smith, 2013; Raman, 2013; Rogers, 2010). The term allied health refers to a wide range of healthcare professions other than medicine or nursing, offering preventive, diagnostic, and rehabilitative therapies. Healthcare specialists include but are not limited to audiology, dental hygiene, occupational therapy, physical therapy, and speech and language pathology, and practice in such settings as clinics, hospitals, rehabilitation centers, schools, and community agencies (American Occupational Therapy Association, n.d.; Thomas et al., 2011). The U.S. Bureau of Labor Statistics (2019) has documented over 45 allied health specialties in the healthcare professions requiring education at the levels of certification, associate, and bachelor's degrees.

A unique problem on the supply side in this context is the lack of familiarity of many postsecondary students with the vast array of career possibilities in allied health professions.

Understanding of the roles of physicians and nurses in the healthcare professions is widespread, but fewer students are informed of and understand the many career possibilities in the allied health professions. A quantitative study of 720 young adults between the ages of 18 and 24 found that the test group perceived allied health professions such as pharmacy and radiologic technology as less desirable than other professions such as nursing (Palumbo et al., 2008). The authors attributed these perceptions as being related to the lack of media portrayal and marketing of allied health profession careers, emphasizing the need for strategies directed at student recruitment and retention.

Allied health professions, much like medicine and nursing, are faced with the dynamic of increasing numbers of professionals retiring from practice across a range of specialties. Concomitant with increasing levels of healthcare demand from a generally aging population, the effect of demand outpacing supply multiplies, as observed in a mixed-methods study of 692 students from four-year colleges and 431 students from two-year colleges (Barfield et al., 2011). As a result of shifting demographics related to aging in the population in general and in health professions in particular, allied health professions will see continued employment growth, increasing employment opportunities for program graduates (Barfield et al., 2011). A component of the growth potential also noted by the authors is the licensure and certification requirement of allied health professions requiring graduation from postsecondary institutions.

Other influences increasing demand and exacerbated by the shortage include higher patient survival rates secondary to technologically advanced medical intervention. The demand for qualified healthcare professionals has increased in response to higher numbers of outpatient care centers and facilities such as dialysis centers, radiology centers, home health services, outpatient emergency facilities, and surgery centers (Bureau of Labor Statistics, 2019).

Increasing numbers of outpatient facilities and physician offices are moving to suburban and rural communities, causing higher demand in those areas for physicians, nurses, and allied health professionals.

Workforce dynamics in allied health professions are similar to those of nursing. Since allied health professions are not generally as well known to the public and specifically not marketed to the same extent as nursing, the need for allied health professionals continues to grow. Reflective of this dynamic is the demand for occupational therapy (OT) services. The current OT workforce of approximately 159,000 active practitioners in the United States does not meet current needs, especially in the specialized care areas of pediatrics, geriatrics, and rural health (American Occupational Therapy Association, n.d.; Dickson, 2015). Similarly, research on physical therapy (PT) services found that demand continues to outpace supply. A study by Zimelman et al. (2010) used a research model of forecast and grading methodology previously applied to nursing to examine PT supply and demand and observed that shortages of physical therapists in the United States would increase nationwide with severe shortages predicted in most states by the year 2030.

Using univariate regression analysis, Lin et al. (2015) documented a nationwide shortage of social workers, most evident in serving the elderly population. The disproportionately aging population and increased attrition contributed to significant workforce shortages. In occupational therapy, physical therapy, and other allied health professions, institutions of higher education have a critical role in filling community needs for healthcare providers.

Outside of the nursing profession, associate degree programs based at community colleges produce a significant number of allied health professions workers. However, enrollment in allied health programs is limited for reasons including students failing to meet minimum

admission criteria (Barfield et al., 2011). Although community colleges in the United States enroll the most significant percentage of undergraduates, the rate of full-time community college students completing an associate's degree in three years stands at less than 30% (Rath et al., 2013). Community college allied health professions programs face the same challenges as nursing schools of increasing enrollment, retention, and graduation rates. Enrollment in community college allied health programs has not kept up with demand. Accordingly, the supply of qualified graduates in allied health and nursing professions potentially will not be enough to meet the need for practitioners (Flores & Simonsson, 2012).

Failing to optimize student opportunities to attain allied health and nursing degrees and certifications has multilevel consequences. Stakeholder students in the community have decreased potential opportunities, and fewer graduating healthcare professionals are available for staff positions in healthcare facilities in the community, affecting stakeholders in the general population. To meet the growing need for healthcare professionals, programs at the graduate, four-year university, and community college levels use various preadmissions criteria. Admissions criteria are program-specific secondary to the increasing number of specialized allied health programs.

Cognitive and noncognitive criteria are used to select applicants; no standard criteria are applied exclusively due to a large number of accrediting agencies in allied health programs. Cognitive criteria include preadmission GPA including high school GPA in some cases, the Graduate Record Exam (GRE), American College Testing (ACT), Scholastic Aptitude Test (SAT), Test of Essential Academic Skills (TEAS), and preadmission exams such as the Health Education Systems Incorporated Admission Assessment (HESI A2; Barfield et al., 2011). Noncognitive criteria include personal interviews, self-appraisals, and reference letters. The main

goal for nursing and allied health programs in South Community College context is to use these criteria to select students who will succeed in the didactic and clinical preparation processes and in passing national accrediting board examinations.

The demand for qualified graduates in the healthcare professions is increasing nationwide, with indications that the supply of graduates will continue to fall short of demand for years to come. In addressing this problem, health professions programs across the United States are expanding programs to facilitate increased enrollment and graduation rates. Admission criteria for nursing and allied health programs vary. A review of the literature reveals that prerequisite GPA is a primary admission criterion in many health professions programs. The consideration of admission criteria as predictors of academic success relates to theories of academic success as being predictive of student retention. The curricular structure is predictive of success in academic disciplines, including psychology and English courses as well as science, technology, engineering, and mathematics (STEM) curricula. Linking these phenomena are theories of academic success as predictive of student retention.

Admission Criteria as Predictors of Academic Success

The theoretical framework of academic success (Braxton, 2008; Scott-Clayton, 2011; Seidman, 2005) and student retention (Astin, 1984; Tinto, 1975, 1993) introduced in Chapter 1 is reinforced in the literature by studies relating admission criteria to student success and retention. Education requirements in healthcare professions programs vary between the certificate, diploma, associate degree, and bachelor's degree programs. The core subject matter curricula reflect the requirements of each program's specialty. However, prerequisite courses required for application and admission to the programs typically include basic health science courses including Anatomy and Physiology I, Anatomy and Physiology II, Medical Terminology,

Pathophysiology, and Pharmacology. At South Community College, students must meet a minimum standard GPA of 2.5 to apply to the programs.

Extensive research exists which identifies admission criteria that are predictors of academic success and explore the relationships between criteria associated with reduced attrition rates and increased graduation rates in healthcare professions programs. In a quantitative study of 157 nursing students at a public two-year college, Knauss and Willson (2013) identified positive correlations between admission criteria and student success. The authors extrapolated academic success as being predictive of increased program graduation rates. The implications of this study relate to the significance of GPA as an admission criterion predictive of academic outcomes and the applicability of these criteria in applicant selection processes.

A quantitative study of predictors of academic success in an ADN nursing program by Trofino (2013) analyzed the relationship between prerequisite courses and advanced nursing courses. The study revealed a statistically significant relationship between performance in these courses and the successful completion of the NCLEX-RN examination. The study further demonstrated that students passing the prerequisite Pharmacology course were 11 times more likely to pass the NCLEX-RN examination. The author also described a statistically significant relationship between the letter grade earned in the prerequisite Pharmacology course and passage of the NCLEX-RN examination.

Using logistic regression analysis to examine admission criteria, Bennett et al. (2016) found preadmission GPA, science GPA (SGPA), and HESI A2 Anatomy and Physiology scores to be significant predictors of academic success in a study of 586 applicants to a Bachelor of Science in Nursing (BSN) program. A predictive selection model based on the statistical analysis of these preadmission variables demonstrated failure and graduation rates in the program studied.

The authors asserted that the use of the model developed would improve retention and graduation rates when compared to other selection criteria, including GPA and noncognitive criteria such as interviews and reference letters.

Hinderer et al. (2014) explored the predictive ability of admission criteria in a nursing program as measured by timely progression and first-time NCLEX-RN success. Using a retrospective descriptive design, the authors used logistic regression to examine variables including student gender, preadmission GPA, SGPA, nursing GPA, and HESI A₂ examination scores. Results revealed a significant correlation between both nursing GPA and HESI A₂ examination scores and NCLEX-RN success. However, while SGPA was found to be a significant predictor of timely progression, the evidence did not support the HESI A₂ examination as a significant predictor of timely progression.

In considering other academic variables as preadmission criteria for nursing programs, Wolkowitz and Kelley (2010) compared preadmission academic performance in mathematics and English courses to performance in science and reading courses and found the latter to be predictive of academic success. Similarly, Wambuguh et al. (2016) used data from 513 nursing students to examine the predictive effects of five admission criteria; preadmission GPA, preadmission university enrollment vs. college transfer, previous baccalaureate degree, TEAS score, and previous healthcare experience. Of the five criteria examined, only preadmission GPA and the TEAS scores were significant predictors of passing the NCLEX-RN exam after graduating. The studies by Wolkowitz and Kelley (2010) and Wambuguh et al. (2016) provided substantial evidence regarding the influence of admission criteria on academic success.

Cunningham et al. (2014) used quantitative analysis to evaluate admission criteria as defined by models of student selection in a nursing program. The first was a rational model

based on scores derived from noncognitive criteria such as interviews and subjective evaluation of candidates by a selection committee. In the second model, statistical techniques provided empirical data combining numerical predictors such as GPA, SGPA, HESI A2, and the Assessment Technologies Institute's Test of Essential Academic Skills (ATI-TEAS) into a formula-based score to guide the selection of applicants. Using regression analysis to compare these four admission criteria, the authors found ATI-TEAS scores and SGPA to be the stronger predictors of academic performance outcomes. The authors recommended the use of admission scores derived from data-based statistical methods in the development of admission criteria.

While the ATI-TEAS and GPA demonstrated significant predictive effects when evaluated together, the ATI-TEAS scores evaluated separately did not have the predictive value of a regression-based formula score. Instead, the overall GPA demonstrated a significant association with program academic outcomes and SGPA as particularly predictive of academic success. This result is consistent with other studies cited indicating GPA as a central component in considering admission criteria in health professions programs.

Manieri et al. (2015) used logistic regression in a study to determine which three preadmission examinations were most predictive of successful completion of an associate degree nursing (ADN) program. The authors noted that between two cohorts tested ($N = 339$), no statistically significant differences in preadmission GPA existed. However, two of the preadmission examinations showed statistically significant differences in predicting program success. Noting this phenomenon, the authors asserted the need for further examination of preadmission variables as predictors of academic success.

The studies cited have the commonalities of quantitative evaluation of data, predominantly using regression analysis to determine the predictive value of a range of

admission criteria including both noncognitive and cognitive variables. A common theme noted in reviewing the literature was the assertion by most of the authors of the need for further study specific to the healthcare professions. The focus in healthcare professions education is on increasing demand, diminishing educational resources, the pressure to optimize completion, graduation, and board examination pass rates in nursing and allied health professions programs.

In this regard, examination and identification of reliable and predictive admission criteria are increasingly significant to society. Further study may aid in demonstrating which criteria are most appropriate as determinants of preprogram curricula and admission criteria directed at optimizing student retention and success by improving selection processes. The consistency of the outcomes of these studies specific to GPA as a reliable predictor of academic success in nursing programs highlights the need for further examination of the use of GPA as a reliable admission criterion for allied health professions programs. However, the HESI A2 examination did not demonstrate the same degree of reliability as a predictor of academic success in nursing programs as GPA (Cunningham et al., 2014; Hinderer et al., 2014; Meagher et al., 2011; Sanderson, 2014).

While using the same general admission criteria as nursing programs, admission criteria for allied health programs vary across the range of specialties, and various disciplines use two or more criteria as potential predictors of student success. Allied health professions programs use various admission criteria to meet the requirements set by accrediting agencies in each specialty (Barfield et al., 2011). The criteria applied to admission standards are not consistent between institutions or even between programs within institutions, and research specific to community college allied health professions programs is limited. Increasing workforce demands have

prompted community colleges with allied health professions programs to increase enrollment; as a result, admission standards vary between programs and may not be consistently applied.

Preadmission criteria including GRE and HESI A2 exam scores, as well as SGPA, have demonstrated reliability in several studies as tools for selective admission in identifying students most likely to complete a program (Mancuso & Udalis, 2012; Vealé et al., 2017). In contrast, other studies have yielded empirical evidence of the lack of consistency of preadmission examinations as reliable predictors of academic success. The need for identifying a reliable predictor of academic success as a student selection criterion for health professions programs applies to other health professions programs in that the number of applicants exceeds the available spaces. Thus, a student who is not successful in a program leaves an opening that remains unfilled. Reliable admission criteria are critical factors in reducing attrition and increasing graduation rates. The consistency and success with which students progress through degree programs have a positive influence on graduation rates (Slim et al., 2016).

Abundant studies are extant on two-year ADN and four-year BSN nursing programs. However, a limitation noted in the literature review is a relative lack of studies directed at the vast array of allied health programs. In addition to admission criteria and curricular structure, variables noted that could affect academic outcomes include demographic characteristics, family background, financial status, and individual ability. Despite these limitations, the significance of preadmission academic criteria such as GPA as a predictor of academic success in various disciplines is well documented. In a study of 105 engineering students at Istanbul Technical University, Calisir et al. (2016) considered variables including ALES scores, English proficiency exam scores, undergraduate GPA (UGPA), concurrent employment, and gender. The researchers

found UGPA to be the key determinant of academic success. Calisir et al.'s (2016) study was specific to the analysis of graduate GPA as the variable used to measure academic success.

Evaluating academic performance in respiratory therapy programs, Ari et al. (2008) studied the relationship between admission criteria of science GPA (SGPA), nonscience GPA (NSciGPA) and cumulative GPA (CumGPA), and student success on two certification examinations, the certified respiratory therapist (CRT) and the written registry for respiratory therapist (WRRT). A longitudinal study of 375 students over 10 years using Pearson product-moment correlation coefficients demonstrated a statistically significant relationship between all of the admission criteria tested and student scores on the CRT and WRRT examinations. In examining the predictive relationship between the variables of admission criteria and examination performance, multiple regression analysis revealed none of the admission criteria to be predictive of student success on the WRRT examination. However, SGPA and CumGPA were not predictive of student success on the CRT examination. Based on these findings, the authors recommended the use of GPA as admission criteria for respiratory therapy programs (Ari et al., 2008). Studies have demonstrated the validity of GPA as admission criteria and as predictors of academic success across the range of health professions programs including dental hygiene, nurse anesthesia, nursing, optometry, pharmacology, radiologic technology, and respiratory therapy (Austin, 2011; Bennett et al., 2016; Buckingham & Bush, 2013; Eiland et al., 2018; Ingrassia, 2016; Parrott-Robbins, 2010; Sanderson, 2014; Wambuguh et al., 2016; Wilson et al., 2015).

Research has demonstrated preadmission GPA to be a predictor of undergraduate retention and graduation, and as such, an essential component in addressing the overall problem of providing increasing numbers of qualified health professions graduates to the communities

served. Examination of predictor variables across the broad spectrum of health professions programs is needed to direct future innovations designed to optimize academic outcomes and student opportunities for application and admission. For example, studies specific to the discipline of dental hygiene examined predictive reliability of preadmission variables. The studies examined incoming college grade point average (I-GPA), SAT scores, incoming college math/science GPA (MS-GPA), Dental Hygiene National Board score (N-BRD), and dental hygiene GPA at graduation (DH-GPA; Austin, 2011; Bauchmoyer et al., 2004; Downey et al., 2002). Results revealed that incoming college grade point average (I-GPA) was the most reliable predictor of success in the N-BRD exams. Other studies of dental hygiene programs revealed positive predictive relationships between college GPA and student retention, as well as GPA and National Dental Hygiene Board Examination (NDHBE) scores (Austin, 2011; Sanderson, 2014). Other variables examined included ACT scores, microbiology lecture grades, English grades, and student age.

A study of cognitive and noncognitive admission criteria in dental hygiene programs revealed three variables as statistically significant predictors of academic success. These include (a) interviews, (b) high school GPA, and (c) college GPA. Interestingly, the study found standardized tests such as SAT and TEAS, when not used as preadmission requirements, retention rates increased. The author recommended interviews, high school GPA, and college GPA for use as criteria in student selection processes (Sanderson, 2014).

While not the only specific variables predictive of academic success, cognitive criteria, including GPA, are nonetheless consistently used and studied. In an examination of other allied health disciplines, Buckingham and Bush (2013) found undergraduate GPA to be predictive of academic success in an optometry program. Studies comparing the Pharmacy College

Admissions Test (PCAT) to GPA have yielded results indicating GPA as a more likely predictor of academic performance.

In a study focused on improving admissions methods in pharmacy programs, Eiland et al. (2018) examined admission criteria including cumulative GPA, SGPA, and PCAT scores. The study also considered covariables of interview scores, prior degree, initial deferred admission, and campus assignment. The study included 417 students over three years at a school of pharmacy; linear regressions compared the variables. Initial deferred admission demonstrated a negative correlation with academic outcomes; prepharmacy cumulative and SGPA, as well as PCAT composite and chemistry scores, were found to be predictors of program success.

Similarly, a study by Meagher et al. (2011) used multiple regression analysis to compare admission variables in 22 pharmacy programs ($N = 2,224$). PCAT scores, preadmission GPAs, first-year pharmacy program GPAs, and demographic variables were examined, including date of birth, native language, parent's level of education, racial/ethnic identity, sex, previous level of two-year or four-year college, the public or private school most recently attended, and previous degrees earned. The authors found no statistically significant demographic predictors of first-year pharmacy GPA. The results confirmed predictive validity between PCAT scores and first-year pharmacy program GPAs. The authors note that the validity of PCAT scores in predicting first-year pharmacy GPAs increased when considered in conjunction with preadmission GPAs.

In a retrospective study of the relationship between academic performance in preprogram science courses and academic success ($N = 424$), McCall et al. (2006) found a statistically significant relationship between successful completion of undergraduate biology and chemistry coursework and GPA for students in their first year in a doctor of pharmacy program. The authors noted the potential for application of similar studies to determine prerequisite

coursework requirements and for assessment of admission requirements in other pharmacy programs.

Unni et al. (2011) used retrospective analysis to study admission criteria in a pharmacy program. The findings showed that preadmission GPA, particularly in math and science courses, a previous bachelor's degree, and age were statistically significant predictors of academic success in the first year of the program. The authors noted interview scores were not statistically significant predictors of academic performance.

Ari et al. (2008) and Sperle (2013) studied admission criteria for respiratory therapy programs, including SGPA, NSciGPA, and cumulative GPA. Consistent with studies in other healthcare professions contexts, these studies revealed SGPA and cumulative GPA as the most reliable indicators of success on the certified respiratory therapist examination. Viewed from a different perspective but reflective of the same phenomenon, Schauner et al. (2013) found lower preprogram cumulative math and science GPA to be associated with poor academic performance as measured by grade attainment in a pharmacy doctoral program.

Research on admission criteria comparing preadmission SGPA and GPA and preadmission testing documented GPA as having the most consistent relationship with academic success (Baker et al., 2016; Burns, 2011; Hinderer et al., 2014; Mancuso & Udilis, 2012; Manieri et al., 2015; Ortega et al., 2013; Raman, 2013; Schmidt & MacWilliams, 2011; Shulruf et al., 2011; Stegers-Jager et al., 2015; Wilson et al., 2015). Studies of GPA as predictors of student progression, retention, and graduation are extant in both baccalaureate and associate degree nursing programs. Timer and Clauson (2011) compared preadmission GPA scores with noncognitive variables such as supplemental application and interview scores to determine if the noncognitive variables held the same level of predictive ability of student success as GPA in a

baccalaureate nursing program. While preadmission GPA scores demonstrated consistent predictability of student success, neither the supplemental application nor the interview scores demonstrated predictive reliability; the authors recommended the use of preadmission GPA as the only criterion for admissions. Studies of noncognitive admission criteria such as preadmission interviews have covered an array of healthcare professions programs, including nursing, medical, dental schools, and dental hygiene programs.

Some studies reviewed suggested noncognitive admission criteria. While they are not consistently a statistically significant predictor of academic success in healthcare professions programs, they are nonetheless useful as predictors of nonacademic issues affecting program retention. Although studies found noncognitive admission variables such as reference letters to be valid predictors of student retention in some programs, the use of reference letters as an admission criterion is not widespread (Sanderson, 2014).

In a study of graduate programs of nurse anesthesia ($N = 435$), Ortega et al. (2013) explored a wide range of admission criteria. Noncognitive criteria included applicant essays, critical care experience, and applicant age; cognitive criteria included Graduate Record Examination (GRE) scores, Bachelor of Science vs. another bachelor's degree, and undergraduate GPA (UGPA). The authors found UGPA, specifically science and nursing GPA, to be most predictive of successful completion of the National Certification Examination for Nurse Anesthetists (NCE). The Graduate Record Examination was less predictive of NCE success, and student age demonstrated an inverse relationship with NCE scores.

Wilson et al. (2015) conducted a retrospective study in a nurse anesthesia program ($N = 180$), which compared noncognitive variables of age, sex, race, and years of nursing experience with cognitive variables of undergraduate nursing GPA, undergraduate science GPA, GRE

scores, and completion of organic chemistry or biochemistry with a 3.0 GPA within 5 years of matriculation. The authors observed higher program completion rates of students with higher undergraduate nursing GPAs and noted the occurrence of success to be proportional to each point increase in GPA. Graduate Record Examination scores also demonstrated association with student success, albeit to a lesser degree than GPA. Gender and age were determined to have a significant correlation with program success, with females and younger students completing the program in higher proportion to males and older students. Race, years of nursing experience, and biochemistry course completion were variables not found to be significantly related to student attrition (Wilson et al., 2015). In a 6-year longitudinal study, Stegers-Jager et al. (2015) found factors having a significant influence on medical students' completion of first-year courses included preadmission college GPA, age, and gender. Some variance in time to completion was found to be related to student age and gender. The authors found recent past performance, particularly first-year GPA, as the most reliable predictor of program completion within four years.

The studies cited provide a framework for comparison of the criteria widely used for admission to healthcare professions programs. Noncognitive and cognitive criteria have been studied and the relative strengths and weaknesses described. A majority of the programs studied use a form of GPA as a primary, and sometimes only, cognitive criterion used in the admissions process.

In comparison, some studies included scores on preadmission examinations such as the ATI-TEAS, GRE, ACT, SAT, and HESI A2 as admission criteria. While used in some programs, preadmission examinations are not significant predictors of academic success for students in healthcare professions as compared with GPA and not recommended for use as primary

admission criteria (Parrott-Robbins, 2010). Studies describe preadmission examinations as predictors of academic outcomes in healthcare professions programs. However, a review of the literature did not reveal studies relating the curricular structure or course sequence to preadmission examination scores (Eiland et al., 2018; Ortega et al., 2013; Wilson et al., 2015). Some studies noted that covariates of age and gender were associated with academic success (Ortega et al., 2013; Stegers-Jager et al., 2015; Wilson et al., 2015). Studies of programs using noncognitive admission criteria such as essays, interviews, volunteerism, self-concept, motivation, goals, and prior healthcare experience demonstrated these measurements as not having a significant relationship to academic success in contrast to cognitive criteria (Siemens, 2011).

This study takes into consideration the array of cognitive criteria, focusing on preadmission GPA in the health science prerequisites. The rationale for this choice is pertinent to the context of the problem of practice, a large community college with extensive health professions programs, and a requirement of prerequisite health science courses with a minimum GPA requirement for application. Using empirical processes to examine the use of GPA as an admissions criterion and as a predictor of academic success in health professions programs across the United States may yield results leading to a broader understanding of phenomena that apply to the specific practice problem at South Community College.

Academic success, in turn, is noted by student retention theorists such as Bean (1980), Braxton (2008), Harris (2006), Scott-Clayton (2011), and Seidman (2005), to be predictive of increased student retention and completion.

Curricular Structure and Academic Success

Studies focusing on the relationship between specific curricular pathway structures and academic success have been conducted extensively in the liberal arts, business, and science, technology, engineering, and mathematics (STEM) disciplines. Little data are extant in the research literature providing empirical evidence of the effectiveness of these interventions in health science curricula. Of particular concern in health professions programs is the orientation of the introductory and program STEM courses, which show higher attrition rates than general education courses (Bloemer et al., 2018). Bloemer et al. identified these courses as “gateway courses,” fundamental introductory classes required for further study (p. 109). Success in these courses correlated to a student’s prior GPA and was predictive of successful degree completion (Bloemer et al., 2018).

The current approach used in many community colleges is a *cafeteria-style* method in which the enrolling student can choose courses at random and without guidance or counseling, often unaware of the curricular progression needed to succeed. An inherent defect in the cafeteria model is the focus on courses rather than programs. Specific to South Community College context, the complex choices in a cafeteria model can lead to students being overwhelmed by the number of course choices available and making inappropriate course selections (Bailey et al., 2015; Scott-Clayton, 2011).

The admissions policy of South Community College is one of open access. Students enrolling from high school are at greater risk of being underprepared for college (Scott-Clayton & Rodriguez, 2015). Incoming students may also be unaware of counseling resources and thus lack awareness of the prerequisite course sequence and the curricular progression through the gateway courses for health professions programs. Students wishing to apply to health professions

programs may skip the gateway courses altogether and take more advanced courses without having had the fundamental instruction needed to understand and apply advanced concepts of Pathophysiology and Pharmacology. Time constraints and the amount of information involved in the decision-making process may also limit students in researching options for appropriate course selection (Scott-Clayton, 2011).

The description of the cafeteria model of enrollment as confusing and inefficient concurs with anecdotal evidence from interactions with students at South Community College. The lack of prescribed curricular structure often leads to student attrition by dropout or failure (Van Noy et al., 2016). A study by Bailey et al. (2015) found up to two-thirds of incoming students to be inadequately prepared for entry-level courses. In addressing this problem, community colleges are reevaluating and revising traditional curricular structures. However, “a one size fits all student success framework is not feasible or beneficial” (Kinzie & Kuh, 2017, p. 26).

While few studies are extant in the context of community college health sciences, studies document the relationship between curricular structure and academic success in other STEM disciplines. Recent studies have provided evidence of improved student performance associated with structured curricula and predesigned program pathways. In a dynamic similar to the healthcare professions, engineering programs face pressure to increase graduation numbers to meet an expanding job market. Educational institutions have responded with research aimed at identifying the existing problems and formulating and initiating innovations directed at improving outcomes.

A study of an undergraduate engineering program described curricular complexity as consisting of (1) “structural complexity, which is determined by the manner in which the courses in a curriculum are organized, [for example,] prerequisites, number of courses, etc.; and (2)

instructional complexity, which is determined by the inherent difficulty of the courses in the curriculum...” (Heileman et al., 2017, p. 10). The structural framework may vary, while the sequential, ordered courses form the traditional curricula, higher levels of student success occurred in courses linked in alternative patterns or *blocks* describing the sequence between developmental and advanced courses in the first year of college.

In a three-year longitudinal study of community college students, Scrivener et al. (2015) found that students enrolled in a program built around a block curricular structure demonstrated increased retention, graduation, and four-year college enrollment than students in a control group ($N = 896$). Using qualitative analysis of survey data to investigate the effects of curricular structure and sequence, Stoloff et al. (2010) studied patterns of prerequisite courses in undergraduate psychology programs ($N = 374$). The courses were classified as (a) required, (b) core group, (c) track courses, (d) capstone courses, and (e) electives. The authors observed the lack of ordered class structure to be problematic. The data revealed that students who enrolled in advanced courses benefitted from having taken basic courses before increasingly sophisticated course content in comparison with students enrolled in capstone or advanced courses before having completed fundamental coursework. The authors recommended the implementation of *scaffolding*, strictly enforced prerequisite programs as used in other disciplines such as biology, chemistry, and physics, to reinforce the development of a baseline of content comprehension.

Institutions of higher education in the United States face ongoing problems with underpreparation of incoming students. A retrospective study review by Bailey and Smith Jaggars (2016) of strategies developed to identify and assess factors of cognitive and noncognitive readiness and institutional approaches to remediation suggested a curricular reform agenda. A central part of the strategies directed at comprehensive reform focused on the

alignment of curricula with the student's program of study. The authors described a program at the City University of New York, which provided dedicated student advising and blocked, structured course pathways. A follow-up study of the program revealed graduation rates of program students nearly doubled over the control group (Scrivener et al., 2015). Similar structure and sequencing of prerequisite courses in beginning college students improved a student's likelihood of completing math and English courses. As a result, the authors recommended the reform and redesign of course-choosing methods to focus on curricular sequence and alignment (Bailey & Smith Jaggars, 2016; Bailey et al., 2013).

In a retrospective study of a baccalaureate business school program, Claypool (2018) found students who deviated from recommended course schedules and sequencing to be at higher risk of attrition and delayed graduation. The author proposed the establishment of a default course combination, sequence, and schedule designed to optimize overall GPA and graduation rates. In their study of electrical engineering students, Kinzie and Kuh (2017) quantified the significance of course enrollment sequence and final GPA. The authors demonstrated the course sequence as having a significant influence on the final GPA. Course sequence demonstrated a statistically significant relationship to degree attainment and time-to-degree. A study on curriculum development using a computer algorithm developed by Xu et al. (2016) found a higher overall GPA and reduced time to graduation to be results related to course sequence planning. Slim et al. (2016) studied course sequence in groups who graduated with high GPAs versus students who graduated with lower GPA scores. Results demonstrated a significant correlation between course sequence and GPA. Students in the low GPA values group tended to have followed course sequences that lacked structure and had "remarkable time gaps" and longer time-to-degree compared to student groups following structured course sequences

(Slim et al., 2016, p. 64). Results demonstrated a positive relationship between the prescribed curricular framework and higher GPA.

Studies in disciplines including chemistry, psychology, engineering, and political science, have investigated curricular sequence and academic success. Dunn et al. (2010) found success in undergraduate psychology courses to be related to the curricular sequence. Success in basic methodology courses provided understanding needed for success in later, more sophisticated courses. The authors recommended a curricular framework in undergraduate psychology programs, core content built on introductory courses, and directed at maximizing scholastic performance.

Research in the disciplines of biopsychology and engineering revealed a significant relationship between course sequence and academic success. In a 6-year longitudinal study of an undergraduate psychology program ($N = 2,313$), Betancur et al. (2019) concluded that even slight changes in course sequence had significant effects on academic performance. Course alignment and sequencing were found to be predictive of academic success as measured by GPA. The authors noted that students taking courses in research methods and biopsychology promoted success in later courses secondary to enhanced learning in the fundamental courses. The authors proposed a course sequencing template for this program based on these data, with extrapolation recommended to other undergraduate majors.

In a study of first-year college students, Hines and Henderson (2017) found retention rates to be higher for students taking general education courses in order than students taking the same courses out of order. Over 76% of students who took the courses in sequence graduated, compared to 57.9% of students who took the courses out of sequence (Hines & Henderson, 2017). The authors noted that aligning courses in scheduling patterns consistent with learning

outcomes ranging from general to more specific in a curriculum pathway facilitated transition in coursework from fundamental to more advanced learning. This observation is consistent with studies that have demonstrated that students connected new knowledge with previous knowledge most effectively in well-organized curricular structures. Considering the literature documenting success in other academic disciplines, students in healthcare professions programs in community colleges may show improved academic performance when provided with curricular options specifically designed to foster the progressive development of comprehension and skills.

Approaching course structure from a different perspective, decreasing the time-lapse between prerequisite and core pharmacotherapy courses was found to have no significant effect on GPA or Pharmacology College Admission Test (PCAT) scores in a Pharmacology program. The authors concluded that placing the course content at closer intervals was not a valid predictor of student success (Kelsch & Sylvester, 2016). In another pharmacotherapy program, a mixed-methods study demonstrated the effect of a planned course sequence on students who followed a course model with a curriculum formulated around a problem-based learning sequence. Students demonstrated significant improvement in academic performance following the prescribed course sequence over two years (Dolder et al., 2012). The literature documents relationships between course sequence and academic performance, particularly in the context of baccalaureate and graduate programs in STEM, business, psychology, and pharmacology. Graduation rates as indicators of academic success showed correlation with curricular efficiency, and divergent and disorganized curricular pathways noted as being contributory to impeding student progress through prerequisite courses (Wigdahl et al., 2014). The phenomenon of course structure and academic success has even undergone study at the middle school and high school levels. In an ex post facto study ($N = 543$) of the effects of the self-directed course sequence, Lim

(2016) found that students with higher GPAs were more likely to complete the course by following a user-driven course sequence. Lim also noted that low ability students performed better with a progressive sequence structure, whereas high ability students were not affected by course sequence.

This study focused on the context of community college students taking health science prerequisite courses required for application to health professions programs. Studies describing curricular framework in terms of contextual structuring, in which a set of concepts combine with skill attainment that becomes increasingly sophisticated, have demonstrated positive outcomes in student retention (Stevens et al., 2013). In a study relevant to South Community College and career-technical college context, students taking courses in a prescribed contextual structure demonstrated higher exam scores and graduation rates compared to similar students in conventional course structures (Scott-Clayton, 2011). In her research on curricular structure, Scott-Clayton proposed a *structure hypothesis*, theorizing that a community college student's success is more likely in tightly structured curricular programs. Such curricular program structures leave little room for intentional or unintentional deviation from the pathway to completion and allow for the restriction of bureaucratic obstacles to enrollment. This hypothesis has its roots in Tinto's (1993) work on student persistence that recognized institutional as well as individual failures as phenomena leading to attrition. While some postsecondary students may relate structured curricula to high school and be resistant and unmotivated, Scott-Clayton (2011) observed that studies in other disciplines, including economics and psychology, have yielded evidence of the success of limiting student enrollment choice in favor of structured curricula.

Summary

The need for healthcare professionals in the United States is increasing and is projected to continue. Community colleges provide a large proportion of healthcare professions graduates and have increased programs and enrollment to address community needs (Barfield et al., 2011; Carnevale & Smith, 2013; Raman, 2013; Rogers, 2010). Subsequently, admissions policies and processes have been subject to scrutiny, including noncognitive and cognitive admission criteria for health professions programs. While cognitive criteria such as GPA, GRE, HESI A₂, TEAS, and SAT examinations have been evaluated in quantitative, qualitative, and mixed-methods studies, preadmission GPA turns out to be the most consistently used and reliable admission criterion in several academic disciplines. Subsequently, GPA is consistently used as a primary admission criterion in health professions programs. The literature reveals that admission criteria like GPA and SGPA are associated with academic success in health professions and other programs as noted in previous sections.

The literature documents the increasing need for healthcare professionals in the United States. Extensive research is extant on the use of GPA as an admission criterion and the relationship between preadmission criteria and academic success in healthcare professions programs. Another influence on academic success is course structure; the research results indicate careful structuring of curricular frameworks results in increasing retention and higher academic outcomes. These findings are consistent with the theoretical framework of Scott-Clayton (2011) describing the relationship between course structure, academic outcomes, and student retention.

The increasing need and decreasing supply of healthcare professionals in the United States has put pressure on healthcare professions programs to increase enrollment and graduation

rates to increase supply. This phenomenon is particularly relevant at South Community College, where the application of students for admission to the health professions programs is dwindling. Community colleges train more than half the nation's healthcare workforce and are increasing health professions program enrollment in response to this demand. The literature reviewed in this study delineates this problem. The lack of systematic, organized enrollment of students in health professions prerequisite courses is problematic at South Community College. In this institution, a need exists for further investigation of admission criteria in health professions specific to the programs offered by the college.

Improving academic outcomes as measured by increasing student PGPA's has the effect of increasing the number of students eligible for application and admission to health professions programs. Variables related to healthcare professions application and enrollment include the relationship between admission criteria and academic success, use of GPA as a primary admission criterion in different disciplines, and the relationship between curricular structure and GPA. Aging of the population and the retirement and decreasing supply of healthcare professionals are current phenomena resulting in shortages of nursing and allied health professions graduates from community college programs. Admission criteria for health professions programs, as demonstrated in the literature, tend strongly toward the use of GPA as an essential admission criterion. The literature also yielded much evidence of GPA as a significant predictor of academic success in many disciplines studied. Bennett et al. (2016) pointed out that although admission committees have exerted great effort to find means of selecting students most likely to graduate, only a limited number of studies have examined GPA in first-year courses as an admission criterion in health professions programs.

Structured curricular frameworks are in place under a variety of names, including guided pathways, blocks, or completion practices. The shared characteristic is adherence to a prescribed framework of academic preparation based on building advanced knowledge on fundamental understanding. The literature documents orderly progression through structured curricular programs as influencing academic science outcomes. While evidence of this phenomenon is abundant in disciplines such as STEM, psychology, business, and liberal arts, the body of knowledge particular to the health sciences is lacking. Since health professions courses focus on science coursework, students may be at increased risk of attrition secondary to lack of curricular structure. Unsystematic enrollment of students in HPRS prerequisite courses at South Community College has far-reaching consequences in terms of effects at the student, faculty, college, and community levels. Capable students become discouraged, faculty are frustrated, health professions program enrollment suffers due to attrition, and community needs for qualified, well-educated and well-trained healthcare professionals fall short of fulfillment.

From a theoretical perspective, this review focuses on theories on student retention and studies by Astin (1984), Bean (1980), Braxton (2008), Harris (2006), Scott-Clayton (2011), Seidman (2005), and Tinto (1975, 1993). Studies by these authors have demonstrated that community college student persistence and success is related to phenomena of social interaction and integration and also on factors such as the relationship between curricular structure and academic outcomes. Evolving from a theoretical basis of social interaction to include incorporation of academic phenomena and the effects of academic outcomes on student retention, Scott-Clayton's (2011) structure hypothesis provided an integrative theory specific to the South Community College context addressed in this study.

Attrition affects all healthcare professions programs. Empirical evaluation of the variables of prerequisite course sequence and PGPA of health science students in South Community College can contribute information useful in addressing the increasing problem of growing workforce demand in healthcare professions. These data may then be made available to provide support for planning evidence-based interventions of curricular structure and admission criteria models directed at fostering student retention and graduation rates in health professions studies.

Chapter 3: Research Method

Demographic shifts in the U.S. population, in general, and in the healthcare professions workforce, in particular, contribute to current nationwide shortages of healthcare providers (Barfield et al., 2011; Hinderer et al., 2014; Juraschek et al., 2012). Studies document present shortages, projecting sustained scarcity of healthcare professionals into the future across a wide range of specialties (Dickson, 2015; Flores & Simonsson, 2012; Harahan, 2010). Burns (2011) noted the increasing societal need for healthcare and a critical shortage of providers and urged “refining admission criteria for the benefit of students, faculty, and society” (p. 200). Kaufman and Guerra-Lopez (2013) defined need as “a gap between current results and desired results” (p. 6). Currently, student enrollment in the health professions programs at a large community college in the southwestern United States falls short of supplying enough graduates to meet the increasing demand for healthcare practitioners in the large metropolitan community served by the college (Zimbelman et al., 2010).

In addressing this problem, the population targeted was incoming students taking health professions related science (HPRS) courses with the goal of admission to one of the health professions programs. The significance of prerequisite preparation as a determinant of academic success is documented in the literature (Ari et al., 2008; Cohen-Schotanus et al., 2006; Kelsch & Sylvester, 2016; Ortega et al., 2013; Stegers-Jager et al., 2015). Prerequisite grade point average (PGPA) is the average of the individual grade scores for HPRS courses. PGPA and science GPA are predictors of academic success widely used as admission criteria for allied health education programs (Bennett et al., 2016). Students with PGPA's lower than 2.5 are not eligible for admission to the healthcare professions programs.

The stakeholders at South Community College have identified the problem of unsystematic enrollment of students in prerequisite HPRS courses. As a result, many students may enroll in advanced courses before basic courses, which has led to students failing, dropping out, or not achieving a GPA sufficient for acceptance into the health professions programs. Resultant decreased admission rates to health professions programs affect stakeholders in that students have reduced opportunities to attain degrees and qualifications in healthcare professions programs, and the diminished supply of healthcare professionals affects community medical facilities' staffing needs. This study is consistent with one of the goals of South Community College to continue to provide well-trained healthcare workers to the community and meet the increasing demand in that industry (Carnevale & Smith, 2013).

Research Design and Methodology

This study was a combination of nonexperimental quantitative *ex post facto* causal-comparative and correlational research designs. Quantitative research designs use numeric data to analyze differences between groups and relationships between variables (Gall et al., 2010; Lund & Lund, 2013). Nonexperimental research is appropriate to conduct when the variables of interest cannot be manipulated and it is not possible to randomly assign participants to groups (Howell, 2013). In this study, it was not possible to randomly assign students to a course sequence; therefore, a nonexperimental approach was needed. Chen and Popovich (2011) noted the existence of a correlation between two variables does not imply causality. Therefore, a causal-comparative design was indicated to examine the data to explore the differences between the two independent and dependent variable groups. Furthermore, a combination of causal comparative and correlational designs was selected as this study's research design because the research aims involve both comparing groups and determining relationships between variables.

Specifically, Research Question 1 involves comparing the PGPA of students with different course sequences, and Research Question 2 involves determining if a significant relationship exists between HPRS course sequence and PGPA after controlling for age and gender. Therefore, a combination of causal comparative and correlational research designs was appropriate for this study.

The data gathered were used to test hypotheses regarding the relationship between the independent variables of HPRS course sequence, student gender and age, and the dependent variable of PGPA in students enrolled in HPRS courses at a large community college in the southwestern United States (Gall et al., 2010; O'Dwyer & Bernauer, 2014; Terrell, 2017). The final grades were recorded from courses limited to Medical Terminology, Anatomy and Physiology I, Anatomy and Physiology II, Pathophysiology, and Pharmacology. Grades from other concurrently enrolled courses were not included in the database.

The final course grades were selected according to the following criteria:

- Anatomy and Physiology I course final grade were defined as the highest grade received in the Anatomy and Physiology I course.
- Anatomy and Physiology II course final grade were defined as the highest grade received in the Anatomy and Physiology II course.
- Medical Terminology course final grade were defined as the highest grade received in the Medical Terminology course.
- Pathophysiology course final grade were defined as the highest grade received in the Pathophysiology course.
- Pharmacology course final grade were defined as the highest grade received in the Pharmacology course.

Population

The target population for this study included students who had completed HPRS courses at South Community College during the academic years 2014–2019. After approval from the Institutional Review Board (IRB; see Appendix A), the data were retrieved from archival transcripts of students having taken prerequisite HPRS courses over five years. To protect confidentiality, no information regarding individual or institutional identity were collected.

Population Sample

The sample for this study included 196 archival transcripts based on the inclusion criteria of students completing HPRS courses at South Community College in fall, spring, or summer semesters in the academic years 2014–2019. Stratified random sampling was employed to assure the data are consistent in the numbers and order of HPRS courses taken. The data were collected from student record archives maintained at South Community College. Each transcript was examined to determine the completion of the HPRS courses in sequence beginning with Medical Terminology or Anatomy and Physiology I; or out of sequence, beginning with Anatomy and Physiology II, Pathophysiology, or Pharmacology. The transcripts were divided into two groups according to the sequence of HPRS courses taken. Grade point averages for HPRS courses were calculated for each student record and entered into the database. De-identified archival data were implemented to achieve adequate sample sizes to power each statistical test. The targeted population was appropriate to the study problem and purpose insofar as the data to be gathered directly reflected the context of the existing problem at South Community College.

G*Power software was used to calculate the appropriate sample size for the study. The G*Power calculation for *one-way analysis of variance* (ANOVA) with a medium effect size, a power of .80, and an alpha level of .05 indicated a total sample size of 128 participants was

needed (64 in each group). For a multiple linear regression with three predictors, a medium effect size, a power of .80, and an alpha level of .05, the G*Power calculation indicated that 77 participants were needed. The total target sample size of the study was 196.

Materials and Instruments

Following approval from the Institutional Review Board (IRB) at Abilene Christian University and South Community College, data were collected from archival transcripts of students enrolled in HPRS courses in academic years 2014–2019 using two instruments (a) HPRS course sequence, a nominal level of measurement; and (b) PGPA, a ratio level of measurement, to provide a numerically scaled score that was used to measure academic performance in HPRS courses (Gall et al., 2010; Salkind, 2017; Trochim, 2006).

Data Collection and Analysis

After approval by the Abilene Christian University Institutional Review Board (IRB), the data collection process was implemented with respect to individuals and study site privacy. The data extracted from the transcript groups were de-identified and coded to assure anonymity and stored on a password protected Microsoft Excel worksheet to remain in the custody of the researcher (Leavy, 2017). The final course grades recorded on student transcripts were indicated with a letter grade. Letter grade values, as utilized by the study institution, were recorded from the transcripts selected and assigned a numerical value on a four-point scale. A letter grade of F was entered as 0.0; a letter grade of D was entered as 1.0; a letter grade of C was entered as 2.0; a letter grade of B was entered as 3.0; and a letter grade of A was entered as 4.0 for each HPRS class on each transcript and the HPRS GPA calculated accordingly. Only the GPA calculated from the final HPRS course grades was used. Grades from other concurrently enrolled courses were not included in the data. The GPA calculated from HPRS courses was labeled as

Prerequisite Grade Point Average (PGPA). The data were compiled from archival transcripts and divided into two sample groups for comparison.

HPRS Course Sequence

Two groups of data from student transcripts comprised the nominal-level independent variables (see Appendix B). The first group consisted of records from students having taken HPRS courses *out of* sequence coded as (X_0), the second group, from students having taken HPRS courses *in* sequence coded as (X_1). The X_0 group consisted of records showing that Pathophysiology or Pharmacology was taken before Medical Terminology or Anatomy and Physiology I and Anatomy and Physiology II. The X_1 group student records reflected a course sequence of enrollment in HPRS courses in the order of Medical Terminology and Anatomy and Physiology I and Anatomy and Physiology II followed by Pathophysiology or Pharmacology.

Prerequisite Grade Point Average

The dependent variable consisted of ratio-level data compiled from student records of grades in HPRS courses calculated and recorded as PGPA (see Appendix B). These data were divided into two sample groups for comparison, PGPA's of the group of students who took HPRS courses out of sequence, coded as (Y_0), and PGPA's of the comparative group who took HPRS courses in sequence coded as (Y_1).

Statistical Methods

The data were analyzed with the Statistical Package for the Social Sciences (SPSS) to determine statistically significant relationships between the HPRS course sequence and PGPA in health professions students at South Community College. Descriptive statistics were used to determine means, modes, and standard deviation of the two groups on the dependent variables (Salkind, 2017). Before the analysis of the research questions, the data were checked for missing

values and outliers. Any cases with missing values were removed from the data. Outliers were checked by computing standardized values for the PGPA scores. Tabachnick and Fidell (2013) suggested that standardized values greater than 3.29 in magnitude are indicative of outliers.

Outliers were removed prior to the analysis.

Inferential analyses using ANOVA were used to compare means between two groups of students in order to address the first research question.

RQ1: What are the differences between mean PGPA scores for students taking HPRS courses in a prescribed curricular sequence and those students taking HPRS courses out of sequence?

One-way ANOVA is appropriate to conduct when the research involves comparing two groups on a continuous dependent variable (Field, 2013). In this analysis, the groups being compared were the students taking HPRS courses in a curricular sequence and the students taking HPRS courses out of sequence. The dependent variable in this analysis was the PGPA score. To ensure the statistical validity of the ANOVA, the assumptions of normality and homogeneity of variance were tested. Normality was tested using a Shapiro-Wilk test, and homogeneity of variance was tested using Levene's test. If these assumptions are violated, a nonparametric alternative test (i.e., Kruskal-Wallis, Mann-Whitney U test) may be conducted. Statistical significance of the ANOVA was evaluated using an alpha level of .05. The evidence may support the null hypothesis, H_{10} , stating there is no statistically significant difference in the PGPA scores of students taking health science prerequisite courses in sequence compared to students taking health science prerequisite courses out of sequence. Alternately, the evidence may support H_{1A} , stating a statistically significant difference in PGPA exists between the two groups.

A multiple linear regression was used to address the second research question.

RQ2: Is there a significant relationship between HPRS course sequence and PGPA, after controlling for age and gender, among health science students at South Community College?

A multiple linear regression is appropriate to perform when the aim of the research is to determine the relationship between a continuous dependent variable and multiple independent variables or covariates (Field, 2013). In this analysis, the dependent variable was the PGPA score, and the independent variable was course sequence. The covariates (control variables) included in the regression were student age and gender. All variables were entered into the regression model in the same step. The regression coefficient for course sequence was evaluated at a significance level of .05 to determine if this variable significantly predicts PGPA scores after controlling for age and gender. To ensure the statistical validity of the regression, assumptions were tested. The assumption of normality was tested by examination of a Q-Q scatterplot. Homoscedasticity was tested by examination of a scatterplot of residuals and predicted values. Multicollinearity was tested by calculation of variance inflation factors. Stevens (2009) suggested variance inflation factors greater than 10 indicate multicollinearity is a problem. Evidence from the proposed study will either support H2₀: no predictive relationship exists between the sequence of health science prerequisite courses and PGPA; or H2_A: a predictive relationship exists between the sequence of health science prerequisite courses and PGPA.

Researcher Role

The researcher has no conflict of interest in the study. Subjectively, the researcher's experience with the problem of practice involves firsthand communications from students and faculty regarding the consequences of disorganized, unsystematic enrollment in prerequisite health science courses. Objectively, the researcher has a professional interest in analyzing the extent and nature of the identified problems with mega-level outcome goals of fostering student

and college success in supplying well-educated, well-trained healthcare professionals to the community.

Ethical Considerations

The ethical principles delineated in the Belmont Report of 1979 were observed. Respect for persons was observed in that no names or other identifying data were used in the compiled archival data file, access to which will remain limited solely to the researcher and appropriate faculty for three years following completion of the study. Since the study was based on archival data and privacy respected and guarded, the risk to any participants was reduced to a minimum, consistent with the principle of beneficence. The principle of justice was honored by the equal distribution of the benefits of this study to future students, the community, and healthcare consumers.

Assumptions

Assumptions for this study included the accuracy of the student records and the data gathered from the years specified extrapolate to other years in the HPRS curriculum. The sample of students was assumed to be representative of health professions students in other community colleges in the United States. It was assumed that external factors did not influence whether students failed exams, failed HPRS courses, or dropped out of HPRS courses.

Limitations

The calculated PGPA used in the study was limited to data compiled from records of students who have completed HPRS courses and excluded files of students who did not complete the HPRS courses. The data collection was limited to records from academic years 2014 through 2019. Students commonly enroll in HPRS classes simultaneously with general education and other courses; a collection of data from HPRS courses alone necessitated a non-random sampling

approach. Also, the study did not account for the effects of concurrent class load, differentiation of faculty, or for students who dropped HPRS courses before completion.

Delimitations

Since the data collection was delimited to a sample of health science students from a population selected from one institution, the results of this study may not be generalized to health professions programs at other community colleges, baccalaureate, or graduate health professions prerequisite programs. This study examined independent variables of HPRS course sequence, covariates of age and gender, and dependent variables of PGPA. Extraneous variables including ethnicity, socioeconomic status, and first time in college status were not included in this study (Gall et al., 2010).

Summary

This chapter described the methodology for a combination of quantitative causal-comparative and correlational designs to study the relationships and effects of course sequence on PGPA in students taking health science prerequisite courses at South Community College. A correlational design was chosen to determine the existence of a statistically significant difference in mean PGPA; the causal-comparative design was selected to examine the predictive influence of a single variable (course sequence) on academic success as measured by PGPA. The research questions and hypotheses proposed to investigate the relationship between the HPRS course sequence and PGPA in the two groups of students. A purposive sample was collected from the archival transcript records of students at South Community College enrolled in the academic years 2014–2019. SPSS statistics was used to determine the mean, mode, median, and standard deviation of two groups of variables. The independent-samples *t* test was used to determine if a statistically significant difference exists between the mean PGPA of the two independent groups

in the study population (Lund & Lund, 2013). Multiple linear regression determined the relationship between the independent variable of the HPRS course sequence and the dependent variable of PGPA, after controlling for age and gender.

This study was intended to provide empirical information regarding the effects of course sequence on academic success in community college students taking health professions prerequisite courses. The results may demonstrate whether changes in the prerequisite course structure are needed, including implementation of curricular framework strategies designed to improve academic performance, increase PGPA levels, and increase application and admission numbers to health professions programs. Increased admission and graduation rates from these programs may be instrumental in addressing the urgent need for healthcare professionals in the community.

Chapter 4: Results

The purpose of this study was to investigate the relationship between HPRS course sequence and PGPA, and the extent to which course sequence predicted PGPA after controlling for age and gender. Archival data of health science students at South Community College were used in a quantitative causal-comparative and correlational method to determine relationship between the independent and dependent variables. The independent variables examined in this study included HPRS course sequence and covariates of student age and student gender. The dependent variable was the grade point average of the students grouped according to the sequence in which the health science prerequisite courses were taken.

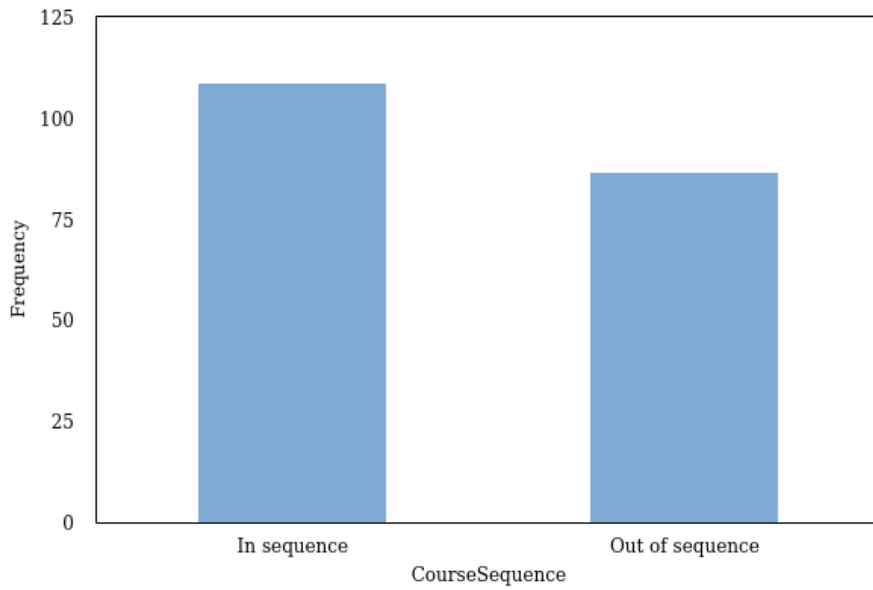
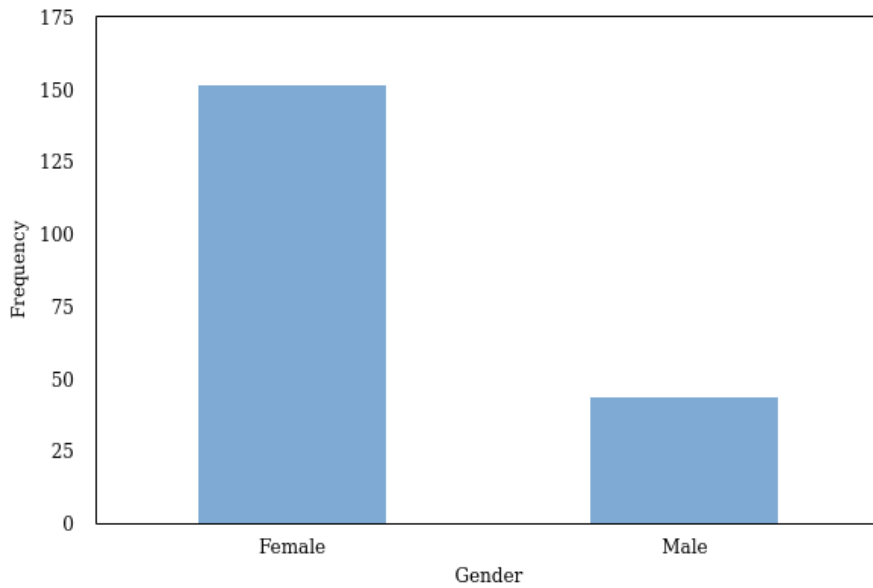
Descriptive Statistics

I calculated summary statistics for each interval and ratio variable. Frequencies and percentages were calculated for each nominal variable. The majority of students were in program plans that sequenced their courses ($n = 109$, 56%). Most of the subjects were women ($n = 152$, 78%). Frequencies and percentages are presented in Table 1. Figures 1 and 2 display bar plots showing the distributions of course sequence and gender, respectively.

Table 1

Frequency Table for Nominal Variables

Variable	<i>n</i>	%
CourseSequence		
In sequence	109	55.61
Out of sequence	87	44.39
Missing	0	0.00
Gender		
Male	44	22.45
Female	152	77.55
Missing	0	0.00

Figure 1*Barplot of Course Sequence***Figure 2***Barplot of Gender*

The observations for PGPA had an average of 3.07 ($SD = 0.90$, $Min = 0.00$, $Max = 4.75$, $Skewness = -0.91$, $Kurtosis = 0.12$, $Mdn = 3.33$). The observations for Age had a mean of 28.86 ($SD = 9.16$, $Min = 18.00$, $Max = 55.00$, $Skewness = 1.02$, $Kurtosis = .17$, $Mdn = 26.00$). Skewness greater than 2 in absolute value is considered to be asymmetrical about its mean. A kurtosis of greater than or equal to 3 indicates its likelihood to show a distribution of the variable markedly different than its tendency to produce outliers in a normal distribution (Westfall & Henning, 2013). These variables, therefore, meet the assumptions of normal distribution and central tendency. The summary statistics can be found in Table 2. Figures 3 and 4 display histograms showing the distributions of PGPA and age, respectively.

Table 2

Summary Statistics Table for Interval and Ratio Variables

Variable	<i>M</i>	<i>SD</i>	<i>n</i>	Min	Max	Skewness	Kurtosis	<i>Mdn</i>
PGPA	3.07	0.90	196	0.00	4.75	-0.91	0.12	3.33
Age	28.86	9.16	196	18.00	55.00	1.02	0.17	26.00

Figure 3

Histogram of PGPA

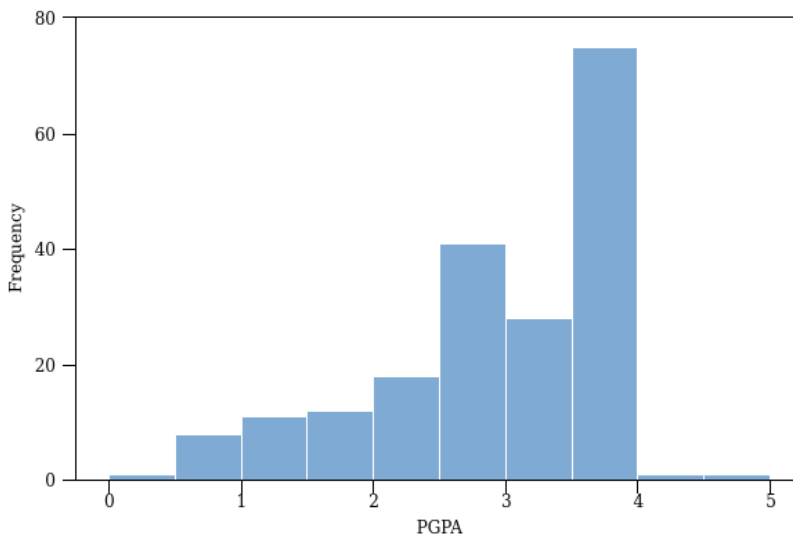
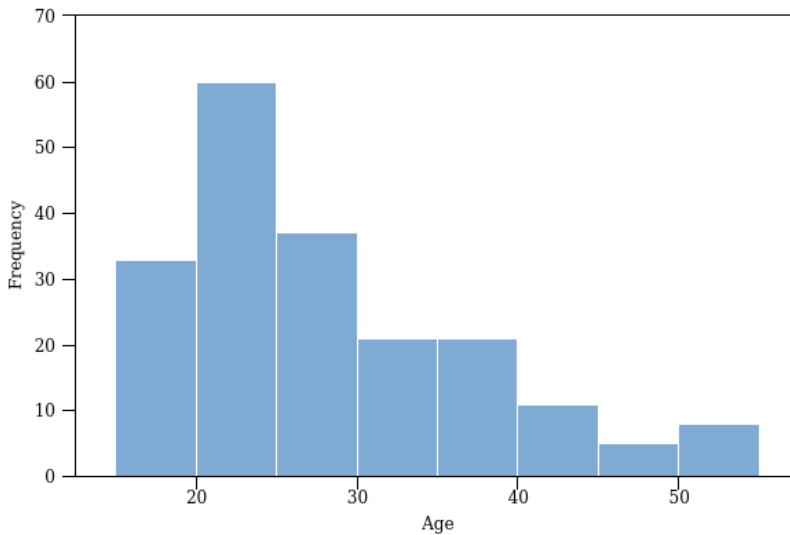
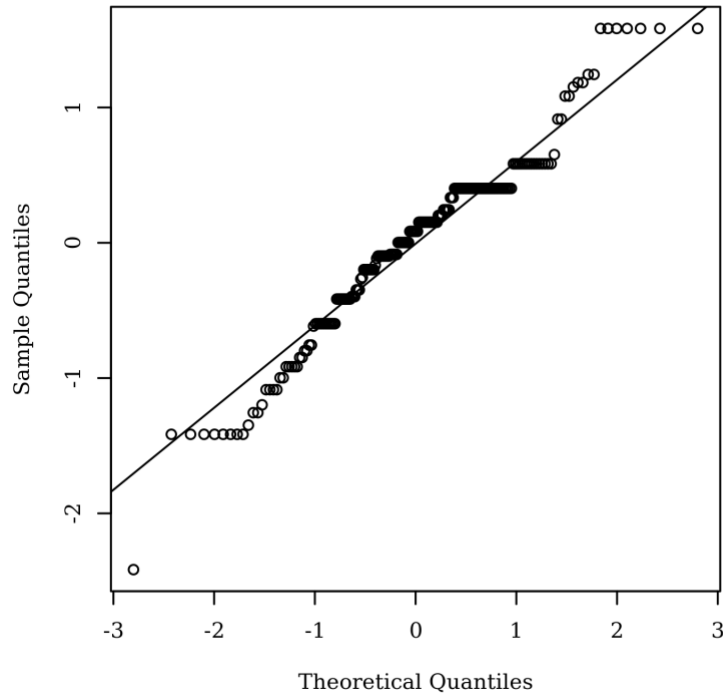


Figure 4*Histogram of Age***Inferential Statistics***Normality and Homoscedasticity*

The assumption of normality was assessed by plotting the quantiles of the model residuals against the quantiles of a Chi-square distribution, also called a Q-Q scatterplot (DeCarlo, 1997). For the assumption of normality to be met, the quantiles of the residuals must not strongly deviate from the theoretical quantiles. Strong deviations could indicate that the parameter estimates are unreliable. Figure 5 presents a Q-Q scatterplot of model residuals.

Figure 5

Q-Q Scatterplot for Normality of the Residuals for the Regression Model



A Shapiro-Wilk test was conducted to determine whether the model residuals could have been produced by a normal distribution (Razali & Wah, 2011). The results of the Shapiro-Wilk test were significant based on an alpha value of .05, $W = 0.97$, $p < .001$. This result suggests the residuals of the model are unlikely to have been produced by a normal distribution, indicating the normality assumption is violated.

A Levene's test was conducted to determine whether the model residuals have similar variances between the groups of the independent variables. The results of the Levene's test were significant based on an alpha value of 0.05, $F(1, 194) = 39.44$, $p < .001$. This result suggests the residuals of the model are unlikely to have similar variances, indicating the homogeneity of variance assumption is violated.

Kruskal-Wallis and Mann-Whitney Tests

To assess if there were significant differences in PGPA between the levels of CourseSequence a Kruskal-Wallis rank sum test was conducted. The Kruskal-Wallis test is a nonparametric alternative to the one-way ANOVA and does not share the ANOVA's distributional assumptions (Conover & Iman, 1981). The results of the Kruskal-Wallis test were significant based on an alpha value of 0.05, $\chi^2(1) = 80.70$, $p < .001$, indicating that the mean rank of PGPA was significantly different between the levels of CourseSequence. Table 3 presents the results of the Kruskal-Wallis rank sum test. Figure 6 presents boxplots of the ranked values of PGPA by the levels of CourseSequence.

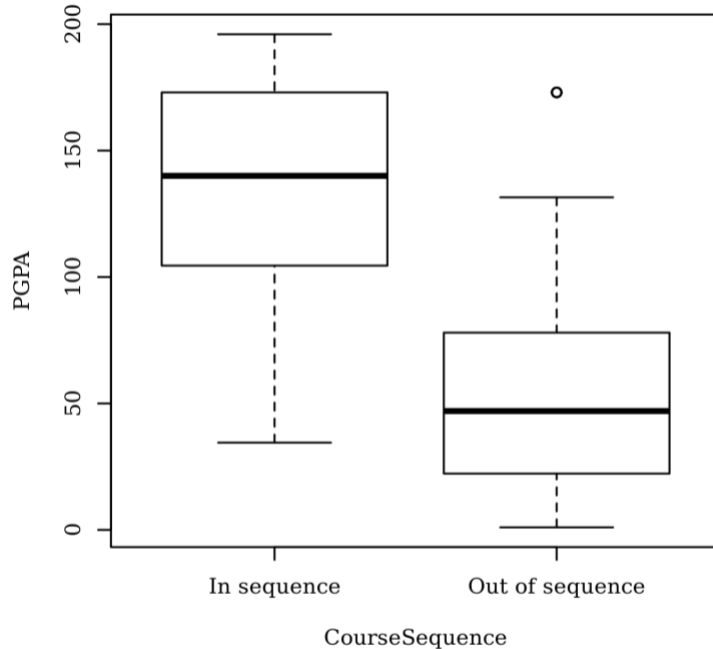
Table 3

Kruskal-Wallis Rank Sum Test for PGPA by CourseSequence

Level	Mean Rank	χ^2	df	p
In sequence	130.78	80.70	1	< .001
Out of sequence	58.05			

Figure 6

Ranked Values of PGPA by the Levels of CourseSequence



I conducted a two-tailed Mann-Whitney two-sample rank-sum test to examine whether there were significant differences in PGPA between the levels of CourseSequence. The two-tailed Mann-Whitney two-sample rank-sum test is an alternative to the independent samples t test, but does not share the same assumptions (Conover & Iman, 1981). There were 109 observations in group In sequence and 87 observations in group Out of sequence.

The result of the two-tailed Mann-Whitney U test was significant based on an alpha value of 0.05, $U = 8260.5$, $z = -8.98$, $p < .001$. The mean rank for group In sequence was 130.78 and the mean rank for group Out of sequence was 58.05. This suggests that the distribution of PGPA for group In sequence was significantly different from the distribution of PGPA for the Out of sequence category. The median for In sequence ($Mdn = 3.75$) was significantly larger than the

median for Out of sequence ($Mdn = 2.50$). Table 4 presents the result of the two-tailed Mann-Whitney U test.

Table 4

Two-Tailed Mann-Whitney Test for PGPA by CourseSequence

Variable	Mean Rank		U	z	p
	In sequence	Out of sequence			
PGPA	130.78	58.05	8260.50	-8.98	< .001

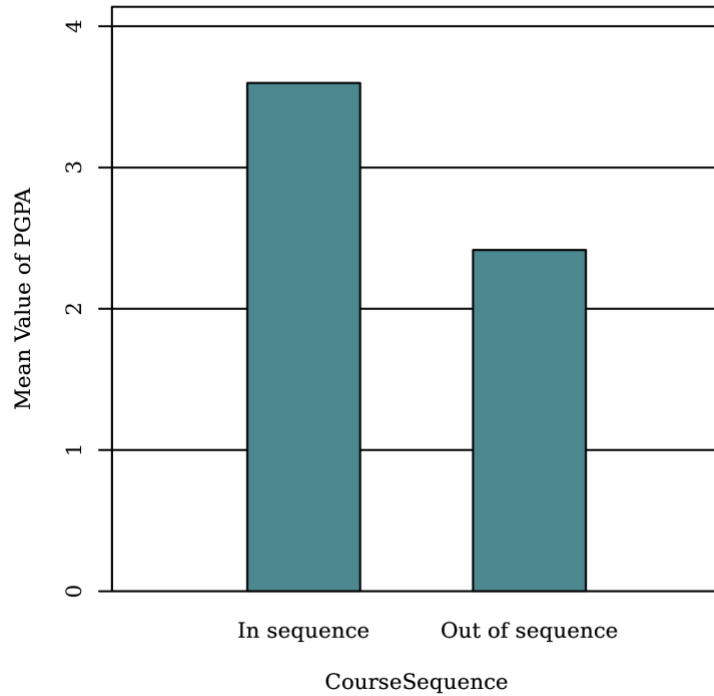
ANOVA

An analysis of variance (ANOVA) was conducted to determine whether there were significant differences in PGPA by CourseSequence. The ANOVA was examined based on an alpha value of 0.05. The results of the ANOVA were significant, $F(1, 194) = 142.45$, $p < .001$, indicating there were significant differences in PGPA among the levels of CourseSequence (Table 5). The eta squared was .42 indicating CourseSequence explains approximately 42% of the variance in PGPA. Figure 7 displays a barplot of PGPA means by course sequence. The means and standard deviations are presented in Table 6.

Table 5

Analysis of Variance Table for PGPA by CourseSequence

Term	SS	df	F	p	η_p^2
CourseSequence	67.61	1	142.45	< .001	0.42
Residuals	92.08	194			

Figure 7*PGPA Means by Factors Levels of CourseSequence***Table 6***Mean, Standard Deviation, and Sample Size for PGPA by CourseSequence*

Combination	<i>M</i>	<i>SD</i>	<i>n</i>
In sequence	3.60	0.44	109
Out of sequence	2.42	0.91	87

Paired *t* tests were calculated between each pair of measurements to further examine the differences among the variables. Tukey pairwise comparisons were conducted for all significant effects based on an alpha of 0.05. For the main effect of CourseSequence, the mean of PGPA for In sequence ($M = 3.60$, $SD = 0.44$) was significantly larger than for Out of sequence ($M = 2.42$, $SD = 0.91$), $p < .001$.

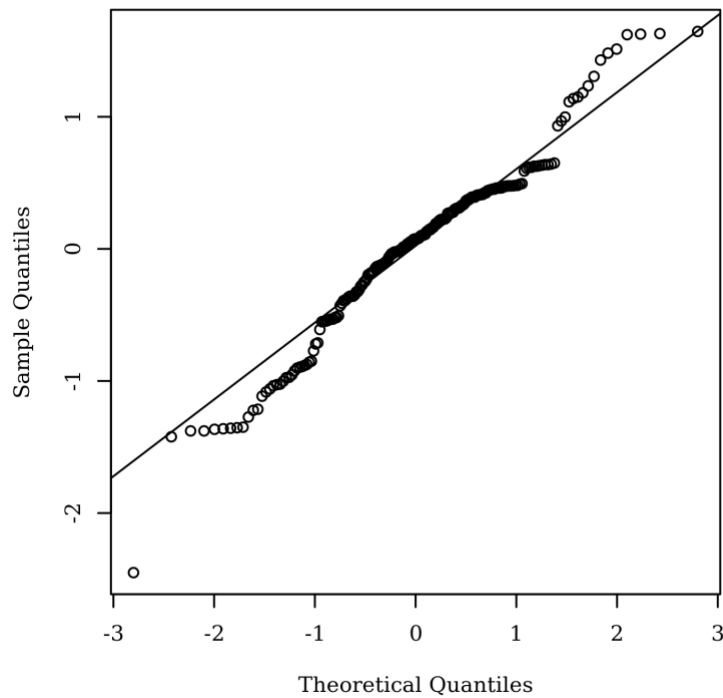
Linear Regression Analysis

I conducted a linear regression analysis to assess whether CourseSequence, Gender, and Age significantly predicted PGPA.

The assumption of normality was assessed by plotting the quantiles of the model residuals against the quantiles of a Chi-square distribution, also called a Q-Q scatterplot (DeCarlo, 1997). For the assumption of normality to be met, the quantiles of the residuals must not strongly deviate from the theoretical quantiles. Strong deviations could indicate that the parameter estimates are unreliable. Figure 8 presents a Q-Q scatterplot of the model residuals.

Figure 8

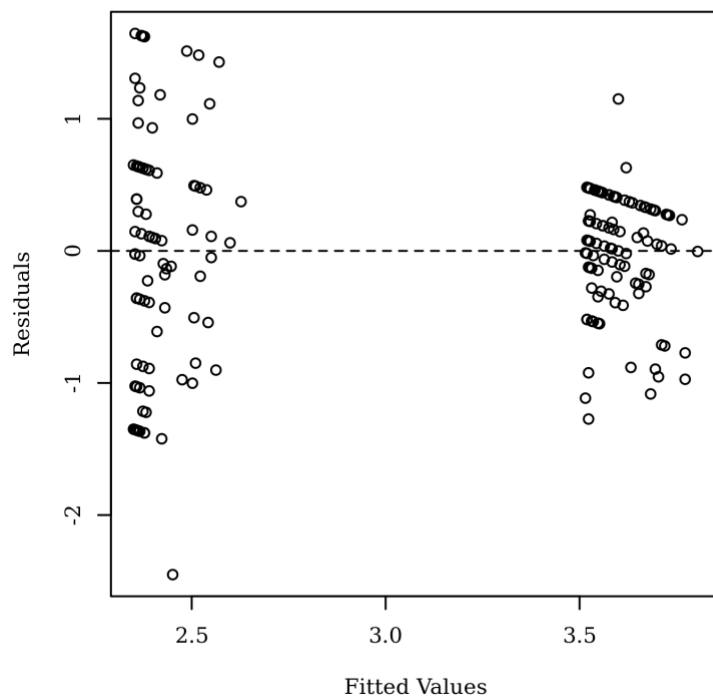
Q-Q Scatterplot for Normality of the Residuals for the Regression Model



Homoscedasticity was evaluated by plotting the residuals against the predicted values (Bates et al., 2014; Field, 2013; Osborne & Walters, 2002). The assumption of homoscedasticity is met if the points appear randomly distributed with a mean of zero and no apparent curvature. Figure 9 presents a scatterplot of predicted values and model residuals.

Figure 9

Residuals Scatterplot Testing Homoscedasticity



Variance Inflation Factors (VIFs) were calculated to detect the presence of multicollinearity between predictors. High VIFs indicate increased effects of multicollinearity in the model. VIFs greater than 5 are cause for concern, whereas VIFs of 10 should be considered the maximum upper limit (Menard, 2009). All predictors in the regression model have VIFs less than 10. Table 7 presents the VIF for each predictor in the model.

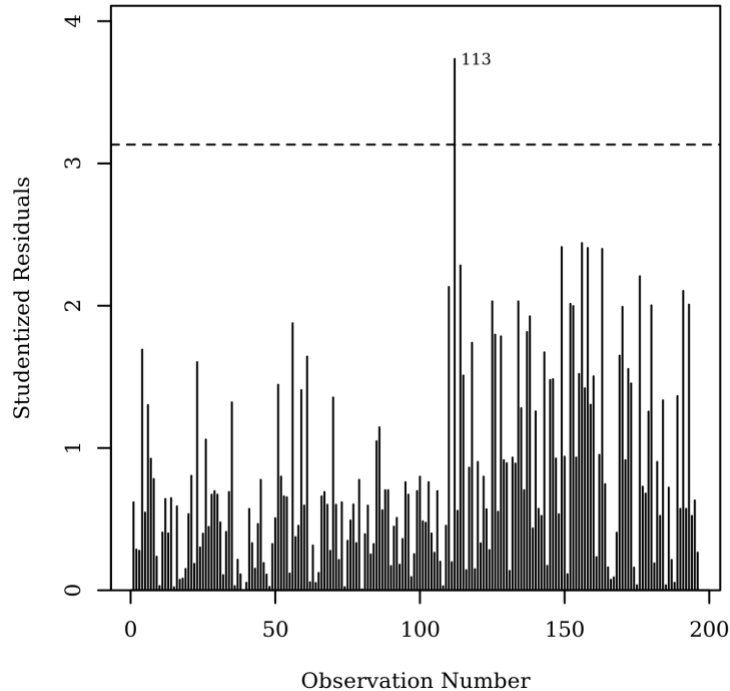
Table 7*Variance Inflation Factors for CourseSequence, Gender, and Age*

Variable	VIF
CourseSequence	1.02
Gender	1.00
Age	1.02

To identify influential points, Studentized residuals were calculated and plotted absolute values against the observation numbers (Field, 2013; Stevens, 2009). Studentized residuals are calculated by dividing the model residuals by the estimated residual standard deviation. An observation with a Studentized residual greater than 3.13 in absolute value, the 0.999 quartile of a t distribution with 195 degrees of freedom, was considered to have significant influence on the results of the model. Figure 10 presents the Studentized residuals plot of the observations. Observation numbers are specified next to each point with a Studentized residual greater than 3.13.

Figure 10

Studentized Residuals Plot for Outlier Detection



A Durbin-Watson test was conducted to assess the degree of autocorrelation among the residuals. The result was not significant, $DW = 1.98$, $p = .406$, suggesting there was little to no autocorrelation among the residuals.

The results of the linear regression model were significant, $F(3,192) = 48.24$, $p < .001$, $R^2 = 0.43$, indicating that approximately 43% of the variance in PGPA is explainable by CourseSequence, Gender, and Age. The Out of sequence category of CourseSequence significantly predicted PGPA, $B = -1.17$, $t(192) = -11.67$, $p < .001$. Based on this sample, this suggests that moving from the In sequence to Out of sequence category of CourseSequence will decrease the mean value of PGPA by 1.17 units on average. The Female category of Gender did not significantly predict PGPA, $B = -0.15$, $t(192) = -1.25$, $p = .211$. Based on this sample, this

suggests that moving from the Male to Female category of Gender does not have a significant effect on the mean of PGPA. Age did not significantly predict PGPA, $B = 0.00$, $t(192) = 0.74$, $p = .459$. Based on this sample, a one-unit increase in Age does not have a significant effect on PGPA. Table 8 summarizes the results of the regression model. Table 9 summarizes the results of the regression model without gender and age.

Table 8

Results for Linear Regression With CourseSequence, Gender, and Age Predicting PGPA

Variable	<i>B</i>	<i>SE</i>	95% CI	β	<i>t</i>	<i>p</i>
(Intercept)	3.59	0.20	[3.20, 3.98]	0.00	17.97	< .001
CourseSequenceOut of sequence	-1.17	0.10	[-1.37, -0.97]	-0.64	-11.67	< .001
GenderFemale	-0.15	0.12	[-0.38, 0.08]	-0.07	-1.25	.211
Age	0.00	0.01	[-0.01, 0.01]	0.04	0.74	.459

Note. Results: $F(3,192) = 48.24$, $p < .001$, $R^2 = 0.43$. Unstandardized Regression Equation:

$$\text{PGPA} = 3.59 - 1.17 * \text{CourseSequenceOut of sequence} - 0.15 * \text{GenderFemale} + 0.00 * \text{Age}$$

Table 9

Results for Linear Regression With CourseSequence Predicting PGPA

Variable	<i>B</i>	<i>SE</i>	95% CI	β	<i>t</i>	<i>p</i>
(Intercept)	3.60	0.07	[3.47, 3.73]	0.00	54.52	< .001
CourseSequenceOut of sequence	-1.18	0.10	[-1.38, -0.99]	-0.65	-11.94	< .001

Note. Results: $F(1,194) = 142.45$, $p < .001$, $R^2 = 0.42$. Unstandardized Regression Equation:

$$\text{PGPA} = 3.60 - 1.18 * \text{CourseSequenceOut of sequence}$$

Figure 11

Scatterplot of Sequence and PGPA

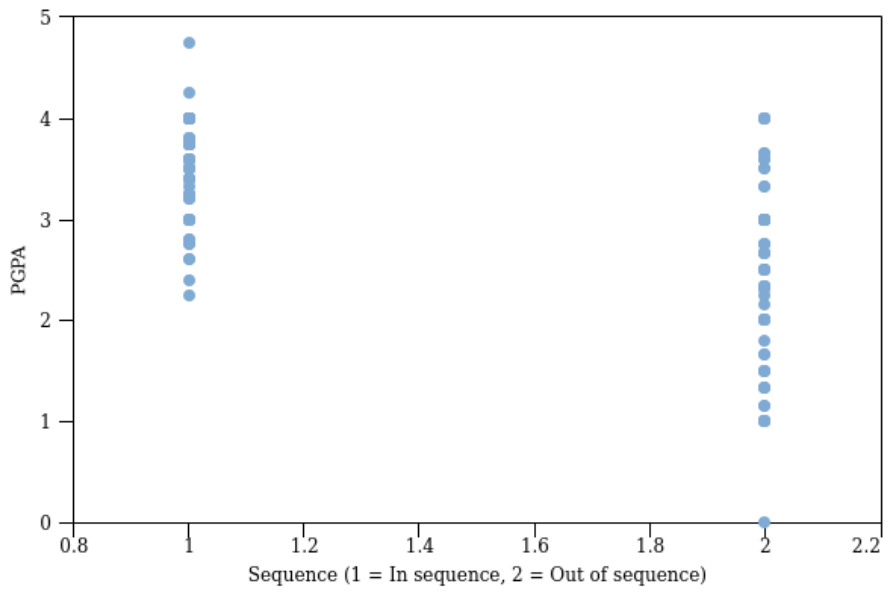
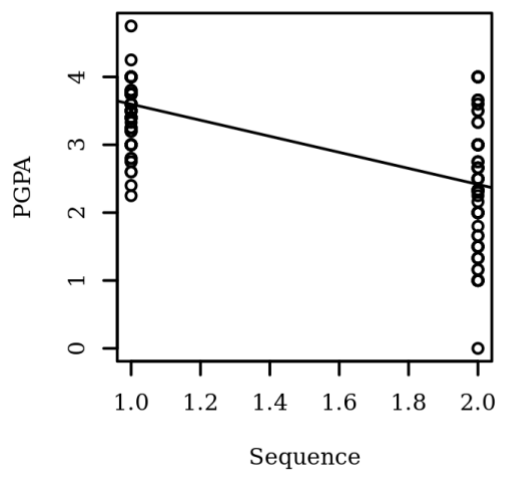


Figure 12

Scatterplot of Sequence and PGPA With Best Fit Line



Independent Samples t Test

A two-tailed independent samples t test was conducted to demonstrate the differences in mean PGPA scores between the In sequence and Out of sequence categories of CourseSequence. The result of the two-tailed independent samples t test was significant based on an alpha value of 0.05, $t(118.55) = 11.14$, $p < .001$. This finding suggests that the mean of PGPA was significantly different between the In sequence and Out of sequence categories of CourseSequence. The results are presented in Table 10.

Table 10

Two-Tailed Independent Samples t Test for PGPA by CourseSequence

Variable	In sequence		Out of sequence		t	p	d
	M	SD	M	SD			
PGPA	3.60	0.44	2.42	0.91	11.14	< .001	1.66

Note. N = 196. Degrees of Freedom for the t -statistic = 118.55. d represents Cohen's d .

Summary

The methodologies described in Chapter 3 were used to analyze the data presented in Chapter 4. This chapter included data analysis and findings described in narrative form and illustrated in tables, barplots, and histograms.

Descriptive statistical analysis was used to calculate measures of central tendency for the study variables and illustrated by histograms noting the distribution of PGPA scores and student age. Assumptions of normal distribution and central tendency were met. The frequencies of CourseSequence and Student Gender are illustrated by barplot graphs.

The first research question was addressed using inferential statistical analysis to examine the relationships between the independent and dependent variables. Tests of homoscedasticity and normality demonstrated violation of these two assumptions, so in addition to the parametric

ANOVA and paired t tests, nonparametric Kruskal-Wallis and Mann-Whitney U tests were deployed to assess for significant differences in PGPA between levels of CourseSequence and PGPA. Each of the parametric and nonparametric tests demonstrated significantly higher PGPA scores for the InSequence group, with levels of CourseSequence explaining approximately 42% of the variance in PGPA.

I conducted multiple linear regression analyses to address the second research question in determining whether CourseSequence, student Gender, and Age significantly predicted PGPA. Assumptions of normality were assessed and confirmed normal distribution of residuals. The results of the linear regression demonstrated a statistically significant predictive relationship between CourseSequence, student gender, age, and PGPA, $R^2 = 0.43$. Simple linear regression using only the variable of CourseSequence resulted in $R^2 = 0.42$, and indicated that the covariates of student gender and age were not significant predictors of PGPA.

Chapter 5: Discussion, Conclusions, and Recommendations

The problem identified and analyzed in this study is the increasingly unmet demand for healthcare workers in the United States, focusing on the academic preparation of health professions workers in the context of postsecondary education. The need for health professionals is increasing; community colleges supply the majority of the healthcare workforce in the United States and enrollment is increasing as a result (Bureau of Labor Statistics, 2019). However, enrollment in and graduation from health professions programs does not meet current or projected needs; ongoing gaps between current and projected needs are expected to increase (Lim, 2016; Wigdahl et al., 2014).

A significant component of graduation rates is the overall number of students accepted into health professions programs. At South Community College, a minimum GPA of 2.5 is required for application to the programs and openings in the programs are limited. The resulting dynamic is that students wishing to apply to one of the programs are encouraged to optimize their GPA scores not only to apply, but to increase their chances of acceptance. With this objective in mind, this study addressed factors related to student retention and academic success. Studies on student retention in higher education are abundant; many theories addressing factors related to student retention and academic success are documented in the literature.

The purpose of this study was to examine the nature of health science prerequisite sequence and the extent to which such sequencing effects prerequisite grade point average. Quantitative analysis was used to determine the relationship between course sequence and prerequisite grade point averages in groups of students taking the courses in sequence, and students taking the courses out of sequence.

Future research may be undertaken to examine academic outcomes on a longitudinal basis as well as in other institutional contexts. Further investigation of other variables related to student retention and academic success should also be undertaken.

Discussion of Findings in Relation to Past Literature

Theoretical Framework

The problem of student attrition in postsecondary education has been the subject of research for decades. Theories posited by Tinto (1975, 1993, 2006), Bean (1980), Astin (1984), Seidman (2005), Harris (2006), Braxton (2008), and Scott-Clayton (2011) addressed the dynamics affecting student retention from several different perspectives. The interactionist theory described by Tinto (1975) focused on student retention as a phenomenon related to the dynamic of social interaction of students with peers in the academic setting. The student involvement theory of Astin (1984) focused on physical, social, and psychological involvement in the academic environment and correlates with Tinto's interactionist theory.

The congruency of social, psychological, and academic factors influencing student retention was described in work by Bean (1980) which noted specific academic criteria such as GPA as a predictor of student retention. The author concluded that students achieving academic success as measured by GPA had higher retention rates; students who had lower GPAs had lower retention rates. Studies by Harris (2006) and Braxton (2008) reinforced extant observations and theories related to social and psychological involvement, and introduced new concepts that concentrated on academic factors as essential components of student retention and success.

Silverman and Seidman (2011) found that students in an integrated, sequential mathematics curriculum similar to the In Sequence group examined in this study, demonstrated higher GPAs and progression rates through the Math My Way program. The results of this

program were congruent with Seidman's 2005 retention model based on academic and social integration as related to improved academic performance. These findings were congruent with the *structure hypothesis* posited by Scott-Clayton (2011) that related curricular structure with improved student retention, supporting the retention theories of Tinto, Seidman, and Braxton.

The results of this study support the literature findings correlating academic variables with student success (Bennett et al., 2016; Knauss & Willson, 2013; Wambugh et al., 2016). This study also supports literature findings correlating curricular structure with academic success (Bloemer et al., 2018; Scott-Clayton, 2011; Van Noy et al., 2016).

This study is a formative evaluation of the relationship between course sequence and prerequisite GPA (PGPA) in health professions programs at South Community College. The findings support the hypotheses that groups of students taking courses in sequence and out of sequence showed a statistically significant difference in PGPA, and that course sequence was a valid and reliable predictor of PGPA. This study relates to the theoretical framework in that based on these findings, measures and innovations may be introduced to improve academic outcomes and retention rates, with resultant higher application and acceptance rates to health professions programs at South Community College. Increased application and acceptance rates to these programs may then result in increased graduation rates and higher numbers of graduates needed to address the increasing need for qualified healthcare professionals at the community level. Optimizing student's opportunities for higher PGPA's increases their chances at program admission and completion.

Attrition rates early in the programs are high, and educators in the healthcare professions face problems with resolving attrition rates with the goals of increasing application and graduation rates in order to supply new professionals to the healthcare community. Presently,

there is no plan in place to help students progress through health science prerequisite courses in such a way as to optimize PGPA. Based on the findings of this study and the extant theories of student retention, innovations in intake procedures and curricular structure may then be developed, implemented, and assessed, with the objective of optimizing student outcomes.

Need for Healthcare Workers

The supply and demand problem in the healthcare professions has emphasized the need for further examination of rates of admission and attrition in health professions programs in the postsecondary context (Carnevale & Smith, 2013; Dickson, 2015). Since community colleges supply more than half of the healthcare workforce in the nation, addressing factors affecting admission and attrition in this context is particularly relevant. The literature reviewed in this study addressed the problem of increasing need for healthcare workers in the United States. The need for healthcare professionals on a nationwide basis is directly reflected in the large metropolitan community served by South Community College.

High student attrition rates are common in health professions programs in community colleges (Beauvais et al., 2014; Staykova, 2012). This problem is compounded by decreased enrollment in community college health professions programs, and completion rates of less than 30% (Rath et al., 2013). Prerequisite health science GPA is a common admission criterion for health professions programs including those at South Community College.

The findings of this study demonstrate the relationships between health science prerequisite course sequence and PGPA at South Community College. Students who took the courses in sequence demonstrated significantly higher PGPA scores than students who took the courses out of sequence. A predictive relationship was also found between course sequence and PGPA. In the context of the problem of increased demand and decreased supply of healthcare

professionals in the community served by South Community College, these data and findings provide empirical support for changes to curricular structure with the goals of improved academic outcomes, increased GPAs, and subsequent increased enrollment.

Admission Criteria as Predictors of Academic Success in Health Professions Programs

In addressing potential solutions directed at increasing enrollment and retention in health professions programs, this study examines literature pertaining to admission criteria as predictors of academic success across the spectrum of programs including certificate, diploma, associate degree, bachelor's degree, and graduate programs. Of the wide array of admission criteria noted in the literature, preadmission GPA was observed to be the criterion most relevant to the specific problem of practice at South Community College.

Studies which examined cognitive and noncognitive criteria were reviewed. Cognitive criteria included preadmission GPA, previous baccalaureate degree, preadmission test scores, and previous healthcare experience. Noncognitive criteria included interview scores, reference letters, applicant essays, age, gender, and race. The cognitive criteria were described as having the highest correlation to academic success in health professions programs, with preadmission GPA in health science prerequisite courses demonstrating consistent correlation. The literature noted the need for further study. Considering these dynamics, I have directed the focus of this study on the cognitive criterion of GPA in the health science prerequisites at South Community College.

Student retention theorists such as Bean (1980), Seidman (2005), Harris (2006), Braxton (2008), and Scott-Clayton (2011) have noted academic success as predictive of student retention and program completion. Braxton (2008) found first-year GPA to be an important component of student persistence and success. Braxton's persistence theory, and retention theories of Seidman

and Tinto were supported by Scott-Clayton (2011), who held that adherence to a formal curricular structural framework had a positive effect on student retention.

Curricular Structure and Academic Success

Studies of liberal arts, business, and STEM disciplines identified curricular structure as a significant predictor of academic success, leading to higher GPA's and graduation rates. Introductory courses in the health professions programs are oriented to the STEM disciplines, and demonstrate higher attrition rates than general education courses (Bloemer et al., 2018; Calisir et al., 2016). In addressing this problem specifically to South Community College, this study proposed to examine the relationship between the order in which prerequisite HPRS courses are taken and GPA. The current enrollment policy at South Community College is a *cafeteria-style* open enrollment format that allows students to choose courses at random, without counseling. This paradigm allows for enrollment in courses that are out of sequence in terms of course content and complexity, and results in students taking advanced courses before basic courses.

The findings of this study demonstrate a statistically significant relationship between HPRS course sequence and PGPA, with students taking the courses in sequence demonstrating a significantly higher PGPA than student taking the courses out of sequence. These results show correlation with the theoretical models of Tinto (1975, 1993, 2006), Seidman (2005), and Braxton (2008), and the structure hypothesis of Scott-Clayton (2011). The results relating course sequence to PGPA are also consistent with numerous studies in other academic disciplines which examined curricular structure and academic outcomes (Bloemer et al., 2018; Van Noy et al., 2016).

The findings of the multiple regression analysis demonstrated a predictive relationship between course sequence and PGPA. The covariates of age and gender were not found to be significant as predictors of PGPA. Identifying the variables that are predictors of academic success is particularly relevant in the context of South Community College in that these data and findings support proposal and implementation of evidence-based interventions of admission criteria and curricular structure models aimed at increasing retention and improving academic outcomes in the health professions programs.

The findings in this quantitative causal-comparative and correlational study were used to investigate the research questions:

Research Question 1

What are the differences between mean PGPA scores for students taking HPRS courses in a prescribed curricular sequence and those students taking HPRS courses out of sequence?

In order to address Research Question 1, a one-way ANOVA was conducted to determine the difference between HPRS course sequence and PGPA. The results of the analysis revealed that students taking courses in sequence demonstrated statistically significant higher PGPA scores compared to students taking HPRS courses out of sequence, $F(1, 194) = 142.45, p < .001$. Course sequence explains approximately 42% of the variance in PGPA. However, Shapiro-Wilk and Levene's tests showed violation of assumptions for normality and homogeneity of variance.

A Kruskal-Wallis test demonstrated significant differences between the levels of CourseSequence, $\chi^2(1) = 80.70, p < .001$. A two-tailed Mann-Whitney test was conducted to examine the presence of significant differences in PGPA between the levels of CourseSequence. The result was significant, $z = -8.98, p < .001$.

Based on these findings, the null hypothesis was rejected. There were significant

differences in PGPA scores for students taking HPRS courses in sequence and students taking HPRS courses out of sequence. These findings are consistent with the literature describing a significant relationship between curricular structure and academic success.

Research Question 2

Is there a significant relationship between HPRS course sequence and PGPA, after controlling for age and gender, among health science students at South Community College?

Multiple linear regression analysis of the data demonstrated a statistically significant predictive relationship between course sequence and PGPA. After testing for assumptions of normality, homoscedasticity, multicollinearity, outliers, and autocorrelation, the results of the linear regression model were significant, $F(3,192) = 48.24$, $p < .001$, $R^2 = 0.43$, indicating that approximately 43% of the variance in PGPA is explainable by CourseSequence. The Out of sequence category of CourseSequence significantly predicted PGPA, $B = -1.17$, $t(192) = -11.67$, $p < .001$.

The findings revealed that age and gender were not statistically significant predictors of PGPA. After removing the gender and age covariates, the results for linear regression changed from $R^2 = 0.43$ to $R^2 = 0.42$, suggesting that neither covariate of age or gender had a significant effect on PGPA.

The findings demonstrated a statistically significant predictive relationship between HPRS course sequence and PGPA. Based on these findings the null hypothesis was rejected. The findings support the use of course sequence as a statistically significant predictor of PGPA. These results are consistent with extant research showing a predictive relationship between curricular structure and academic success in health professions programs (Bennett et al., 2016; Wambuguh et al., 2016).

These findings are pertinent to the problem at South Community College. The empirical evidence of statistically significant relationships between course sequence and PGPA can be used to address the problems of student retention and academic underachievement secondary to unsystematic enrollment procedures at the study site. The implementation of standardized curricular frameworks characterized by orderly advancement can be used to prevent enrollment errors, unfavorable academic outcomes, and student attrition.

The problems of increasing demand and limited supply of healthcare professionals are reflected in the body of research. The issues described in the research are reflected in the local context at South Community College. Variables affecting the supply dynamics include academic and demographic factors (Burns, 2011; Raman, 2013; Wilson et al., 2015). While demographic characteristics are widely variable, academic variables are consistent among healthcare professions programs.

The problems associated with curricular structure and academic outcomes are well documented in the literature. This study also provides evidence that not only affirms previous research, but provides empirical data specific to the healthcare professions programs at South Community College. Moving from a micro- and macro- level focus, the phenomena documented and supported by the findings in this study are active at the mega-levels in the context of graduation rates and the supply of qualified healthcare professionals who are successful in passing national certification and licensure examinations.

The theoretical foundations supporting these findings were posited in the *structure hypothesis* of Scott-Clayton (2011). Works by other researchers, including Astin, Bean, Braxton, Harris, and Seidman evolved from Tinto's seminal interactionalist theory to embrace more complex theories reflective of the changing paradigm of student retention studies. These later

theories, while congruent with interactionalist theory, describe the integration of academic factors into the social and psychological spheres of influence as determinants of student retention. The results of this study are consistent with Seidman's retention model based on academic and social integration as well as Scott-Clayton's structure hypothesis. The relationship of course sequence with academic outcomes was clearly demonstrated in the findings.

The evidence revealed in this study provides an empirical basis for implementation of changes in curricular structure, as well as procedures directing academic counseling and guidance policies. A formal curricular framework for health professions students can be put in place to direct students in course choices and enrollment with the goal of preventing the disordered course sequence selection that this study clearly shows will lead to lower GPA and diminished chances of acceptance in the health professions programs.

This structured program of curricular progression for health professions students exists, the Career Pathway in Health Sciences (CPHS). Based on the findings of this study, and reflective of the theoretical framework described herein, CPHS provides an orderly enrollment plan designed to promote optimal academic outcomes and increased opportunity for students who wish to become healthcare professionals. Initially designed for implementation at South Community College, informal inquiry into other community colleges as well as four-year universities has revealed that CPHS, or a program based on the same theoretical framework and empirical evidence, is typically nonexistent, leaving open opportunities for new innovation and implementation. Desirable, direct, anticipated outcomes include higher PGPA's and retention rates, increased enrollment in health science courses, and increased rate of acceptance/admission into and graduation from nursing and allied health professions programs. Anticipated but indirect consequences may result from students re-scheduling classes to fit into the CPHS paradigm.

Once in place, the field of inquiry is then open to include longitudinal studies of the same variables to determine the relative outcomes of the innovation. Formative studies of other academic cognitive and noncognitive variables may then also be undertaken with specific direction to healthcare professions programs. The summative goals of increased enrollment in and graduation from the programs, and increasing supply of well-trained, qualified healthcare professionals to the community may also be evaluated on a longitudinal basis to determine if further changes are indicated.

Recommendations to Professional Community

Based on the findings of this quantitative causal-comparative and correlational study and the review of literature, recommendations to educators in the health professions programs are proposed.

Research Question 1 compared the mean PGPA of the two independent variable groups; a statistically significant relationship was observed between scores of the two groups, with the group taking courses in sequence demonstrating higher mean PGPA. Research Question 2 explored the existence of a predictive relationship between the variables of course sequence, student age, and student gender. The data showed a statistically significant predictive relationship between course sequence and PGPA. Student in the Out of sequence category of CourseSequence showed decreased mean values of PGPA by 1.17 units. The variables of student age and student gender respectively, showed no significant effect on or predictability of PGPA.

Based on the results derived from these data, recommendations regarding course sequence and curricular structure are relevant to application of changes to practices and procedures at South Community College. The findings of significant relationships between course sequence and PGPA and a predictive phenomenon related to course sequence should

prompt inquiry into curricular structure and enrollment policies, not only at South Community College, but at other institutions of higher education using similar enrollment formats. The results of this study can also be useful in formulating articulation plans with four-year institutions, as well as dual-credit programs with high schools in order to increase the likelihood of academic success. These findings are clear indicators of support for innovations in the curricular structure with the formative and summative goals of improving academic outcomes for students wishing to apply to the health professions programs. A curricular structure of standardized progression should be proposed to prevent random, out of sequence enrollment of students in prerequisite HPRS courses with the formative goals of optimizing student retention and increasing health professions programs application and acceptance rates.

Limitations

The calculated PGPA used in the study was limited to data compiled from records of students who have completed HPRS courses, exclusive of transcripts from students who did not complete the HPRS courses. The population of the study, limited to de-identified archival transcripts of 196 students obtained from South Community College yielded statistically significant results, but the purposive sampling procedure limited generalizability to a larger population. The purposive sampling procedure was limited to a 5-year period, and did not control for courses taken in an online vs. face-to-face classroom format. Many students enroll in HPRS courses concurrently with general education courses; this study does not account for concurrent class load or for other criteria which may have yielded different findings. The findings may be limited in application in that the data are compiled only from South Community College transcripts, and may not be generalizable to other community colleges.

Implications for Future Research

Future research could include longitudinal studies pertaining to increasing numbers of students with GPAs of 2.5 or greater. Increasing numbers of students enrolled in and graduating from health professions programs, increasing numbers of graduates passing national certification exams, and increasing numbers of graduates employed in health professions career fields could require assessment on an ongoing basis, consistent with annual admission and graduation intervals. Research into admission criteria and academic outcomes is also indicated at health science programs at other community colleges as well as four-year universities.

Annual assessment of attrition/retention rates can provide feedback needed for modification of curricular changes as needed. Retrospective studies of successful program graduates may provide a basis of comparison of curricular structure. Subsequent assessments may be implemented for macro- and mega- level needs in response to organizational and societal outcomes regarding program graduation rates and postgraduation employment rates. The same variables could also be studied in health professions courses and programs in other community colleges as well as the four-year university context.

Other variables to examine in the context of academic success include cognitive criteria such as preadmissions test scores, math GPA, science GPA, non-science GPA, cumulative GPA scores, and final course grades in anatomy and physiology courses (Siemens, 2011). Noncognitive criteria such as interviews, essays, student ethnicity, native language, parent's level of education, previous college experience, concurrent employment, and socioeconomic status can be examined to determine a positive correlation with academic success specific to health professions programs. These criteria can be examined on an individual basis, or in combination to determine the existence of interacting influence.

After graduation from the programs, students must take national licensure or board certification examinations such as the National Council Licensure Examination for Registered Nurses (NCLEX-RN) for nursing, and other specialties including but not limited to the written registry for respiratory therapists (WRRT) and certified respiratory therapist (CRT) exam, and the National Dental Hygiene Board Examination (NDHBE) for dental hygienists. The same variables considered for analysis in the context of academic outcomes and success in the programs should also be examined with attention to postgraduate outcomes in the national certification examinations across the spectrum of the health professions specialties. Information derived from these studies may be used to identify variables predictive of national licensing exam success and increase the likelihood of positive student outcomes.

Innovations in Curricular Structure and Planning

On application of these data and findings, community college administrators, faculty, and registrar officials may be challenged with planning and implementing changes to curricular structure, course configuration, and enrollment procedures. These changes could range from simple recommendations in enrollment counseling to formal, mandatory structures of course sequence, similar to the Math My Way construct of Silverman and Seidman.

Conclusions

The need for qualified health professions practitioners continues to increase (Hinderer et al., 2014). Health professions programs at community colleges across the U.S. supply most of the healthcare professionals (Carnevale & Smith, 2013). Health professions programs are increasing resources to address the burgeoning demand for healthcare practitioners by external stakeholders in the medical community and the county (Zimbelman et al., 2010). Increased enrollment, application, and program acceptance rates are essential components in increasing the

numbers of graduates, and meeting nationwide needs (Dickson, 2015). By failing to optimize student opportunities for admission, the college runs the risk of undersupplying community needs for qualified, well-trained practitioners (Zimbelman et al., 2010).

The consequences of unsystematic prerequisite course enrollment at South Community College have not to date been formally identified or addressed, nor any interventions or solutions proposed. Researchers have explored similar problems related to prerequisite preparation and academic success in health professions programs (Carnevale & Smith, 2013; Ingrassia, 2016; Kelsch & Sylvester, 2016). In addressing the current problem, the population targeted is incoming students taking health science courses with the goal of admission to a health professions program.

In assessing the needs of South Community College in the context of the health professions programs, the plan for proposed intervention is the implementation of a “guided pathway” program of curriculum; a Career Pathway in Health Sciences (CPHS) focused on sequential progression through health science courses. The findings of this study lend strong support to this innovation; the formative goals to increase enrollment, application, and acceptance to health professions programs, the summative goals to increase graduation and national certification licensure exam success rates. Attainment of these goals will provide opportunity to students and serve the needs of the college and the community in a mutually beneficial relationship of service and support.

References

American Occupational Therapy Association. (n.d.). *Workforce trends in occupational therapy*.

https://www.aota.org//media/Corporate/Files/EducationCareers/Prospective/Workforce_trends-in-OT.PDF

Ari, A., Goodfellow, L. T., & Gardenhire, D. S. (2008). Admission criteria as predictors of student performance on the national board for respiratory care examinations. *Respiratory Care Education Annual, 17*, 1–6.

<https://www.aarc.org/wpcontent/uploads/2015/05/rcea08.pdf>

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of College Student Personnel, 25*(4), 297–308.

https://www.asec.purdue.edu/lct/hbcu/documents/Student_Involvement_A_Developmental_Theory_for_HE_Astin.pdf

Austin, L. D. (2011). Predicting national dental hygiene board examination success based on specific admission factors. *Journal of Dental Hygiene, 85*(4), 335–339.

<https://jdh.adha.org/content/jdenthgy/85/4/335.full.pdf>

Bailey, T. R., Jenkins, D., & Smith Jaggars, S. (2015). *Redesigning America's community colleges: A clearer path to student success*. Harvard University Press.

Bailey, T. R., & Smith Jaggars, S. (2016). *When college students start behind*. Century Foundation.

Bailey, T. R., Smith Jaggars, S., & Scott-Clayton, J. (2013). Characterizing the effectiveness of developmental education: A response to recent criticism. *Journal of Developmental Education, 36*(3), 18-25.

<https://doi.org/10.7916/D857191J>

- Baker, J., Tucker, D., Raynes, E., Aitken, F., & Allen, P. (2016). Relationship between student selection criteria and learner success for medical dosimetry students. *Medical Dosimetry, 41*(1), 75–79. <https://doi.org/10.1016/j.meddos.2015.08.006>
- Barfield, J. P., Folio, M. R., Lam, E. T. C., & Zhang, J. J. (2011). Factors associated with enrollment in allied health education programs: Development of a predictive scale. *Journal of Allied Health, 40*(2), 82–89. <http://www.asahp.org/journal-of-allied-health>
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2014). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*(1), 1–48. <https://www.jstatsoft.org/article/view/v067i01>
- Bauchmoyer, S. M., Carr, M. P., Clutter, J. E., & Hoberty, P. D. (2004). Predicting academic and national board dental hygiene examination performance based on academic factors. *Journal of Dental Hygiene, 78*(1), 39–45. https://etd.ohiolink.edu/!etd.send_file?accession=osu1418401625&disposition=inline
- Bean, J. P. (1980). Dropouts and turnover: The synthesis and test of a causal model of student attrition. *Research in Higher Education, 12*(2), 155–187. <https://www.jstor.org/stable/40195329>
- Beauvais, A. M., Stewart, J. G., DeNisco, S., & Beauvais, J. E. (2014). Factors related to academic success among nursing students: A descriptive correlational research study. *Nurse Education Today, 34*(6), 918–923. <https://doi.org/10.1016/j.nedt.2013.12.005>
- Bennett, M., Bormann, L., Lovan, S., & Cobb, B. (2016). Preadmission predictors of student success in a baccalaureate of science in nursing program. *Journal of Nursing Regulation, 7*(3), 11–18. [https://doi.org/10.1016/S2155-8256\(16\)32315-8](https://doi.org/10.1016/S2155-8256(16)32315-8)

- Betancur, L., Rottman, B. M., Votruba-Drzal, E., & Schunn, C. (2019). Analytical assessment of course sequencing: The case of methodological courses in psychology. *Journal of Educational Psychology, 111*(1), 91–103. <https://doi.org/10.1037/edu0000269>
- Bloemer, W., Swan, K., Day, S., & Bogle, L. (2018). Digging deeper into the data: The role of gateway courses in online student retention. *Online Learning, 22*(4), 109–127. <https://doi.org/10.24059/olj.v22i4.1515>
- Braxton, J. M. (1999). Theory elaboration and research development: Toward a fuller understanding of college student retention. *Journal of College Student Retention, 1*(2), 93–97. <https://doi.org/10.2190/W42A-1ECN-VGLH-XPA8>
- Braxton, J. M. (2008). Toward a scholarship of practice centered on college student retention. *New Directions for Teaching and Learning, 115*, 101–112. <https://doi.org/10.1002/tl.328>
- Braxton, J. M., Doyle, W. R., Hartley, H. V., Hirschy, A. S., Jones, W. A., & McClendon, S. A. (2014). *Rethinking college student retention*. Jossey-Bass.
- Braxton, J. M., Milem, J. F., & Sullivan, A. S. (2000). The influence of active learning on the college student departure process: Toward a revision of Tinto's theory. *Journal of Higher Education, 71*(5), 569–590. <https://doi.org/10.2307/2649260>
- Buckingham, R. S., & Bush, S. R. (2013). Predictors of academic success for students at the Michigan College of Optometry. *Optometric Education, 38*(3), 92–99. <https://scholarworks.wmich.edu/dissertations/24>
- Bureau of Labor Statistics. (2019). *Occupational outlook handbook: Healthcare occupations*. Washington, DC: U.S. Bureau of Labor. <https://www.bls.gov/ooh/healthcare/home.htm>

- Burns, S. M. (2011). Predicting academic progression for student registered nurse anesthetists. *AANA Journal*, 79(3), 193–201.
<https://pdfs.semanticscholar.org/29a0/130f6edc2b23af63fe226822758f337e13dd.pdf>
- Calisir, F., Basak, E., & Comertoglu, S. (2016). Predicting academic performance of master's students in engineering management. *College Student Journal*, 50(4), 501–512.
<https://www.projectinnovation.com/college-student-journal.html>
- Carnevale, A., & Smith, N. (2013). In demand: Community colleges already train more than half the nation's health care workforce and demand for their services is on the rise. *Community College Journal*, 84(2), 20–26. <https://www.aacc.nche.edu/publications-news/community-college-journal/>
- Carnevale, A., Smith, N., & Strohl, J. (2010). *Help wanted: Projections of job and education requirements through 2018*. Georgetown University Center on Education and the Workforce.
- Chen, P. Y., & Popovich, P. M. (2011). *Correlation: Parametric and nonparametric measures*. Sage.
- Claypool, C. (2018). *Course offering support system*. Paper presented at the Twenty-fourth Americas Conference on Information Systems, New Orleans, LA. Abstract retrieved from <https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1091&context=amcis2018>
- Cohen-Schotanus, J., Muijtens, A. M. M., Reinders, J. J., Agsteribbe, J., van Rossum, H. J., & van der Vleuten, C. P. M. (2006). The predictive validity of grade point average scores in a partial lottery medical school admission system. *Medical Education*, 40(10), 1012–1019. <https://doi.org/10.1111/j.1365-2929.2006.02561.x>

- Commission on Accreditation of Allied Health Programs. (2018). *CAAHEP Accreditation Process*. <https://www.chea.org/commission-accreditation-allied-health-education-programs>
- Conover, W. J., & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *American Statistician*, *35*(3), 124–129. <https://doi.org/10.1080/00031305.1981.10479327>
- Cunningham, C. J. L., Manier, A., Anderson, A., & Sarnosky, K. (2014). Rational versus empirical prediction of nursing school success. *Journal of Professional Nursing*, *30*(6), 486–492. <https://doi.org/10.1016/j.profnurs.2014.03.006>
- DeCarlo, L. T. (1997). On the meaning and use of kurtosis. *Psychological Methods*, *2*(3), 292–307. <https://doi.org/10.1.1.454.9547>
- Dewberry, C., & Jackson, D. J. R. (2018). An application of the theory of planned behavior to student retention. *Journal of Vocational Behavior*, *107*, 100–110. <https://doi.org/10.1016/j.jvb.2018.03.005>
- Dickson, J. J. (2015). Supporting a generationally diverse workforce: Considerations for aging providers in the US healthcare system. *Journal of Best Practices in Health Professions Diversity*, *8*(2), 1071–1086. <https://uncpress.org/journals/journal-of-best-practices-in-health-professions-diversity/>
- Dolder, C. R., Olin, J. L., & Alston, G. L. (2012). Prospective measurement of a problem-based learning course sequence. *American Journal of Pharmaceutical Education*, *76*(9). <https://doi.org/10.5688/ajpe769179>

- Downey, M. C., Collins, M. A., & Browning, W. D. (2002). Predictors of success in dental hygiene education: A six-year review. *Journal of Dental Education*, 66(11), 1269–1273. <https://doi.org/10.1002/j.0022-0337.2002.66.11.tb03600.x>
- Dunn, D. S., Brewer, C. L., Cautin, R. L., Gurung, R. A. R., Keith, K. D., McGregor, L. N., Nida, S. A., Puccio, P., & Voigt, M. J. (2010). The undergraduate psychology curriculum: Call for a core. In D. F. Halpern (Ed.), *Undergraduate education in psychology* (pp. 47–61). American Psychological Association. <https://doi.org/10.1037/12063-003>
- Eiland, L. S., Gaillard, P. R., Fan, S., & Jungnickel, P. W. (2018). Differences in predictors of academic success using multi and individual year student admissions data. *Pharmacy Education*, 18(1), 255–258. <http://54.77.129.155/pharmacyeducation/article/viewFile/640/581>
- Field, A. (2013). *Discovering statistics using SPSS* (4th ed.). Sage.
- Flores, M., & Simonsson, M. (2012). Determining college performance of allied health students. *Radiologic Technology*, 83(4), 325–336. <http://www.radiologictechnology.org/content/83/4.toc>
- Gall, M. D., Gall, J. P., & Borg, W. R. (2010). *Applying educational research* (6th ed.). Pearson.
- Harahan, M. F. (2010). A critical look at the looming long-term care workforce crisis. *American Society on Aging*, 34(4), 20–26. <https://www.asaging.org/generations-journal-american-society-aging>
- Harris, B. A. (2006). The importance of creating a “sense of community”. *Journal of College Student Retention*, 8(1), 83–105. <https://doi.org/10.2190/AMNM-2VKP-V6MH-D1GF>

- Heileman, G. L., Hickman, M., Slim, A., & Abdallah, C. T. (2017). *Characterizing the complexity of curricular patterns in engineering programs*. Paper ID No. 19918 presented at the meeting of American Society for Engineering Education, University of New Mexico.
- Hepworth, D., Littlepage, B., & Hancock, K. (2018). Factors influencing university student academic success. *Educational Research Quarterly*, 42(1), 45–61.
<https://doi.org/10.1080/13803610902804382>
- Hinderer, K. A., DiBartolo, M. C., & Walsh, C. M. (2014). HESI admission assessment (A2) examination scores, program progression, and NCLEX-RN success in baccalaureate nursing: An exploratory study of dependable academic indicators of success. *Journal of Professional Nursing*, 30(5), 436–442. <https://doi.org/10.1016/j.profnurs.2014.01.007>
- Hines, R., & Henderson, A. (2017, September). *Relationship between general education course sequence and student success*. (Assessment in Practice). Urbana, IL: National Institute for Learning Outcomes Assessment (NILOA).
- Howell, D. C. (2013). *Statistical methods for psychology* (8th ed.). Wadsworth Cengage Learning.
- Ingrassia, J. M. (2016). Successful admission criteria to predict academic and clinical success in entry-level radiography programs. *Radiologic Technology*, 87(5), 502–510.
<https://pubmed.ncbi.nlm.nih.gov/27146174/>
- Jaggars, S., & Fletcher, J. (2014). *Redesigning the student intake and information provision processes at a large comprehensive community college* (CCRC Working Paper No. 72). New York, NY: Teachers College, Community College Research Center, Columbia University. <https://doi.org/10.7916/D8GQ6VWW>

- Juraschek, S. P., Zhang, X., Ranganathan, V. K., & Lin, V. W. (2012). United States registered nurse workforce report card and shortage forecast. *American Journal of Medical Quality*, 27(3), 241–249. <https://doi.org/10.1177/1062860617738328>
- Kaufman, R., & Guerra-Lopez, I. (2013). *Needs assessment for organizational success*. ASTD.
- Kelsch, M. P., & Sylvester, R. K. (2016). The effect of prerequisite pharmacodynamics course timing on student performance in pharmacotherapy courses. *American Journal of Pharmaceutical Education*, 80(6), 1–99. <https://doi.org/10.5688/ajpe80699>
- Khan, S. (2015). Comparison of student’s retention of core concepts in traditional, hybrid and writing-intensive allied health microbiology and infection control courses. *HETS Online Journal*, 6(1), 1-10. <http://hets.org/ejournal/2015/11/03/785/>
- Kinzie, J., & Kuh, G. (2017). Reframing student success in college: Advancing know-what and know-how. *Change: The Magazine of Higher Learning*, 49(3), 19–27. <https://doi.org/10.1080/00091383.2017.1321429>
- Knauss, P. J., & Willson, P. (2013). Predicting early academic success: HESI admissions assessment exam. *Journal of Professional Nursing*, 29(2S), S28–S31. <https://doi.org/10.1016/j.profnurs.2012.07.001>
- Leavy, P. (2017). *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches*. Guilford.
- Levit, L., Smith, A. P., Benz, E. J., & Ferrell, B. (2010). Ensuring quality cancer care through the oncology workforce. *Journal of Oncology Practice*, 6(1), 7-11. <https://doi.org/10.1200%2EJOP.091067>

- Lim, J. M. (2016). The relationship between successful completion and sequential movement in self-paced distance courses. *International Review of Research in Open and Distributed Learning*, 17(1), 159–179. <https://doi.org/10.19173/irrodl.v17i1.2167>
- Lin, V. W., Lin, J., & Zhang, X. (2015). U. S. social worker workforce report card: Forecasting nationwide shortages. *Social Work*, 61(1), 7–15. <https://doi.org/10.1093/sw/swv047>
- Lund, A., & Lund, M. (2013). *Independent t-test using SPSS statistics*. Laerd Statistics. <https://statistics.laerd.com/spss-tutorials/independent-t-test-using-spss-statistics.php>
- Mancuso, J. M., & Udilis, K. A. (2012). Doctor of Nursing Practice programs across the United States: A benchmark of information. Part II: Admission criteria. *Journal of Professional Nursing*, 28(5), 274–283. <https://doi.org/10.1016/j.profnurs.2012.01.002>
- Manieri, E., De Lima, M., & Ghosal, N. (2015). Testing for success: A logistic regression analysis to determine which pre-admission exam best predicts success in an associate degree in nursing program. *Teaching and Learning in Nursing*, 10(1), 25–29. <https://doi.org/10.1016/j.teln.2014.08.001>
- Marquand, A., & York, A. (2016). Squaring to the challenge: Who will be tomorrow's caregivers? *Journal of the American Society on Aging*, 40(1), 10–17. <https://www.asaging.org/blog/squaring-challenge-who-will-be-tomorrows-caregivers>
- McCall, K. L., Allen, D. D., & Fike, D. S. (2006). Predictors of success in a doctor of pharmacy program. *American Journal of Pharmaceutical Education*, 70(5), 1-7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1637008/>
- Meagher, D. G., Pan, R., & Perez, C. D. (2011). Predicting performance in the first-year of pharmacy school. *American Journal of Pharmaceutical Education*, 75(5), 1–6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3142965/>

- Menard, S. (2009). *Logistic regression: From introductory to advanced concepts and applications*. Sage.
- Northouse, P. G. (2016). *Leadership: Theory and practice*. Sage.
- O'Dwyer, L. M., & Bernauer, J. A. (2014). *Quantitative research for the qualitative researcher*. Sage.
- Ortega, K. H., Burns, S. M., Hussey, L. C., Schmidt, J., & Austin, P. N. (2013). Predicting success in nurse anesthesia programs: An evidence-based review of admission criteria. *AANA Journal*, *81*(3), 183–189.
<https://pdfs.semanticscholar.org/cf69/a8355f3b337ea3075830ae5a83b05b1fb371.pdf>
- Osborne, J., & Waters, E. (2002). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research & Evaluation*, *8*(2), 1-9.
<https://doi.org/10.7275/r222-hv23>
- Palumbo, M. V., Rambur, B., McIntosh, B., & Naud, S. (2008). Perceptions of an ideal career versus perceptions of six health careers. *Journal of Allied Health*, *37*(1), 8–14.
https://www.researchgate.net/profile/Shelly_Naud/publication/5408810_Perceptions_of_an_ideal_career_versus_perceptions_of_six_health_careers/links/0912f506596dc9e68100000.pdf
- Parrott-Robbins, R. (2010). *Identifying the value of the ACT score as a predictor of student success in respiratory care, radiography, and nursing at southeast Kentucky community and technical college* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 3412668).

- Pence, P. L. (2011). Predictors of retention among undergraduate students attending associate-degree nursing programs in Illinois. *Teaching and Learning in Nursing*, 6(3), 131–138. <https://doi.org/10.1016/j.teln.2011.01.004>
- Raman, J. (2013). Nursing student success in an associate degree program. *Teaching and Learning in Nursing*, 8(2), 50–58. <https://doi:10.1016/j.teln.2012.12.001>
- Rath, B., Rock, K., & Laferriere, A. (2013). *Pathways through college: Strategies for improving community college student success*. Our Piece of the Pie. <http://opp.org/wp-content/uploads/2017/06/Pathways-through-College-OPP-April-2013.pdf>
- Razali, N. M., & Wah, Y. B. (2011). Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. *Journal of Statistical Modeling and Analytics*, 2(1), 21-33. <https://www.nrc.gov/docs/ML1714/ML17143A100.pdf>
- Rogers, T. L. (2010). Prescription for success in an associate degree nursing program. *Journal of Nursing Education*, 49(2), 96–100. <https://doi.org/10.3928/01484834-20091022-03>
- Salkind, N. J. (2017). *Statistics for people who (think they) hate statistics*. Sage.
- Sanderson, T. R. (2014). Relating admissions criteria to dental hygiene student retention. *Journal of Allied Health*, 43(4), 235–240. <https://www.asahp.org/journal-of-allied-health>
- Schauner, S., Hardinger, K. L., Graham, M. R., & Garavalia, L. (2013). Admission variables predictive of academic struggle in a PharmD program. *American Journal of Pharmaceutical Education*, 77(1), 1–7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3578340/>
- Schmidt, B., & MacWilliams, B. (2011). Admission criteria for undergraduate nursing programs: A systematic review. *Nurse Educator*, 36(4), 171–174. <https://doi.org/10.1097/NNE.0b013e31821fdb9d>

- Scott-Clayton, J. (2011). *The shapeless river: Does a lack of structure inhibit student's progress at community college? CCRC Working Paper No. 25*. New York, NY: Community College Research Center, Teachers College, Columbia University.
- Scott-Clayton, J., & Rodriguez, O. (2015). Development, discouragement, or diversion? New evidence on the effects of college remediation policy. *Education Finance and Policy*, *10*(1), 4–48. https://doi.org/10.1162/EDFP_a_00150
- Scrivener, S., Weiss, M. J., Ratledge, A., Rudd, T., Sommo, C., & Fresques, H. (2015). *Doubling graduation rates: Three-year effects of CUNY's accelerated study in associate programs (ASAP) for developmental education students*. MDRC.
- Seidman, A. (2005). *Where we go from here: A retention formula for student success*. In A. Seidman (Ed.), *College student retention: Formula for student success* (pp. 295–316). Praeger.
- Shulruf, B., Wang, Y. G., Zhao, Y. J., & Baker, H. (2011). Rethinking the admission criteria to nursing school. *Nurse Education Today*, *31*(8), 727–732. <https://doi.org/10.1016/j.nedt.2010.11.02>
- Siemens, S. (2011). *Predictors of academic success in allied health programs* (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. (UMI No. 3493003).
- Silverman, L. H., & Seidman, A. (2011). Academic progress in developmental math courses: A comparative study of student retention. *Journal of College Student Retention*, *13*(3), 267–287. <https://doi.org/10.2190/CS.13.3.a>

- Slim, A., Heileman, G. L., Al-Doroubi, W., & Abdallah, C. T. (2016). *The impact of course enrollment sequences on student success*. Presented at the 2016 IEEE 30th International Conference on Advanced Information Networking and Applications, Crans-Montana, Switzerland. <https://doi.org/10.1109/AINA.2016.140>
- Slim, A., Heileman, G. L., Kozlick, J., & Abdallah, C. T. (2014). *Predicting student success based on prior performance*. Presented at the 2014 IEEE 30th International Conference on Advanced Information Networking and Applications. <https://doi.org/10.1109/CIDM.2014.7008697>
- Sperle, C. K. (2013). Predictors of success in a baccalaureate respiratory therapy program. *Respiratory Care Education Annual*, 23, 28–33. <https://etd.ohiolink.edu/>
- Staykova, M. P. (2012). Community college education through the looking glass of associate degree nursing. *Teaching and Learning in Nursing*, 7(3), 93–97. <https://doi.org/10.1016/j.teln.2012.01.005>
- Stegers-Jager, K. M., Themmen, A. P. N., Cohen-Schotanus, J., & Steyerberg, E. W. (2015). Predicting performance: relative importance of students' background and past performance. *Medical Education*, 49(9), 933–945. <https://doi.org/10.1111/medu.12779>
- Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). Routledge Academic.
- Stevens, S. Y., Shin, N., & Peek-Brown, D. (2013). Learning progressions as a guide for developing meaningful science learning: A new framework for old ideas. *Educacion Quimica*, 24(4), 381–390. [https://doi.org/10.1016/S0187-893X\(13\)72491-1](https://doi.org/10.1016/S0187-893X(13)72491-1)

- Stoloff, M., McCarthy, M., Keller, K., Varfolomeeva, V., Lynch, J., Makara, K., Simmons, S., & Smiley, W. (2010). The undergraduate psychology major: An examination of structure and sequence. *Teaching of Psychology, 37*(1), 4–15.
<https://doi.org/10.1080/00986280903426274>
- Tabachnick, B., & Fidell, L. (2013). *Using multivariate statistics*. Pearson Education.
- Terrell, P. (2017). *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches*. Sage.
- Thomas, S. W., McLean, L., & Debnam, A. (2011). The role of allied healthcare in health care reform. *NC Medical Journal, 72*(5), 417–419. <https://classic.ncmedicaljournal.com/wp-content/uploads/2011/09/72522-web.pdf>
- Timer, J. E., & Clauson, M. I. (2011). The use of selective admissions tools to predict students' success in an advanced standing nursing program. *Nurse Education Today, 31*(6), 601–606. <https://doi.org/10.1016/j.nedt.2010.10.015>
- Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*(1), 89–125.
<https://doi.org/10.3102/00346543045001089>
- Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition*. The University of Chicago Press.
- Tinto, V. (2006). Research and practice of student retention: What next? *Journal of College Student Retention, 8*(1), 1–19. <https://doi.org/10.2190/YNU-4TMB-22DI-AN4W>
- Trochim, W. M. K. (2006). *What is the research methods knowledge base?* Sydney, Australia: Web Center for Social Research Methods. <https://www.socialresearchmethods.net/kb>

- Trofino, R. M. (2013). Relationship of associate degree nursing program criteria with NCLEX-RN success: What are the best predictors in a nursing program of passing the NCLEX-RN the first time? *Teaching and Learning in Nursing*, 8(1), 4–12.
<https://doi.org/10.1016/j.teln.2012.08.001>
- Unni, E. J., Zhang, J., Radhakrishnan, R., Smith, K. P., Bridgen, C. M., DeYoung, M. H., & Metzger, T. G. (2011). Predictors of academic performance of pharmacy students based on admission criteria in a three-year pharmacy program. *Currents in Pharmacy Teaching & Learning*, 3(3), 192–198. <https://doi.org/10.1016/j.cptl.2011.04.006>
- Van Noy, M., Trimble, M., Jenkins, D., Barnett, E., & Wachen, J. (2016). Guided pathways to careers: Four dimensions of structure in community college career-technical programs. *Community College Review*, 44(4), 263–285. <https://doi.org/10.1177/0091552116652939>
- Vealé, B. L., Clark, K. R., Killion, J. B., & Sharma, P. (2017). The HESI admission assessment and radiography exit examination as predictors for student success. *Journal of Medical Imaging and Radiation Sciences*, 48(1), 90–94.
<https://doi.org/10.1016/j.jmir.2016.10.001>
- Wambuguh, O., Eckfield, M., & Van Hofwegen, L. (2016). Examining the importance of admissions criteria in predicting nursing program success. *International Journal of Nursing Education Scholarship*, 13(1), 87–96. <https://doi.org/10.1515/ijnes-2015-0088>
- Westfall, P. H., & Henning, K. S. S. (2013). *Texts in statistical science: Understanding advanced statistical methods*. Taylor & Francis.
- Wigdahl, J., Heileman, G. L., Slim, A., & Abdallah, C. T. (2014). Curricular efficiency: What role does it play in student success? *121st ASEE Annual Conference & Exposition, USA*.
https://pdfs.semanticscholar.org/d99f/5cf90b938_ea0377ed3c2cd79a0a14ee96f20.pdf

- Wilson, J. T., Gibbons, S. W., & Wofford, K. (2015). Process improvement: Addressing attrition from the Uniformed Services University of the Health Sciences nurse anesthesia program. *AANA Journal*, 83(5), 351–356.
<https://pdfs.semanticscholar.org/ad02/5f5983163580fe134d5b2875533ac7a09896.pdf>
- Wolkowitz, A. A., & Kelley, J. A. (2010). Academic predictors of success in a nursing program. *Journal of Nursing Education*, 49(9), 498–503. <https://doi.org/10.3928/01484834-20100524-09>
- Xu, J., Xing, T., & van der Schaar, M. (2016). Personalized course sequence recommendations. *IEEE Transactions on Signal Processing*, 64(20), 5340–5352.
<https://doi.org/10.1109/TSP.2016.2595495>
- Zhang, X., Tai, D., Pforsich, H., & Lin, V. W. (2018). United States registered nurse workforce report card and shortage forecast: A revisit. *American Journal of Medical Quality*, 33(3), 229–236. <https://doi.org/10.1177/1062860611416634>
- Zimelman, J. L., Juraschek, S. P., Zhang, X., & Lin, V. W., (2010). Physical therapy workforce in the United States: Forecasting nationwide shortages. *American Academy of Physical Medicine and Rehabilitation*, 2(11), 1021–1029.
<https://doi.org/10.1016/j.pmrj.2010.06.015>

Appendix A: IRB Letter of Approval

ABILENE CHRISTIAN UNIVERSITY

Educating Students for Christian Service and Leadership Throughout the World

Office of Research and Sponsored Programs
320 Hardin Administration Building, ACU Box 29103, Abilene, Texas 79699-9103
325-674-2885



April 23, 2020

Patrick Dupont
Department of Education
Abilene Christian University

Dear Patrick,

On behalf of the Institutional Review Board, I am pleased to inform you that your project titled "Academic Success and Curricular Structure: Exploring the Relationship Between Prerequisite Course Sequence and Grade Point Average in Community College Health Science Students",

(IRB# 20-051) is exempt from review under Federal Policy for the Protection of Human Subjects as:
Non-research, and

Non-human research

Based on:

The research does not involve interaction or intervention with living individuals, and the information being collected is not individually identifiable [45 CFR 46.102(f)(2)]

If at any time the details of this project change, please resubmit to the IRB so the committee can determine whether or not the exempt status is still applicable.

I wish you well with your work.

Sincerely,

Megan Roth

Megan Roth, Ph.D.
Director of Research and Sponsored Programs

Appendix B: Variable Descriptions

Variable Name	Variable Label	Type	Role
Course Sequence	In Sequence = ISeq Out of Sequence = OSeq	Nominal	Independent
Gender	Male = 1 Female = 2	Nominal	Covariate
Age	18-60	Ratio	Covariate
Prerequisite GPA	0.0-4.0	Ratio	Dependent