META-ANALYSIS OF ENTRANCE STANDARDS FOR UNDERGRADUATE NURSING AND SELECTED ALLIED HEALTH PROGRAMS

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The purpose of this study was to evaluate the efficacy of admission standards that have been used for undergraduate allied health and nursing programs. Five professions met the initial criteria including the awarding of a 2- or 4-year degree, a national board examination administered upon program completion, and published research covering entrance standards. The professions are: dental hygiene, medical technology, registered nursing, radiologic technology, and respiratory therapy.

Random-format meta-analysis was used to evaluate 28 years of research gathered from both published and unpublished documents. Length of time used for data collection was defined by published research using outcome parameters, including national board examinations. Forty-eight studies resulted in 230 comparable effect size variables.

Twenty-one predictors were identified in the research and were measured against 4 criterion variables. ACT English, entrance grade point average, and biology were statistically significant predictors for all 5 professions. While no predictors had a shared variance across all professions, 8 predictors resulted in shared variance when moderators were considered. These included: ACT English, math, science, and social science; chemistry; entrance grade point average; SAT verbal; and a specialized test, the AHPAT. Each of these measures used board scores as the criterion measure.
Moderators included the length of time used to gather data, year of study or publication, whether the study was published, and the profession. Profession had the largest effect on the statistical significance of the predictors.

Two- and 4-year programs were identified as subgroups. Considering the moderator, profession, only 2 predictors were affected by the subgroups: entrance grade point average in Medical Technology and ACT science in Registered Nursing.
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CHAPTER I
INTRODUCTION

Admission standards have long been a common practice in higher education. Initially those standards included a student’s ability to pay for his or her own education and an oral exam often administered by the university president. As institutions grew in number and size, admission requirements became more standardized to accommodate the increased number of students accessing higher education (David & Grimes, 1999). Today, over three-quarter of four-year colleges and universities require incoming first year students to meet at least one admission standard prior to college acceptance (Provasnik & Planty, 2008). However, a report issued by the United States Department of Education revealed that a significant portion of first year undergraduates enter higher education through the community college system. The majority of community colleges in the United States have an open admissions policy meaning “students neither need to compete for admission at a set time of the year nor demonstrate a level of academic proficiency to enroll” (2008, p. 10). In fact, the National Center for Education Statistics reported that in the 2005-06 school year, only 4% of community colleges nationwide had at least one admission requirement (2008). The difference in admission standards to colleges is significant as community colleges are the most common type of two-year college in the United States and house more than one-half the undergraduate allied health and nursing programs.

Allied health and nursing programs are two- and four-year accredited degree programs hosted by both two-year and four-year institutions. Acceptance into these
programs often extends beyond the traditional enrollment guidelines used in the colleges and universities. The need for additional standards is a direct consequence of stakeholder influences including external accrediting agencies and internal institutional guidelines (Commission on Collegiate Nursing Education [CCNE], 2008; Commission on Dental Accreditation [ADA], 1998; Committee on Accreditation for Respiratory Care [CoARC], 2003; Joint Review Committee on Education in Radiologic Technology [JRCERT], 2002; National Accrediting Agency for Clinical Laboratory Sciences [NAACLS], 2006; National League for Nursing Accrediting Commission [NLNAC], 2005). Documentation of success in prerequisite coursework such as math and science, entrance examinations, or aptitude placement as high school rank or grade point average are used to assess the quality of incoming students as programs are limited in time to degree and are accountable for their graduates’ success on licensing and registry examinations.

The purpose of this study is to evaluate the efficacy of admission standards that have been used for undergraduate allied health and nursing programs resulting in two- or four-year degrees. This study uses a meta-analysis technique to review research on admission standards for five undergraduate health programs including dental hygiene, medical technology, registered nursing, radiologic technology, and respiratory therapy relative to student outcomes including grade point average, degree completion, and successful completion of national board examinations. The five professions selected for this study are all nationally accredited, offered in two-year and four-year colleges and universities awarding associate and bachelor degrees. The selected undergraduate programs are grouped as one under the umbrella term, health professions.
Health Professions

Programs preparing individuals for health professions are accredited by external organizations including national professional associations and state licensing bureaus. These organizations uphold standards for each profession defining program content and, in some cases, require specific program structure including classroom, laboratory, and clinical experience. Accreditation from these organizations permits graduates access to professional board examinations designed to measure basic knowledge necessary to enter a profession. Successful completion of the board examinations may qualify graduates for licensure and professional employment. The accrediting organizations also track how well programs meet established outcome criteria including graduate success on board examinations and graduate employment (ADA, 1998; CoARC, 2003; JRCERT, 2002; NAACLS, 2006; NLNAC, 2005). In addition to professional organizations, programs are accountable internally to their host colleges, resulting in limits on time and credit allowed for program completion.

Profession specific coursework in these programs includes classroom, on-campus laboratory time, and clinical experience, creating additional clock and credit hours for each program, essential requirements for professional accreditation standards. The need for up-to-date laboratories and contracts with external medical facilities places additional stress on host colleges as most have limited resources, including financial restrictions. Programs must work within those limits while addressing content and outcome guidelines as defined by their external professional organizations. These additional hours must be
balanced with requirements necessary for the college degree, including general education, related prerequisite, and support coursework.

Given the mandates and clearly defined student outcomes, the only point of flexibility for programs is the quality of students at entrance. Selection of students is not defined by the accrediting organizations and is left to individual program faculties. Assuring that incoming students are capable of learning the material and working in a healthcare environment is an important first step in meeting the outcomes set forth by the various external agencies. Additionally, programs must select students that will be served by the institutional mission to assure a match between resources, as student services, and the incoming student (Billson & Terry, 1987). Admission requirements are determined with the intent of selecting students best prepared for entrance into a particular professional program.

Including only the five selected professions, there are 1,661 accredited two-year health programs and 1,100 accredited four-year health programs in the United States (see Appendix A). Each of these programs operates within both the college and profession specific guidelines, yet there is no empirical evidence demonstrating shared successful admission standards, either within the professions or within the institutions. What is lacking is a comprehensive longitudinal review of admission standards related to student success for undergraduate allied health and nursing professions from a national point of view.

This study fills the existing gap by statistically summarizing existing research for selected health professions leading to undergraduate degrees. This meta-analysis reviews
existing research to identify significant predictors of success for each profession, and to
determine if those predictors are applicable to all selected professions. This analysis
evaluates research on admission standards for selected undergraduate allied health and
nursing programs over a 28-year period beginning in 1980 and ending in 2008. The years
were selected following a review of the literature. Nursing was the last profession to
begin nationally standardized testing, and that began in 1982. Prior to this time students
graduating from nursing programs took State Board Examinations (Fowles, 1992). The
significant time line allotted for the study increases the number of research articles for
review and identifies standards that have continued to be significant predictors over time.

Professions selected for review were chosen following a literature review. Those
professions with publications in peer-reviewed journals were reviewed further for
outcomes including national board examinations and future preservation of the two- or
four-year degree status. Final selection includes five professions resulting in associate or
bachelor degrees, qualifying the graduate for professional licensure or registry
examinations with national reciprocity at outcome. Dental hygiene, medical technology,
registered nursing, radiologic technology, and respiratory therapy met the aforementioned
guidelines and are included in the final study.

Rationale

This research addresses a government report issued by the United States Secretary
of Education on the future of higher education in September 2006. The report identified
the need to develop methods to control the cost of education without affecting quality and
called for educational research and curricula to serve multiple disciplines (U.S.
Department of Education, 2006). This investigation attends to that request by reviewing research conducted on admission standards as they relate to resource utilization for the selected undergraduate health programs. As public colleges and universities already face reduced funding from states, finding common entrance standards for health programs will help reduce costs to the institution, increasing enrollment in courses designed to serve more than one health profession, and allow an institution to address its student services utilization more efficiently. A common set of admission standards will also benefit students by creating initial flexibility between the health programs, giving students the option of selecting a specific profession after beginning prerequisite coursework.

Resource utilization within institutions will be affected as educational programs for allied health and nursing require resources over and above general education coursework. Additional resources increase costs to the institution. Facilities required to run these programs include classrooms as well as up-to-date equipment in special laboratories and access to medical facilities for student learning. Necessary resources are often prescribed by accrediting organizations and include specific equipment as well as types and quantity of clinical experiences (ADA, 1998; CoARC, 2003; JRCERT, 2002; NAACLS, 2006; NLNAC, 2005). An increased need for resources increases operating costs per student and limits the number and availability of hands-on experiences accessible to programs and their students, restricting admission numbers to the health professions. However, low admission numbers do not always equate with low programmatic attrition, and allied health programs historically have high attrition rates (Gupta, 1991).
To address the trend of high attrition, accrediting agencies require programs to report attrition and may suggest limits on the number of students a program can lose after initial enrollment. Programs must also report the number of graduates employed in the profession within one year of graduation, and the results from state and national board examinations (ADA, 1998; CCNE, 2008; CoARC, 2003; JRCERT, 2002; NAACLS, 2006; NLNAC, 2005). Educators are held accountable for assuring student success within the professional program as well as after graduation. Student selection is thus the first step in providing programs with individuals prepared for program rigors, and the first step in providing each profession with future practitioners.

Measures used in initial student selection are not defined by the accrediting organizations and vary both institutionally and by profession. Reasons for differences in admission practice relate to the type of colleges involved in the education, missions, and philosophies of those institutions and its faculty. Many allied health and nursing programs are located in two-year colleges, especially community colleges, known for open admission policies for entrance into general studies. Differences in initial selection of candidates create differences in student populations requiring varying institutional resources and support systems (Billson & Terry, 1987). The difference in admission policies does allow for colleges to define its populations, however, those differences may not be consistent with skills, knowledge, and qualities associated with professional programmatic success.
Theoretical Perspective

Systems theory presents a conceptual framework in which to view health occupation programs. The health programs work within the larger social system of higher education and must interact with their environment to survive. Systems theory presents a way of looking at and describing that interaction. Rather than proposing hypotheses and attempting to explain cause and effect by investigating one specific incident, this theory looks at a sequence of events that recur and is used to describe and explain those events (Katz & Kahn, 1966).

Systems theory can be divided into closed and open systems. A closed system contains all it needs to function and is independent of its environment. Early systems theory was dominated by this viewpoint. While it accounts for internal actions of a system, it is an incomplete theory when one recognizes the need of a system to interact with its environment to survive. The defining characteristic of an open system is its interaction with its environment (Marion, 2002). More recent research has focused on this interaction as the environment in which they exist influences both the structure and behavior of organizations including higher education. To function, open systems must have a way of controlling effects of the environment and one method is the utilization of selective input (Katz & Kahn, 1966).

Input is what an organization takes from the environment (Birnbaum, 1988). It is the first of three major phases of systems. Systems rely on the environment to provide them with resources for operation, and when viewing educational institutions as systems their input can be defined as the students who come to the college with different
educational, cultural, and motivational backgrounds. As environments differ and change, the input, or students, will also change and is therefore not guaranteed to be consistent (Katz & Kahn, 1966). Systems must adapt to changes in the environment as not only will the input change, but also changes in the environment will necessitate changes in the output. Both the input and output are subject to the external environment and require a system to change for survival. Advances in medical knowledge and technology, and a growing global culture, are examples of external environmental changes that have affected the health professions.

Open systems utilize resources from the environment for their input, process them, and then send them back to the environment changed, as an output (Marion, 2002). Interpreting systems thinking for the allied health professions requires a specific definition for each of the three components. Inputs may be defined as a student’s entrance knowledge and skills; through-puts as professional program information; and outputs as desired outcome standards. Students are the college resources that enter from the external environment to gain knowledge. As they enter the health professions they do so with varying levels of life experience and motivation. Consequently, their potential for successful program, practice, and board examination completion varies, requiring institutions to match student potential with available resources (Hawley-Oliver, 1985). Identifying those students who will best fit the particular college environment thus creating the best inputs for that program is done through the selective admission process.

The second phase of the resource transformation process in open systems is the internal action termed through-puts. When an input is brought into a system it is changed
before returning to the external environment as an output. This transformation is less
influenced by the environment, but results in a change in the input (Katz & Kahn, 1966).
In the health professions, through-put is defined by the examination boards. Outlines or
matrices gathered from surveys of active practitioners are based on current practice and
guide program content or through-put. The matrices are reassessed by the organizations
on a regular schedule, and are used to develop the national board examinations.

The output is evaluated through profession-specific board examinations and
employment data. Each program reports results of examination success and employment
placement back to the accrediting agencies (ADA, 1998; CCNE, 2008; CoARC, 2003;
JRCERT, 2002; NAACLS, 2006; NLNAC, 2005). The through-put, or matrices, and the
output, board examinations and employment, are defined for each profession. What the
accrediting organizations do not require is a common standard for students at admission.

In an open system “characteristics of the input often cannot be accurately assessed
or controlled, and processing input can be problematic because it may rely on uncertain
interactions between elements” (Birnbaum, 1988, p. 34). Viewing the educational system
as an open system allows for some variation at entrance. The issue of how much and
what type of variation there is at entrance does arise, because the tendency of professions
to define the core of knowledge needed to succeed upon graduation leads to the
underlying assumption that there must be some initial shared knowledge or abilities at
entrance that provide success in program outcomes. An open system allows for selective
input from the environment (Katz & Kahn, 1966). Admission standards need to relate to
the core of knowledge taught within the program and measured at outcome. Selective
admission will identify students that relate most closely to those cognitive standards at entrance.

However, cognitive standards are not enough to guarantee student success in the health professions. When students enter an institution they bring different life experiences and backgrounds. They possess affective differences that may influence their motivation within the program and final completion (Bloom, 1976). The college mission and subsequent availability of resources allows for some variation in student selection between institutions. While providing more consistency in the student knowledge base at entrance will help predict which students will be scholastically successful, evaluating those students against the institution’s purpose and mission will help colleges predict attrition, and ultimately, program completion. In addition to a core knowledge base, students must have an affect that is appropriate to the profession. To be comprehensive, admission standards must include non-academic factors related to behaviors associated with professional affect, thus providing an output that is consistent with the environment’s needs.

**Rationale for Shared Standards**

Nursing and allied health programs share coursework outside of the profession specific curriculum including sciences and general education classes. Much of the research conducted on entrance standards is focused on standardized tests, cumulative grade point averages, or grades in specific coursework taken prior to program admittance. These admission criteria are similar for all the health professions research. With similar
initial coursework and admission measures, it is possible to view the entrance criteria as predictors for more than one profession.

While programs within institutions often share coursework prior to admission, much of the published research has been conducted by a single institution for a single program. Little published research looks at all professions within one organization. Additionally, research that has been conducted has generally been in a longitudinal format to gain the statistical advantage of sample size as developed over time. Decisions based on concrete statistical evidence are protracted because a single program may need to gather several years of data before the sample size is sufficient to generate significant results. The results of this research are not likely to be shared internally or reported in peer reviewed journals, creating a knowledge gap in the health professions education (Westat, 2005).

Two important considerations regarding professional investigation in the allied health professions stem from the fact that many of the allied health and nursing programs are housed in community colleges where faculties are not required to publish research for tenure, and that the allied health professions have few graduate programs to contribute to the professional publication process. Combining results from what is available in the literature over time increases the statistical advantage for those professions with few published articles. Internal institutional research requested from programs that might not be published in the literature adds to the sample size and decreases the risk of bias resulting from the use of published articles that favor statistically significant results (Rosenthal, 1991).
Research from the selected professions is evaluated both as a whole under the heading of health professions and separately for each occupation to determine if there are core admission standards and to identify additional standards that are beneficial to a single profession over and above the core. A meta-analysis technique is used to statistically review the data. This statistical method is used to compare research data from varying methodologies and give strength to smaller studies (Glass, McGaw, & Smith, 1981).

**Meta-Analysis**

Meta-analysis is a statistical procedure designed to add strength to smaller studies by combining results to evaluate effect sizes. Studies with smaller sample sizes may not be published in the professional literature due to lack of statistical significance. By combining study results, meta-analysis increases the sample size, increasing the chance of identifying a treatment effect with statistical significance. Combining studies creates a larger sample with a better possibility for generalization and inference of results to a larger population (DePoy & Gitlin, 2005). Adding unpublished research to the analysis also decreases the risk of bias toward studies with statistical significance as those are more likely to be published in professional journals (Wolf, 1986).

An advantage of meta-analysis is seen in its ability to combine studies with unlike statistics. Research methodologies vary relative to the question asked, and meta-analysis allows for statistical integration of results independent of the methodology used. This technique provides the researcher with an objective review of previously published research, combining studies to determine which measured parameters are significant.
when viewed from a larger sample size. Through statistics, a meta-analysis gives practical strength to a literature review that might otherwise be open to personal interpretation by the reviewer (Glass et al., 1981).

**Purpose**

The purpose of this meta-analysis is to identify a core set of entrance standards used as predictors of success for selected allied health and nursing programs. Data was gathered electronically from published research, dissertations, and professional presentations. Unpublished papers were requested online from health professions faculty through email addresses identified by their respective professional organizations. Samples drawn from various sources were used to help prevent sampling bias that might be introduced if the search was limited to peer-reviewed publications (Rosenthal, 1991).

Skills and qualities most often cited in the literature as predictors for successful completion are the same for nursing and some allied health occupations (Op’t Holt & Dunlevy, 1992). This research compares those predictors across the professions. The meta-analysis is used to identify universal predictors, and as this technique allows for categorization of results, providing the researcher with the ability to group data according to profession and to compensate for selected moderators. The research technique allows for universal and individual assessment of each predictor (Glass et al., 1981).

**Significance**

This research will add to the body of knowledge surrounding entrance standards for undergraduate nursing and selected allied health professions adding statistical strength to smaller studies and identifying universal qualities associated with successful outcomes.
The research is limited to two- and four-year undergraduate degrees as those programs share the same outcome standards of national certifications or registry and state licenses. The five professions evaluated individually and as an aggregate are: dental hygiene, medical technology, nursing, radiologic technology, and respiratory therapy.

The literature search is longitudinal covering a time span from 1980 to 2008. The significant length of time permits a review of standards allowing the researcher to identify knowledge or characteristics that have remained strong predictors of success over time. It also allows for identification of changes in perspective as knowledge within or about the specific role of the professions in medical care has matured.

**Operational Definitions**

**Academic entrance standards** Academic entrance standards are program specific and include coursework and tests taken prior to program entrance that are thought to be reliable indicators of student success.

**Allied health** Allied health degrees are specialty degrees designed to educate practitioners who will work under the supervision of a medical doctor. The allied health professions do not include nursing. For this paper, allied health will include dental hygiene, medical technology, radiologic technology, and respiratory therapy undergraduate programs.

**Health occupations** For this study, health occupations will include undergraduate programs culminating in degrees and qualifying the graduate for a professional board examination. The occupations meeting these standards include dental hygiene, medical
technology, nursing, radiologic technology, and respiratory therapy (ADA, 1998; CCNE, 2008; CoARC, 2003; JRCERT, 2002; NAACLS, 2006; NLNAC, 2005).

Medical technology The name, Medical Technology, will be used to represent both two- and four-year programs. It will replace the official name for the two-year program in this profession, Medical Laboratory Technology.

Meta-analysis A meta-analysis is a statistical technique that uses empirical research as the sample. The technique blends various statistical tests to evaluate the size of a treatment effect. It gives statistical strength to smaller sample sizes. Literature resources can be varied and include research from peer-reviewed journals, unpublished papers located through an internet search, professional presentations, and dissertations (DePoy & Gitlin, 2005).

Moderators Moderator variables are factors that influence the magnitude of the causal effect of the predictors on the outcomes (Rosenthal, 1991). Moderators may affect the external validity inhibiting generalization of results. For this study, moderator variables considered are: the time point at which the research was published, whether the research was published or not, the separate professions, and whether the research was conducted in a single year or over multiple years. Additionally, results are evaluated for two- and four-year programs.

Non-academic entrance standards Non-academic standards reflect a student’s moral character and/or their social behavior. Examples of evaluation methods as reflected in the health profession literature include interviews and self-reporting surveys.
Successful outcomes  The literature defines successful program outcomes in various ways. For the purpose of this research, the following outcomes were considered: cumulative and professional grade point average; successful program completion or graduation; and passing scores on the respective board examinations.
CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this project is to identify entrance standards that have been used as predictors of success for selected allied health and nursing programs, and to determine which of those factors have been effective at predicting outcomes as defined by the professional programs. This chapter presents a narrative review of the literature to identify admission standards for allied health programs including both significant and non-significant findings in published and unpublished research. Twenty-eight years of allied health and nursing literature is reviewed, allowing a significant length of time to identify those predictors that have continued to be important to the individual professions over time and to increase sample size for undergraduate allied health literature. The length of time used for data gathering was determined by the criterion selected as outcome measures. Nursing did not begin to use a national examination until 1982 (Fowles, 1992). Prior to that time board examinations were run by the states. This study used national board examinations as a delimiter; thus studies conducted prior to 1982 and using state board examinations as an outcome were not included. Studies defining outcomes as graduation or grade point average were included and this took the research back to 1980. The research moderator, time point, was also determined to be in decades, thus 1980 proved to be a good starting point for data gathering. The research gathered over the 28-year period includes both academic and non-academic factors and these are included in the discussion here. To understand the role of entrance standards, a brief history of admission processes are presented, followed by a discussion of the role of the
community college in higher education. More than one-half of undergraduate health professions are housed in community colleges known for open admission policies into general studies (Palinchak, 1973). While the health professions use a selective admission process, they require two years of professional classes where admission into a program occurs early in the student’s academic experience (Laudicina, 1997). Limits on time prior to entrance into a program affect the number and type of admission standards that can be used for program acceptance. Thus, the admission standards need to be a minimal set of predictors that correlate with positive student outcomes.

Background

Higher education in the United States has always used admission standards for students seeking entrance. Initially those standards included money or social status, supporting the premise that education was for the elite class (David & Grimes, 1999). The need for wealthy students was influenced by a lack of public monies for higher education with institutional income heavily dependent upon tuition and donations from private individuals. Evaluating incoming students for their ability to contribute to financial support of the institution through tuition was an important admission consideration. At the time, most colleges were small with private entrance tests often administered by the university president. The exams were subjective and could be slanted toward the student’s preparatory study, but were reflective of the type of learning the institution would be providing (Wechsler, 1977). Thus, students were matched to institutions through preparatory work and the ability to pay for their own education.
Higher education began to change in the 19th century as the government became more involved. One of the most significant contributions to the growth of higher education was the 1862 Morrill Act. In return for receiving land from the state, universities across the nation became state institutions established to serve the entire populace, not just the wealthy, and to provide educational support to the economic community (Altbach, 2001; Brawer & Cohen, 1996; David & Grimes, 1999). Resources provided for the new colleges allowed for unprecedented growth. Public secondary schools improved preparing more students for college level work, and public funds became available allowing students from varying backgrounds to pursue higher education. This change in student population created a need for a new objective measure of incoming freshmen. Individualized oral entrance exams were no longer practical. Time and consistency became important issues in entrance selection as increasing numbers of students applied for the opportunity to pursue a degree. To meet the increased demand, colleges began to use standardized written entrance exams. These examinations, with their objective assessments of basic student cognitive abilities, could be used to evaluate a large number of incoming students (David & Grimes, 1999). Scores on these exams were used, and continue to be used, as a popular tool for selection of incoming students.

Regardless of the form or method of administration, academic admission standards have always served the same purpose, to support the curriculum by selecting students capable of handling the work (Wechsler, 1977). If students are prepared to learn and have demonstrated success with past learning, resources can be applied efficiently to
further student knowledge. The argument that each college, division, or professional department establishes its own entrance standards relative to specific curricular content is logical as entrance standards become a part of a sequential learning process. Given this premise, admission to an allied health or nursing program often uses a second standard that is more reflective of learning in the specific program (Evans & Dirks, 2001). The double admission process where students are first admitted to a college and then gain admission to a specific program after demonstration of academic success is a common practice in the United States.

The problem with a double admission process is that most allied health programs are currently housed in undergraduate institutions, including community colleges (ADA, 1998; CoARC, 2003; JRCERT, 2002; NAACLS, 2006; NLNAC, 2005). Completion of two-year programs must be possible within two years thus limiting the number and type of standards used for admission (U.S. Department of Education, 2008). This differs significantly from graduate programs where proven success in related coursework is often used as entrance criteria. Admission requirements to undergraduate programs are further limited by the demands inherent in the curriculum as most programs begin their professional instruction in the first semester or quarter. Students entering as freshmen do not have the opportunity to experience college coursework, let alone coursework related to their profession (Clark & Sharf, 1983). Identifying criteria other than higher education experience is, therefore, a goal of undergraduate health professions, particularly for those housed in two-year colleges. The most common two-year college in the United States is the community college (Provasnik & Planty, 2008). This college serves a unique purpose
in the higher education hierarchy; therefore a brief discussion of its foundation and role is discussed here.

**Community College**

The community college is an American institution with beginnings in the early 20th century and an ideal of promoting democracy through access to higher education for students from any socio-economic class with its origins in society’s economic needs (Brawer & Cohen, 1996). As American society grew, the economy changed from an agricultural to an industrial workforce, thus changing the knowledge and skill base needed from its populace. This change brought many factors together to create a need for access to higher education for a wider variety of students. Higher education became a significant method of social mobility, a democratic ideal, and thus became the place society deemed as a change agent (Altbach, 2001; Brawer & Cohen, 1996). A college education became an important step toward a better life for both individuals and society as both benefited from an educated workforce.

Because the community college opened its doors to the local community and the disadvantaged, it was and remains non-selective in its admission policies. The lack of stringent admission standards has allowed the community college to be very responsive to variations in societal economics. The most significant example of this ability was the population boom in the late 1940s that created a need for additional colleges and access to higher education as the number of high school graduates increased in the late 1960s and early 1970s. During that time, states provided funding for an unprecedented growth of community colleges across the country (Brawer & Cohen, 1996).
Colleges opened their doors and students entering the community colleges did so with less understanding of the higher educational process than those entering four-year campuses. This type of student continues to place a higher demand on the two-year college to provide resources for curricular planning, counseling, tutoring, and smaller class sizes when compared with larger universities. The provision of developmental coursework is important if the students are to succeed in the traditional framework of two years. In addition, most community colleges are located near students’ homes and allow them to work and attend classes part-time (Brawer & Cohen, 1996). Thus, the student may have outside responsibilities to family, work, and home, in addition to schoolwork. This is in direct contrast to four-year students living in on-campus housing who have few outside responsibilities and the privilege of focusing their attention on their academic interests.

Changes in traditional college life were influenced by changes in the American economy in the late 20th century as employment in the industrial sector decreased and the service economy took hold. The need for additional education to fill white collar roles further contributed to community college growth (Brawer & Cohen, 1996). The number of jobs once requiring only a high school education declined as equipment in factories and plants became more automated and workers began to need advanced skills to operate machinery and computers as part of their work environments. These students came to the community college for specific coursework that may or may not have resulted in a final degree. The proximity of higher education and increased access provided by community
colleges allowed students the option of pursuing certificates or coursework specific to changing work demands (Brawer & Cohen, 1996).

The majority of financial support given to community colleges is from the state. The colleges serve both as preparation for university transfer and as terminal degrees for technical programs (Altbach, 2001; Brawer & Cohen, 1996). Key among the terminal degree programs is the two-year health occupation degrees. These programs are expensive to run as they are resource intensive and must meet standards established by accrediting boards over and above general studies (Lang, 2009). They create a need for colleges to maintain quality programs while assuring students entering the programs are prepared to succeed. Selective admissions are a necessary part of the process assuring stakeholders that resources are used efficiently.

**Health Professions Literature**

A review of current literature evaluating admission standards to undergraduate health occupation programs reveals predictors of success to be similar across all the health professions. Academic factors such as overall grade point average, science or math grade point average, a variety of entrance exams both standardized and specific to allied health, and high school rank, appear to be the most frequently evaluated predictors for the professional programs as they are most often reported as successful in the published literature (Bauchmoyer, Carr, Clutter, & Hoberty, 2004; Flanigan, 1985; Goodyear & Lampe, 2004; Miller, 1993). Non-academic factors reported in the literature are most frequently evaluated through interviews and self-reporting surveys (DeAngelis, 2003; Jeffreys, 2007; Op’t Holt & Dunlevy, 1992; Rifken, Maturen, Bradna, Brace, &
Review of the literature reveals a lack of consistency in the definition of non-academic factors creating the need to compare methods of evaluation rather than specific criteria.

The role of the predictors in selection of candidates is to assist faculty in choosing individuals who have the best potential for becoming future practitioners in a specific field of study. In the allied health professions, students will be required to interact with other health professionals as team members and also possess the ability to manage and operate technical equipment in the care of patients. For these reasons, predictors need to include both academic and non-academic variables, as students in the health professions need to possess the skills to complete the academics, as well as, function in a medically-oriented, interactive clinical environment (Agho, Mosley, & Williams, 1999; Salvatori, 2001).

**Academic Predictors**

**Cumulative Grade Point Average**

Previous grade point average is often used as a predictor of future success. Studies conducted in the health occupations suggest a strong correlation between pre-professional and program grade point averages (Gramet & Terracina, 1988; Hawley-Oliver, 1985). However, the research literature does not always define cumulative grade point average, especially at the undergraduate level (Flanigan, 1985; Helm, Grabarek, & Reveal, 2002; Op’t Holt & Dunlevy, 1992). The lack of a clear definition and uniformity in previous college level coursework may contribute to the inconsistency in its application as a valid predictor of success for undergraduate programs. The use of grade
point averages works best when the coursework prior to program entrance can be standardized (Jeffreys, 2007; Safian-Rush & Belock, 1988). Four-year programs that do not allow admission until the junior year and graduate programs that require a minimum of a bachelor’s degree benefit from specific and significant college level coursework prior to admission. Two-year programs have more difficulty defining coursework prior to program entrance due to limited time and restrictions on credit hours.

Another influence affecting the use of previous grade point average is the amount of time since previous coursework (Goodyear & Lampe, 2004). In an eight-year longitudinal study, previous cumulative grade point averages and science grade point averages did not correlate significantly with medical laboratory program completion or passing the board of registry on the first attempt. Grades issued five years or more prior to admission were not found to be reliable indicators of student success adding further questions to the validity of using this factor as an entrance predictor. The study also evaluated cumulative grade point average when students transferred from another institution. When the grade point averages from these students were evaluated, they were not statistically significant. The program had approximately 30% transfer students raising the concern of grade transferability between institutions.

Overall grade point average presents a problem for non-traditional students as their educational backgrounds vary significantly. Grade point average might reflect as few as one or two courses or an earned baccalaureate. In addition, the grade point average may include coursework not related to the specific type of knowledge needed in the allied health or nursing fields. Students may enter with previous educational work in
other professions or coursework toward an associate degree but with courses completed in humanities. This unrelated coursework does not always correlate well with successful programmatic outcomes (Byrd, Garza, & Nieswiadomy, 1999). In a retrospective study of entrance standards for a baccalaureate degree nursing program, entrance grade point average was not a significant predictor of graduation from the program. Graduates and non-graduates had similar averages indicating that attrition from this program could not be predicted from this measure (Sadler, 2003). As this program was undergraduate, the courses and credit hours comprising the entrance grades could have been varied.

To study the effect of grade point averages, in both related coursework and other studies, a four-year respiratory program evaluated records of 375 students admitted over a 10-year period. Correlations for science, non-science, and cumulative grade point average were similar and significant when compared to national certification examination results. The science grade point average was calculated using a broad spectrum of coursework including mathematics (Ari, Goodfellow, & Gardenhire, 2008). Using science and math coursework to predict student success is common within the health professions. Problems arise in the selection of specific courses particularly when considering transfer credits for admission (Bauchmoyer et al., 2004).

A study conducted at East Tennessee State University for the radiologic technology program utilized a system of academic ranking to determine candidates for interview (Shehane et al., 1994). The ranking document included cumulative grade point averages as well as course specific grades. Each letter grade was awarded a score. Scores were then tallied and compared with student completion. This inclusive form of
ranking correlated significantly with program outcomes. Rather than rely on cumulative
grade point average alone, grades were added to this score by combining it with specific
science and math prerequisite coursework. The process saved resources, specifically
faculty time, by creating a step process in the admission system where academic variables
were considered prior to the interview, reducing the number of candidates for final
consideration (Shehane et al., 1994).

Admission grade point average was found to be a good predictor of success on the
NCLEX-RN but also as a guide for effective use of resources identifying students
needing remediation. The study reviewed records from 408 students in a baccalaureate
nursing program. The authors noted that often the best predictors of success on the board
examination occur late in the student’s educational process when it is too late for
remediation, and as the initial grade point averages did predict performance on the board
exam, using this factor to identify students at risk was proposed to help match resources
to those in need (Horns, O’Sullivan, & Goodman, 1991).

A study conducted on baccalaureate nursing students supported the use of
cumulative grade point average as a good predictor of success on the graduate board
examination; however this study found a higher correlation with the prerequisite science
grade point average (Peddicord-Whitley & Chadwick, 1986). The stronger correlation
with science may be indicative of the relationship between the sciences and the health
professions. Overall grade point average does generally indicate a stronger student but
the health programs and the sciences have laboratory components demanding application
of knowledge. It would appear that students drawn toward the health professions might be stronger in a learning environment similar to that used in science classes.

**Science and Math Grade Point Average**

One could assert that previous educational success should predict future academic success. This premise is especially true if the previous educational success correlated with the current course of study. Many research studies have demonstrated successful results when previous science and math grades are considered. The current allied health literature supports a positive correlation between educational success in related subjects and success in professional coursework. Math and science, particularly courses in the biological sciences, are the courses most often correlated with success in the health programs (Friedemann & Valentine, 1988; Griffiths, Bevil, O’Connor, & Wieland, 1995; Heilman, 1991; Jefferys, 2007; Oliver, 1985; Op’t Holt & Dunlevy, 1992; Somma, 1988; Talarczyk, 1989; Tompkins & Harkins, 1990; Winkler & Bender, 1989).

A baccalaureate dental hygiene program conducted a regression analysis to determine if prerequisite science courses were predictive of success on the national board examination. The courses evaluated included chemistry, anatomy, physiology, and microbiology. No courses were statistically significant when assessed by themselves, but when combined into one variable with entrance grade point average they were found to be good predictors (Alzahrani, Thomson, Bauman, & Shuman, 2005). The authors also found that the need to repeat prerequisite courses to get a passing grade was not a significant predictor of future success on board examinations, a finding supported by two in-house studies conducted separately for each of two health programs in a separate
in institution. A six-year regression analysis conducted for a two-year respiratory program identified the first of two anatomy and physiology courses as a significant predictor of both attrition and exit grade point average. Repetition of coursework by students to obtain a passing grade made no significant difference in the outcome (Kenny, 2003). The six-year study (n = 77) was conducted internally for program assessment. A separate study for a radiologic technology program in the same institution (n = 104) supported these results identifying the same anatomy and physiology course as a significant predictor of success without regard to the number of attempts needed to complete the class with a passing grade (Thomas, 2006).

With a large percentage of allied health programs set in two-year college settings and their significant number of non-traditional student enrollments, most allied health programs rely on the science and math courses to predict grades within the professional programs. Science and math coursework is a part of every health profession curriculum as the professions build on the knowledge first presented in these courses.

Health program research has demonstrated a positive correlation between science coursework and allied health grade point averages (Bauchmoyer et al., 2004; Hawley-Oliver, 1985; Jeff & West, 1988; Jeffreys, 2007; Rifken et al., 1981). Algebra grade point averages were higher for students who ultimately passed their NCLEX-RN exams in a study of baccalaureate nurses than those for students who failed the examination (Munden-Quick, Krupa, & Whitley, 1985).

Science and math scores have been cited in the literature as better predictors of student success than cumulative grade point averages. In a four-year respiratory therapy
program students were not even advanced to an interview for the program without a pre-professional grade point average of 2.20. A higher grade point average of 2.26 in science and math was correlated with successful program completion inferring a closer correlation of skills acquired in science and math to the respiratory therapy program curriculum (Op’t Holt & Dunlevy, 1992).

In a study of four-year nursing students in Florida where entrance to the program was not granted until the junior year, a positive correlation was reported with entrance grade point average when the students had completed all science prerequisites with a grade of C or better. In addition, students were not admitted unless their cumulative grade point average was 2.5 or better on a 4.0 scale (Safian-Rush & Belock, 1988). Both the respiratory and nursing programs identified strong correlations in program success with success in the science courses. They also selected students capable of college work in general by insisting applicants earn a grade point average higher than what would be required for graduation from their institutions.

Science and pre-nursing grade point averages were found to be significant in a study conducted on 278 students enrolling in a four-year nursing program where the pre-nursing coursework was specifically defined and accounted for 64 hours of coursework (Byrd et al., 1999). The significant number of credit hours accounts for two years of full time credit. The ability to develop a foundation for a nursing or allied health program with specifically defined coursework leading up to the professional studies is an advantage four-year programs have over two-year colleges. A much larger study
(n = 505) of baccalaureate nursing students found biology grade point average to be a significant predictor of success on the NCLEX-RN. Students passing the exam had higher grade point averages and fewer grades of “C” or below in both biology and sophomore nursing coursework (Beeson & Kissling, 2001). Eight of 10 science courses held significant correlations with the NCLEX-RN for four university-based programs. The two science courses that were not statistically significant had enrollments of less than 20. The study sample size was 254, creating the possibility that the small number of students taking these two courses, Chemistry III and physics, may have contributed to the non-significant result. This research study was able to quantify four programs as a single sample and compare outcomes to the board examinations creating the assumption of continuity between university science courses (Brown, 1988). As many baccalaureate programs select students for program specific coursework after preparatory coursework has been completed, using science coursework to select students who will be successful on the board examinations supports a logical sequence of study.

A significant portion of the health profession curriculum is laboratory and clinically based. In a study of baccalaureate nursing students, knowledge of anatomy and physiology was identified as a significant predictor of success with nursing clinical coursework (Griffiths et al., 1995). Anatomy and physiology coursework involves laboratory work requiring the student to apply the knowledge learned from classroom lecture. The correlation found between the anatomy and physiology and the clinical portion of the professional program might simply reflect a better student or may be understood as a better aptitude for applying knowledge as in laboratory coursework.
The combined factors of limited college level coursework and the need to include all college coursework in the final degree credit count support the use of these foundational classes as program prerequisites. Defining which science courses are the best predictors may be more difficult as with a baccalaureate nursing program that did not have significant correlation of anatomy coursework with the NCLEX-RN. This particular program found a particular pathophysiology to be the only significant predictor of success on the board exam at program admission. Anatomy coursework and entrance grade point average were not statistically significant in predicting success (Seldomridge & DiBartolo, 2004). This finding is significant in light of transfer students. The pathophysiology course is not considered as general in content as a college anatomy course. If it were considered a prerequisite course, students completing two years of coursework at another college would still have to complete that particular course before admission to the nursing program.

**Transfer Credits**

The concern over the consistency in educational preparation between institutions has mixed findings. Site of preparatory work has been an issue brought up throughout the literature with comparisons made between types of colleges, including two- versus four-year preparation, and transfer students versus students continuing within the same institution where prerequisite coursework was completed. Whereas most of the literature addressing this topic is from four-year institutions, an internal unpublished study \((n = 104)\) conducted for a radiologic technology program found no statistical difference on final registry board scores between students transferring preparatory coursework and
those continuing within the same institution in a two-year program (Thomas, 2006). Students came to this program transferring credits from both two- and four-year institutions.

Claims of transfer difficulties appear in the literature when programs are evaluating students entering baccalaureate programs using preparatory work from community college coursework. In a study of nursing transfer students, two-year transfer students were more likely to have difficulty maintaining a grade point average of 2.5 on a 4.0 scale in a four-year nursing program than those already enrolled in a four-year college. However, transfer students performed better as they completed more of the required science courses on the two-year campus and additional statistical analysis found no difference in initial preparation between successful students at the end of their junior year. Because of this finding, the authors suggest variables outside of academic preparation may be responsible for transfer student difficulty (Lewis & Lewis, 2000). Research conducted for a dental hygiene program supports this finding. When requirements were completed at a two- or four-year institution, students had better grade point averages in the program than those who split their science requirements between the two institutional types (Bauchmoyer et al., 2004).

Correlation of entrance grade point averages with results on the NCLEX was poor when all students admitted to a baccalaureate program were transferred in during their junior year (Jenks, Seleman, Bross, & Paquet, 1989). Students were admitted from both two- and four-year institutions, and authors noted heterogeneity in the background as a
possible reason for the finding. Although correlation was low, the results were statistically significant.

As the number of courses completed increases, there is reported evidence documenting student performance at the transfer institution improves. In a study of nursing students completing an associate degree in nursing prior to transferring to a baccalaureate program, the transfer students were successful (McHugh, 1991). Student success was attributed to similarities in curriculum as the two programs were held to the same professional coursework and outcome standards by their professional accrediting organization. Differences in definitions of the transfer student exist based upon credit hours completed prior to the transfer. In McHugh’s study students did not transfer until they successfully completed their associate degree. Lewis and Lewis (2000) looked at students transferring science classes into a baccalaureate nursing program. The result however, was the same. The more coursework completed at the associate level, the more successful the transfer.

In a separate study conducted on a four-year nursing program where transfer students were graduates of other nursing programs, a low and statistically non-significant correlation was found between grade point averages in the two nursing programs. However, cumulative grade point averages at admission were good predictors of the final four-year nursing grades. There appeared to be no clear grade cutoff for determining admission, rather registered nurses who had not received a grade of “D” in previous coursework had higher grade point averages in the baccalaureate program (Kroll, 1990).
The current published literature suggests the possibility of differences in the preparatory courses leading into the professions dependent upon the type of college. When using specific coursework as entrance criteria, the question of consistency in presentation or course material and evaluation appears repeatedly. The single largest factor for transfer appears to be the number of credit hours completed at the transferring institution (Lewis & Lewis, 2000; McHugh, 1991). This is an important finding when set in the context of the health programs and state and national standards. It raises questions about the validity of using grades in specific support coursework for program entrance when students move from one institution to another.

**High School Rank**

The idea that student success in previous academic work continues through the educational continuum is supported by the successful use of high school rank in program admissions. When students begin allied health programs soon after high school graduation, high school rank and grade point average may play a significant role in selection.

Studies in various allied health programs support the use of high school rank in student selection. The University of Missouri-Columbia School of Health Related Professions identified students in the top half of their graduating classes as those most likely to succeed in the allied health profession programs. Their findings encouraged the use of high school rank in student selection, but also identified this as a tenuous process because it addressed only a very small proportion of students entering their programs (Shaw & Prewitt, 1996). This finding is supported in a study conducted for a
baccalaureate nursing program where high school rank correlated well with final cumulative grade point average but was only measured for 108 of 198 students (Seither, 1980). In another study of 141 associate degree nursing students, a difference in rank was found between those who completed the program and those who did not; however the difference between these groups was not statistically significant. The author suggested time away from school may have contributed to the non-significant finding as the average age of students in the study was 26 (Hawley-Oliver, 1985).

High school rank has been used to predict both future grade point average and success on board examinations following graduation. In a study conducted by a hospital-based radiologic technology program, high school rank was found to correlate strongly with scores on the professional registry board exam. To address the question of validity in this measure with the significant time and information gap between high school and the professional board exam, the author also looked at those students with lower high school ranking and found they had significantly lower board pass rates (Miller, 1993).

High school rank was shown to be a good predictor of final program grade point average for most of the health professions reviewed for this study. A six-year study of dental hygiene, radiologic technology, and respiratory therapy students found high school rank to be among the best entrance standards contributing to the prediction of the final grade point average at the Southern Illinois University at Carbondale. The regression analysis identified four entrance variables, including high school rank that cumulatively accounted for 22% of the variance in the final grade point average (Jensen, 1989).
Nursing research supports these findings as well with statistically significant findings, although correlation numbers might be small. A study of 210 baccalaureate nursing students identified a 17% correlation between high school rank and the NCLEX-RN but found this correlation to be significant at the \( p < .01 \) level. The average age of the sample was 23, with a range of 21 to 41 years, indicating a larger sampling of students closer to the lower range or closer to their high school graduation (Yang, Glick, & McClelland, 1987). As a predictor for minority students entering a baccalaureate nursing program, high school rank was significant, but entrance grade point average and ACT scores held better predictive value (Klusnik-Boyle, 1986).

The literature on this variable is not as well documented as some of the other predictors as many students entering the health professions are older and non-traditional. High school rank may not be considered a viable standard by the departments determining entrance standards for all students. Two-year college programs do not have the benefit of requiring significant college level coursework, so this variable may serve a portion of the population entering the health professions directly out of high school. Its validity as a measure may decrease with student maturity and time away from secondary education. In a study of nursing students entering an associate degree program, high school percentile was a non-significant finding as the program identified an emerging trend of increasing age for those selecting this higher education pathway (Woodham & Taube, 1986). The study covered three years and student age for each class was greater than 28 years. Additionally this study data was significant for age at graduation, indicating greater success with the board examination for the older student. Years away
from high school may have affected the validity of this measure for students within this program (Woodham & Taube, 1986).

**Standardized Tests**

The number of considerations evaluated by colleges as entrance standards reflects the assumption that success in higher education requires more than good grades in preparatory work. The current American College Test (ACT) and Scholastic Aptitude Test (SAT) are standardized exams that provide a national norm to assess general college entrance skills. These tests are administered in the last year of high school and as such may prove useful for graduates attending college without any interruption in educational experience. Standardized tests fall into the same category as high school rank, as they may not be as useful for the older student with significant time lapses in their educational experience (Aldag & Rose, 1983). An interesting counterpoint to this assumption is the result of a study for a dental hygiene program where the average age of the incoming student was 23. The total SAT score was used in a probability equation and accurately predicted exit grade point averages (Downey, Collins, & Browning, 2002).

SAT scores were found to be positively correlated with success on nursing board exams in a large national study conducted to identify successful predictors for nursing education. However, this study identified a negative relationship for programs requiring high admission SAT scores and program pass rates on the board exams (Crow, Handley, Morrison, & Shelton, 2004).

An additional nursing study at a four-year institution identified SAT scores as predictive of success on the nursing board examination and suggested that this finding be
used to identify students at risk of failure early in the program. These students could then be counseled and provided with additional resources to help improve their scores on the board examination post graduation (McKinney, Small, O’Dell, & Coonrod, 1988). A later study supports this suggestion and uses the SAT to identify students at risk for board examination failure. College resources are then provided for the students with low SAT scores, including note and test-taking programs and reading comprehension classes. The program does not deny entrance, rather uses the information provided to apply resources in an efficient manner (Foti & DeYoung, 1991).

In a predominately Black baccalaureate nursing program, SAT results were better predictors of program completion than board examinations. This study identified this basic skills test as a significant predictor of student success within the program, and on that measure is in keeping with findings from other ethnic groups. However, the SAT was not as good a measure for predicting the board examinations, and the authors noted the single best predictor for both graduation and professional examinations was a pre-nursing examination provided by the National League for Nursing (Dell & Halpin, 1984).

The lack of predictability of SAT results on the NCLEX results is supported by a two-year study conducted on a baccalaureate nursing program. The authors used path modeling to determine measures that had an effect on the final board examination score, and the SAT verbal and math sections did not contribute to the causal pathway (Froman & Owen, 1989). Interestingly, the applicant’s age was the single influence of entrance predictors measured that did present a causal influence. The older student performed
better in the classroom and on the national board examination upon graduation (Froman & Owen, 1989).

Both the SAT and ACT are general tests in terms of academic scope and may serve as effective predictors of foundational skills for the health professions. In a study correlating SAT scores with the nursing accreditation exam, a nursing program found significant correlation with the math and verbal components of the test and much higher correlation values between individual nursing courses and accreditation exam scores (Woodham & Taube, 1986). This finding is supported with research conducted on a separate baccalaureate degree nursing program where SAT component and composite scores were significantly correlated with both the nursing coursework and the NCLEX-RN (Payne & Duffey, 1986).

In an associate degree nursing program where a number of admission variables correlated with results on the NCLEX-RN, a regression analysis found that the ACT composite score was the only initial variable contributing to success on the test. Other variables within the program, including grades from specific coursework, were better predictors of success on the board examination (Lengacher & Keller, 1990). This is a finding one would expect as the nursing board exam measures content provided within the nursing program.

The ACT proved to be the best predictor of academic success as measured by both the final grade point average and the state board examination for minorities, both Black and non-Black, in a baccalaureate nursing program. The other measures used in this study were the entrance grade point average, the number of hours of college credit
prior to program admission, high school grade point average, and high school rank.

Entrance grade point average, not ACT results, was the best predictor of attrition (Kluznik-Boyle, 1986). This study points to the fact that one measure may be inadequate when trying to predict the success of students in a program. If the definition of student success is to include graduation as well as success on board examinations, factors other than general objective cognitive measures may be needed.

In a study conducted for a nursing program the ACT reading component was identified as the only statistically significant portion of the exam to predict success on the NCLEX (Gilmore, 2008). The author noted that the NCLEX is written at an 11th-grade reading level and that reading and comprehending at this level may influence graduate success on the examination. If this is true, one can also extrapolate the finding that students entering with poor reading skills did not remediate the problem prior to graduation.

As with any predictor, the outcome measured needs to be reflective of the abilities of the initial measure. Using a cognitive test to identify students leaving a program will only identify those students with potential for poor grades. Many other personal factors interfere with students’ progress through programs. In a 10-year study, a radiologic technology program found ACT results to be of little value in predicting attrition, and in fact, students with higher ACT scores were more likely to drop out (Schulz, Dowd, & Fischbach, 1995). ACT scores might be used for prediction of a student’s ability to handle academic coursework but, as with other predictors, seems to be limited in its scope and dependent upon the outcome measures used for evaluation.
Both the ACT science and composite scores were statistically significant predictors of success for the dental hygiene national board exam in a study conducted for one dental hygiene program in Ohio. Correlations were moderate, 28% and 26% respectively. Interestingly, the ACT English assessment was not found to be significant but had a correlation similar to the other two findings. Sample size was small ($n = 77$), possibly contributing to the statistical non-significance found in the other component portions of the ACT exam (Longenbecker, 1984).

SAT and ACT results appear to be good predictors of academic success as reported in the research, especially for the recent high school graduate. Concerns arise with student age and the effects of maturity, the value for specific health professions, and the outcome measure used for comparison. Additionally, the research raises questions about using specific components of the test rather than simply the composite score. Findings are mixed enough to warrant further investigation, and also raise the question of use of an entrance test that focuses on skills needed in the health professions coursework.

Specialty Examinations

With minimal previous college experience available for evaluation at the two-year level, published research reflects a growing interest in specific tests geared to the needs of healthcare education. Many tests have been developed and used by the various professions over the 28-year span of this study. It is difficult to identify one test for any one profession let alone a test that appears to cross the professions universally. Limited published research on admission standards in the health professions magnifies the problems of assessing specialty examinations. This study discusses the application of
tests as published in the research, but uses the classification of specialty examinations as a single predictor.

A study conducted in North Carolina identified 31 different entrance tests for six allied health occupations from 26 institutions within the state (Petty, 1985). It is obvious from this sample that faculty within the same professions, as well as within the same institutions, differed in their perception of core entrance standards that would correlate with successful outcomes. There appears to be little agreement on what skills are necessary at entrance to better guarantee student success within each program, as well as on board examinations upon graduation.

With so many tests available and each touting its special application to the entrance process, it is no wonder there are so many tests in use. The correlation of these tests with program outcomes varies from not at all to correlation with cumulative grade point averages or laboratory skills, depending upon the nature of the test (DeAngelis, 2003; Leitsch, 1988; Petty, 1985; Standridge, Boggs, & Mugan, 1997).

Two-year programs with limited time and academic data prior to program entrance can benefit from the addition of admission exams specifically designed for allied health and nursing programs. These admission exams focus on skills used in the health professions and correlate well with successful program completion. Nursing and allied health programs are prescriptive as outcome standards are established by professional organizations with outlines or matrixes provided to the programs. Professional board examinations are pulled from these outlines and programs are held accountable for student success on the examinations (ADA, 1998; CoARC, 2003; JRCERT, 2002;
NAACLS, 2006; NLNAC, 2005). A standardized entrance exam that focuses on skills necessary for the health programs would assist programs in utilizing resources effectively.

One such test is the Nursing Entrance Test (NET) or the Health Occupations Basic Entrance Test (HOBET). Although the names are different, the tests are the same with results normed in overall standards and again as separate indicators for each allied health profession. The advantage of this type of test is its universality as it addresses skills useful to the health occupations (Sayels, Shelton, & Powell, 2003; Schultz & Rakow, 1999). A two-year respiratory therapy program found the reading portion and the composite score of the HOBET to correlate 30% with the national certification test, but identified a stronger correlation with program completion and attrition. High school grade point average had a better correlation with the HOBET composite score, indicating that the HOBET is a good reflection of academic skills acquired in secondary education. As its purpose is to evaluate entrance skills, this study found it to be a good predictor for program attrition, successful completion of the national certification examination, and a good reflection of academic ability otherwise evaluated through the subjective measure of high school grade point average (Gardenhire & Restrepo, 2003).

These results were supported in a study of nursing students using the NET at entrance to an associate degree nursing program. As the examination is focused on skills used in the health professions, using a test to predict future academic performance on similar tasks helps focus both faculty and students on those skills prior to entering the program. In this particular study, ACT scores did not correlate significantly with student
success on the NCLEX-RN, but results from the NET test did (Sayels et al., 2003). The NET test is given to all students prior to program entrance where validity factors as age, maturity, or time away from studies may affect ACT scores.

In a study involving student nurses, the Test of Essential Academic Skills (TEAS) proved to be a better predictor than grade point average when the applicants required repeated attempts at pre-nursing coursework. When the students were stronger scholastically, grade point average proved to be a better indicator of programmatic success. This study used a convenience sample of nursing students in one program entering biannually (Newton, Smith, & Moore, 2007).

The Allied Health Professions Admission Test (AHPAT) was successfully reviewed by two medical technology programs. In the first study, a 2 + 2 medical technology program identified the entrance test score as a better predictor of student success in the program than other criteria including cumulative grade point average and the science grade point average. The AHPAT also had higher correlations with the examinations than either the science or entering grade point averages (Somma, 1988). A second study conducted 16 years later supported these findings with results similar to Somma. In this study, program graduates could select one of two professional examinations upon completion of their studies, and the AHPAT correlated successfully with both examinations. Both science and entering cumulative grade point averages were also successfully compared to the two board scores but at lower correlations than the AHPAT. The program accepts transfer students, and consequently the authors suggested differences in grade assignment including different grading scales, as reasons to use a
specialized entrance test. Length of time since coursework was completed was also noted as a concern for using previous grade point averages (Goodyear & Lampe, 2004).

The lack of abundant research conducted on any one specialized admission test for the health professions can be attributed to two components: first, the sheer number of tests available, and secondly, their longevity. The AHPAT test had some longevity, as a study published in 1980 demonstrated its successful use in the prediction of profession specific grade point average for a four-year medical technology program at the State University of Stony Brook (Leiken & Cunningham, 1980). This span of 24 years is significant; however, little published research exists during that time to evaluate its efficacy.

A nursing program used the College Level Academic Skills Test (CLAST), required of all students entering their junior year in Florida colleges, to successfully predict success on the licensure examination. As this examination is already a requirement for students it would not increase cost to a prospective student and would serve as an equivalency marker for all students in the state. Where students chose to take their first two years of college would not matter since all students are required to complete this exam to advance to upper level coursework (Safian-Rush & Belock, 1988).

There are additional specialized tests, although not all share the ability to accurately assess student capabilities. In two separate reviews of the Health Occupations Aptitude Examination (HOAE), respiratory therapy programs found conflicting results when comparing data from the exam to program success (Standridge et al., 1997; Tompkins & Harkins, 1990). In this instance, one program used the specialty exam to
supplement criteria used to determine academic success, whereas the second used the same exam to evaluate clinical preparedness. Inability to identify where a specialty test might best be used may contribute to how the test is evaluated and eventually adopted. A study involving two-year radiologic technology programs sought to identify admission factors that would predict success within the programs for both academic and clinical performance. Four programs within one state used the inventory. They found it correlated significantly with student performance in the clinical setting. The inventory measures three variables: interpersonal, initiative, and dependability. All measures correlated greater than 20% with clinical performance, but initiative and the total score were statistically significant in this small sample \((n = 63)\). The author suggested some variance in evaluation of clinical performance among the different programs as a possible reason for the non-significant finding of two measures in the inventory (Rutz, 2002).

In a four-year study of academic predictors for 11 two-year medical technology programs, the Nelson-Denny Reading Test (NDRT) was correlated with both student final grade point average and certification examination results. All the components of the test, including vocabulary, comprehension, reading rate, and total score, correlated with the students’ final grade point averages; only the vocabulary and total scores correlated significantly with the certification examination. The study also evaluated ACT scores and while there appear to be more areas of correlation with the individual components of the test and the outcomes, only 42 of the 105 students evaluated had this measure for reference. In comparison, the program was able to test all 105 of the incoming students with the NDRT (Heilman, 1991).
There is limited published research regarding the efficacy of specific admission tests for health professions at the current time, as there have been so many different tests offered by different companies. Generalization and projection of results from entrance tests to board exam scores would appear to be inappropriate due to validity concerns, including, but not limited to, student maturity, time, and ultimately the quality and quantity of instruction from the college program. Sample size relative to the profession-specific education programs is small for each of the studies with little information published on the significance or non-significance of each test.

In addition to the noted concerns, using entrance tests specific to the background knowledge needed to succeed in the health programs may be helpful in predicting student outcomes, but it also increases the cost to the student at entrance placing further distance between the student and a career. Community colleges were developed to serve local communities, so in addition to program length colleges have an obligation to weigh the financial burden on the student when considering admission standards. Asking a student to pay for and take an entrance exam over and above prerequisite coursework may be placing a financial obstruction in the way of admission. To study the question of whether to use specialty tests at all, a nursing program found no significant difference between the mean scores of students completing the NET and those earning grades of “C” or better (Gallagher, Bomba, & Crane, 2001). The NET did not add to the admission process in any statistically significant way other than additional costs for students prior to program entrance. This finding is significant when considering the context in which postsecondary institutions function in the United States.
The large number of postsecondary institutions in the United States creates access for most students seeking a higher education degree. However, admission to college is not the issue it is in other countries where there is a limited selection of higher educational institutions and only the scholastic elite attend (Detterman, 2000). Students may shop for an institution that fits their background or needs. The problem of where to go to school is more one of selection for the student, as the power to make the decision of attendance rests in the hands of the applicant, not the college. Cost, obstructions to entrance, such as waiting lists and numerous prerequisites, the reputation of the college, and specifically, the desired program, all weigh in as factors for students as they select an institution (Anders, 2005).

Saudi Arabian students entering a four-year nursing program were required to take either the English Language Institute or Test of English as a Foreign Language test. Scores on these tests did not correlate with the cumulative grade point average at graduation (Carty, Moss, Al-Zayyer, Kowitlawakul, & Arietti, 2007). These tests increased the cost to the international student and time needed to complete this prerequisite over and above additional requirements in place for local students, yet neither test correlated with graduating grade point average, the outcome measure of success. In this instance, entering grade point average was the most significant predictor evaluated at entrance for students entering the nursing program, regardless of country of origin (Carty et al., 2007).

All the considerations students evaluate are also evaluated institutionally when the college defines and evaluates itself. When considering selective admission, a college
considers its mission to provide assistance and support for a desired student body. The type of student selected will affect resource utilization, and the college’s cost-per-student ratio. To provide the right resources, a college must consider factors other than academic data when selecting those individuals who will succeed in its environment (Johnson & Young, 2004).

**Non-Academic Predictors**

Non-academic standards reflect student skills other than cognitive abilities and have changed significantly since their inception. In the early colleges, non-academic standards were generally limited to letters of recommendation regarding the applicant’s good moral character. Today’s student may have to meet standards that have evolved to include extracurricular activities to reflect morals and social behavior (Wechsler, 1977). These behaviors reflect professionalism in a high stress environment where patients may not have the ability to communicate for themselves. Healthcare providers must be able to work in a team environment where their professional affect will allow them to interact with other professionals in a manner that will provide the best patient outcomes (Hess, 2005).

In a study evaluating admission standards for a medical laboratory program, researchers found that non-academic factors correlated with clinical success and work experience. Non-academic factors were evaluated using (a) a structured interview, (b) a written form completed by the applicant, (c) references, and (d) a manual dexterity test. The structured interview conducted by two faculty members was used to elicit an applicant’s knowledge of the profession and the relationship of the applicant’s personal
goals to the profession. The interview also evaluated the students’ problem-solving skills, their ability to communicate, and their interests both in and outside of science. The written form, (b), supported the interview process and was used to gather further information about the applicant’s perception of the profession. Students also provided references (c) to help faculty evaluate their affect and related abilities. The dexterity test, (d), was administered to assure applicants would be able to handle equipment safely (Rifken et al., 1981).

In a separate study predicting academic success in a nursing program and passing scores on the NCLEX-RN for black students in five baccalaureate programs, learning style and motivation contributed to the identification of successful students. Three factors were identified as good predictors of success. The factors included cognition as evaluated by SAT math scores and college grade point average, learning style as measured by Kolb’s Learning Style Inventory, and motivation, identified using factor analysis. Kolb’s Learning Style Inventory and the Tennessee Self-Concept Scale were used to measure non-cognitive characteristics. Student preferred learning style and self-concept did not independently relate to either academic success or passing the NCLEX-RN exam, as measured with a Pearson correlation and regression analysis. However, when the variables were identified through factor analysis and then entered into a discriminant function analysis, they identified successful students in every case. Sample size in this study was small ($n = 30$), but was taken from a total of five schools in five different states (Baldwin, 1987).
In a study conducted in two historically Black colleges, the researcher used Sedlacek’s eight non-cognitive factors, correlating them with grade point averages. The only non-cognitive factor associated with the grade point average of students in the health professions was the ability to deal with racism (Dalton, 1997). Students entering the health programs had to have a grade point average of 2.75 or higher. The author suggested the limited range of grade point average (2.75 – 4.0) may have contributed to the statistical non-significance of the other seven factors.

A separate study of health science students in one community college used Sedlacek’s non-cognitive factors and identified community service, leadership, and strong support person as significant independent predictors for grade point averages. When variables were grouped for multiple correlations all non-cognitive factors contributed to the students’ grade point average at one or more points in their education. The study only evaluated grade point average as a criterion and the authors concluded that future analyses might best include retention when using these prediction factors (Noonan, Sedlacek, & Veerasamy, 2005).

A nursing program used student records including transcripts and the program application to determine personality variables that would equate with success in the program. Three nursing faculty used these records to score applicants on each of nine categories, and the results were averaged among the three. This value was then included with social variables for the admission committee to review. The admission committee rankings correlated well with students earning lower grades in the program (Allen, Higgs, & Holloway, 1988).
The non-academic factors reflect an important component of assessment for admission to the health professions where practitioners are expected to work as part of a team and perform the duties inherent in the job. Specific factors do not appear to be universal in the literature, although there is consensus in methods of assessment. Interviews and self-reporting surveys are most frequently reported although the questions asked in the meetings or on the surveys are specific to the institution or program and not as clearly defined as those seen on standardized testing.

**Interview**

Health occupation programs have both academic and clinical components. A student’s grade is a compilation of classroom, laboratory, and clinical experiences. The student has the opportunity to practice professional skills under the guidance of licensed professionals in professional practice. Identifying skills that predict how students will interact outside of the formal classroom require more than the traditional academic measures. Interviews can be useful in determining if students have skills needed for working in a laboratory setting (Evans & Dirks, 2001). However, they can increase cost to a program, as they demand faculty time for preparation, inter-rater reliability measures, and evaluation, in addition to the face-to-face interview session (Shehane et al., 1994). Ideally, interviews reduce the loss incurred by programs when students do not successfully complete for non-academic reasons, as they assist faculty in identifying interpersonal skills needed at the bedside. Interviews need to be useful, and yet, the results of their efficacy are mixed. Even with careful attention to the process, the
interview may fail to predict which students will succeed within a program (Op’t Holt & Dunlevy, 1992; Shehane, 1995; Shehane et al., 1994).

A radiologic technology program incorporated interviews into the admission process, awarding it 20% of a weighted admission score. The other weighted 80% is comprised of entrance grade point average, high school class rank, ACT composite score, and additional objective measures. Results indicated a positive correlation with success in the program and on the board examinations, although it is noted that once in the program, success may be related to the individual student’s motivation. While measurement of motivation is elusive, the program focused on personal qualities they wanted to see in their graduates as part of the interview. These traits included independent evaluation of personal attributes by three separate individuals at three separate times (Winkler & Bender, 1989).

In a study conducted with three consecutive years of data for one radiologic technology program (n = 110), the interview made a difference in the admission process, but did not correlate with retention. This finding was consistent with other academic measures used to predict student retention. The admission standards were not significant in predicting those students who would ultimately complete the program. Considering the findings, the author suggests further study using qualitative inquiry to assist in prediction of attrition (Shehane, 1995).

A respiratory therapy program tested the interview as a predictor for national board examinations with mixed findings. Interview scores correlated best, 47%, with the decision-making portion of the clinical simulation examination necessary for national
registry. The scores did not correlate well with the first two national examinations, the certification and the first of two required registry tests. Consequently findings indicated some value to the process, but the authors concluded the results were subjective and dependent upon the interviewer’s ability to identify those qualities commensurate with decision making (LeGrande & Shelledy, 1999).

An earlier study conducted on a respiratory therapy program identified a good correlation \( r = .59 \) between the interviewer’s score and subsequent grade point average in the professional coursework, and an even stronger correlation \( r = .63 \) with the clinical performance rating. The interview score is an average of six individual rankings from the program director and faculty, both classroom and clinical, who have direct contact with the applicants throughout the program (Tompkins & Harkins, 1990). The article notes the program accepts 10 students per year, and the sample size was 40 with data collected for a five-year period.

A cost of $63 per interviewee was calculated in a study for a radiologic technology program with little added value to the admission process. The interviews were conducted using a questionnaire developed by the radiologic technology department and administered by the faculty. There was no indication of an inter-rater reliability review prior to use, and the interview process did not prove to be a statistically significant variable in student success (Shehane et al., 1994).

Additional literature is not as specific in how an interview is conducted and what preparation raters receive prior to the process. Despite this, a survey of 52 respiratory therapy programs identified the interview process as one of the most frequently used
entrance criteria (Coates & Herbert, 1984). The interview is a subjective component of the admission process and will be specific to each individual program. To quantify the relationship of interviews with criterion values as student success through graduation, grades, or national board examination scores, this study uses the interview as a predictor classification.

**Self-Reporting Surveys**

Self-reporting surveys evaluating items such as problem-solving, leadership skills, community involvement, and other realistic self-descriptors have been used to assist in student selection. When these self-evaluating reports are added to more traditional selection criteria, they can provide a clearer picture of the applicant. Adding questions to assess personal characteristics in a dental hygiene program resulted in a more equitable selection process, as supported by the increased number of minorities selected for the program. The diversity of the student population changed to one more reflective of the area in which the college was located (Helm et al., 2002).

In a separate study, a problem-solving inventory was used to assist in prediction of student success within a dental hygiene program. Self-reported scores evaluating students’ perceptions of their problem-solving abilities correlated with higher entrance grade point averages and ACT scores indicating that students with confidence in their problem-solving skills also scored well on other entrance measures. The author concluded that the inventory added to the predictive ability of the other two measures used at program entrance (DeAngelis, 2003).
The California Psychological Inventory and Survey of Interpersonal Values were used to assess non-cognitive variables for 290 baccalaureate nursing students (Hayes, 1981). No significant difference was found in student success when these non-cognitive variables were added to the already predictive cognitive variables. The author suggested the possibility of a Type II error as the number of categories limited the sample number in each group.

Two interest surveys were used to assist in the selection of medical technology students. Results indicated the inventories were good at identifying students interested in health careers but not in selecting students for a particular profession (Clark & Sharf, 1983). The study had a small sample size ($n = 22$) that may have contributed to the non-significant results.

**Statistical Evaluation**

This study uses meta-analysis, a statistical technique seen with increasing employ in medical literature. A meta-analysis is a statistical review and analysis of previous empirical studies (Glass et al., 1981). When studies are conducted with small sample sizes relative to the population they represent, there is a distinct possibility that predictors might contribute to an outcome but not prove statistically significant. This results in a Type II error, or failure to reject the null hypothesis. When we accept the null hypothesis, we assume the predictor has no effect on the outcome. Meta-analysis reduces the risk of Type II errors as it groups studies for adequate sample size and magnification of the effect (Rosenthal, 1991). When many of these studies are pulled together to increase sample size, those predictors have a better chance of statistical significance,
resulting in a better description of what is influencing the outcome. Therefore, a meta-
analysis is a statistical technique used to combine many studies together to identify

One of the benefits of meta-analysis is the ability to identify smaller effect sizes
of factors contributing to a final outcome. The limitations imposed on most allied health
and nursing programs by resource constraints restricts the sample size for any one
program. Limited sample size with a small effect size renders problems with statistical
significance in research findings (Rosenthal, 1991). To increase the chances of statistical
significance, it is often necessary to gather data over years in a single program delaying
any beneficial changes to the student population. In a meta-analysis of nursing
admissions using a 10-year period, the limited number of publications hindered the study.
Only four studies, three experimental and one quasi-experimental, were deemed complete
enough to include in the inquiry. The authors identified a problem with the lack of
consistency in design and poor reporting of sampling techniques (Campbell & Dickson,
1996).

A meta-analysis requires extensive coding to analyze the quality of studies but
should not preclude studies from inclusion a priori because of weak design. Rather, the
researcher needs to examine the quality of studies and their relationship to the study
findings (Wolf, 1986).

An important part of every meta-analysis with which we have been associated has
been the recording of methodological weaknesses in the original studies and the
examination of their relationship to study findings. Thus, the influence of study
quality on findings has been regarded as an empirical a posteriori question, not an a priori matter of opinion or judgment used to exclude large numbers of studies from consideration. (Glass et al., 1981, p. 22).

**Summary**

Allied health programs run the gamut from certificate and diploma programs to graduate degrees. Consistency within specific professions regardless of the degree level is guaranteed by outside accrediting organizations. While professional coursework is specific to knowledge and skills within that particular specialization, most allied health and nursing programs share core coursework in the general education areas, basic science, and math (ADA, 1998; CoARC, 2003; JRCERT, 2002; NAACLS, 2006; NLNAC, 2005). Standards for entrance vary with specific professions and institutions, but most share common variables as grade point averages, success in previous coursework, especially when that coursework is related to science or math, standardized tests, and an interest in assessing non-academic variables through interest surveys or interviews.

The literature regarding allied health and nursing entrance is difficult to locate as many programs are housed in community colleges that do not require publication for professional employment. Programs within community colleges also face the dilemma of open door access and outcome measures of success. Faculty are held accountable for pass rates on the national board exams at graduation, but are limited in their ability to assess student preparation at entrance.
Both program faculty and students are affected by the lack of flexibility in
assessment prior to program entrance. In a study conducted by a respiratory therapy
program, the two most significant barriers to students at entrance were the prerequisite
coursework and costs (Anders, 2005). To benefit both the program and the student, it is
best to identify the predictors most reflective of student success to keep the initial cost
and coursework to a minimum.

The need to provide well-educated and skilled healthcare workers to medical
facilities continues to grow with advances in medical knowledge. To keep up with
advances in the medical world, schools require significant investments in resources from
classroom space and equipment to educated caregivers in teaching roles. Colleges are
responsible to funding agencies and constituents; they must make the best use of their
resources and graduate capable students ready to join the workforce. Admission policies
are the first step in this process.
CHAPTER III

METHOD

The purpose of this chapter is to identify and discuss the process used to gather and analyze the data used in this study. Data sources gathered from both published and unpublished research were identified through online database searches, bibliographic reviews, personal contacts, and inquiries through professional organizations. This chapter states the research questions related to health program admission standards and includes validity and reliability concerns as well as limitations and delimitations of the study. Predictor and criterion variables, as identified through a review of the literature, are also presented.

The published research regarding entrance standards to undergraduate programs for allied health and nursing is presented in a variety of statistical formats. Although test statistics may vary, the underlying question for all the health program research on admission standards addresses the definition of best practice as programs seek to identify those qualities that effectively relate to student preparation best representative of successful student outcomes. A meta-analysis combines results from different tests to draw conclusions and generalizations around a given hypothesis (Glass et al., 1981).

Meta-Analysis

A meta-analysis is defined as the statistical evaluation of a collection of research (Glass et al., 1981). Its purpose is to “integrate results from existing studies to reveal patterns of relatively invariant underlying relationships and causalities, the establishment of which will constitute general principles and cumulative knowledge” (Hunter &
Schmidt, 2004, p. 16). Wolf (1986) suggested that a meta-analysis corrects problems associated with a traditional literature review, as it provides an objective, quantitative weighting of studies, a review and inclusion of study characteristics and their differences, and an appraisal of moderating variables that might otherwise affect the issues under study (p. 10). The meta-analysis treats research results like data. Glass et al. (1981) further noted that when research around a topic has been extensive, the results need statistical analysis, as those results are “no more comprehensible . . . than would be hundreds of data points in one study” (p. 12).

Meta-analysis is a technique that allows for different statistical tests and sample sizes to be grouped into a whole to evaluate for statistical effect. Sample size relates to research design and subsequent errors of inference. When sample size is inadequate, results may appear non-significant. Increasing sample size by combining tests decreases standard error adding practical strength to findings and identifying treatment effect that might not be seen in smaller studies (Glass et al., 1981). Inadequate sample size and subsequent statistical error may contribute to the contradictions in and lack of documented universal skills at entrance, although every health program uses some of the same foundational coursework. This next section defines the more common types of statistical error and how a meta-analysis may correct for it, thus decreasing the risk of interpretation error.

Meta-analysis combines tests with the same variables to add statistical strength to research results. To understand why statistical error is an important consideration in research methodology, it is necessary to understand the assumptions of induction applied
through the use of sampling. Realistic constraints, including resources and available populations, create the need to use subsets of a population when conducting research studies (DePoy & Gitlin, 2005). These subsets are called samples and are representative of a larger population. Mathematic derivation allows for use of samples to study and generalize to a larger population (Keppel & Zedeck, 1989). Studies conducted for health profession programs use convenience samples, as they study applications of theory or knowledge related to their specific situations. Past and current students are used to predict performance for future students within that program and the professional field. The convenience sample size is generally small and presents limitations in the application of research models for the professional population.

Understanding the assumptions and limitations of the mathematical models is essential to development of research methods that will produce valid and reliable outcomes. Research design needs to account for the risk of error and minimize that risk to increase validity and allow for generalization of results to a defined population (Crocker & Algina, 1986). Two types of statistical error that may limit the researcher’s ability to generalize results to a population are referred to as Type I and Type II and are related to acceptance or rejection of a null hypothesis (Keppel & Zedeck, 1989). Type I error is commonly assessed for and reported in the research literature, whereas Type II errors are not as commonly reported in the literature (Onwuegbuzie & Leech, 2004).

It is common practice to propose a null hypothesis to account for the possibility of statistical error. A null hypothesis implies that a treatment has no effect or that results obtained from the treated sample will not differ from any untreated sample drawn from
the same defined population. The method most commonly used to determine the
significance of the null hypothesis is the significance criteria or alpha. This value is
selected a priori and represents the probability that the largest percentage of results will
not occur by chance. If alpha is set at .05, the value most commonly selected in the
literature, the researcher is stating that 95% of the test results occurred due to a treatment
effect (Keppel & Zedeck, 1989). Another way of viewing this is that the researcher is
willing to accept changes in the results due to random effects, or error, 5% of the time
(Hunter & Schmidt, 2004).

A Type I error occurs when the researcher rejects a true null hypothesis. The
researcher identifies an effect or a difference between two variables when there is no
difference (Keppel & Zedeck, 1989). The probability that this will occur is the stated
level of significance (Bakan, 1966). Published research generally uses 5% as the
accepted level of error.

A second type of error, Type II, occurs when the opposite mistake is made. A
null hypothesis is not true, but the statistics fail to detect this, and the researcher fails to
reject it. In this instance, there is a difference between two variables. This error requires
an alternative hypothesis positing a difference between population means and therefore a
treatment effect (Keppel & Zedeck, 1989). Errors in research design are often
responsible for Type II errors. A researcher thinks there is a difference caused by a
treatment but fails to detect it statistically. A Type II error is referred to as beta and is
necessary to determine the ability of a test to accept a true alternative hypothesis
(Sedlmeier & Gigerenzer, 1989). One of the factors influencing Type II error is sample
size. Obtaining an adequate sample size in a reasonable time frame is one of the issues with research in the allied health professions. It is probable that results demonstrating an effect but lacking sample size will be considered non-significant. There is a high probability of Type II error with research in the allied health professions, as the length of time needed to gather an adequate sample is often prohibitive because of small class sizes. Sample size is an important factor in determining test validity for generalization of results to a population. Increasing sample size by merging studies with the same variables reduces standard error as it decreases the effect of variance. Reduction in variance increases the precision of the results and, consequently, the chance of detecting an effect (Cohen, 1969).

Another factor affecting a study is the size of the treatment effect. If a null hypothesis is true, there is no treatment effect and the effect size is zero. Effect size is defined as the variance in the treated sample that is due to the treatment (Onwuegbuzie & Leech, 2004). Any number other than zero indicates the presence of a treatment effect. Glass et al. (1981) noted that effect size is not interpreted as small, medium, or large, rather that it is present.

Effect size can be presented in a variety of formats depending upon what is measured (Rosenthal, 1991). The format used for this research is displayed as the standardized mean difference ($d$). Individual evaluations also use Hedges $g$ to evaluate for bias. The term bias is used to describe the difference in individual sample effect size from the population’s effect size and is considered inconsequential when sample size is greater than 20 (Hunter & Schmidt, 2004). However, as sample sizes used to compute
effect sizes in this study range from 12 to 471, Hedges $g$ is calculated with each evaluation of $d$. Calculations also include a fail safe number ($N_{fs}$), defined as the number of nil studies needed to negate the results. The $N_{fs}$ is used to further support any positive relationships between the measured variables, as it statistically determines the number of studies with non-significant results that would be needed to produce the probability of a true null hypothesis (Wolf, 1986). A fail safe number is included with the data run for each research question where three or more studies are used to assess the predictor. All the aforementioned calculations are calculated by the software used for this study, Comprehensive Meta-analysis, Version 2 (Biostat, 2005).

**Research Questions**

1. Are there differences in predictive effectiveness of entrance standards for allied health and nursing programs when grouped as a whole under the name health professions?

2. Are there differences in predictive effectiveness of entrance standards for the health professions in the level of the undergraduate degree?

3. Are there differences in predictive effectiveness of entrance standards for individual allied health professions and nursing?

4. Are there differences in the predictive effectiveness of entrance standards for the different degree levels of undergraduate academic preparation for the specific professions?

5. Are there differences in predictive significance of entrance standards for allied health and nursing based on sample size?
6. Are there differences in the predictive significance of entrance standards for allied health and nursing due to the design method, specifically the length of time used to gather data?

7. Are there differences in predictive significance of entrance standards when considering time points?

8. Are there differences in the predictive significance of entrance standards for allied health and nursing dependent upon the method of dissemination (professional publication versus non-published research)?

9. Are there differences in the predictive significance of entrance standards for allied health and nursing due to the statistical method used to evaluate results?

10. Are there differences in the predictive significance of entrance standards for allied health and nursing due to the criterion variables used to evaluate program success?

Data Sources

Meta-analysis is a form of survey research that samples research literature (DePoy & Gitlin, 2005). The sample is an important step in meta-analytic research as it introduces the possibility of sampling bias. Statistically significant results are more likely to be published in peer reviewed journals with little or no representation of non-significant findings. To omit results not published in journals introduces the possibility of sampling error or bias, eliminating what might be statistically significant given a larger sample size (Rosenthal, 1991; Wolf, 1986). Sampling error created by omitting non-published research may affect the validity of the meta-analysis. For that
reason, the sample for this study was gathered from three separate sources: electronic database systems, manual searches, and personal contacts.

**Electronic Databases**

Samples were drawn from literature published in peer-reviewed journals as identified through OhioLINK online databases including: Educational Resource Information Clearinghouse (ERIC), Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Electronic Journal Center, PsychInfo, Dissertation Abstracts, spanning a 28 year period from 1980 to 2008. Articles were identified using key words and phrases including: undergraduate health programs, dental hygiene, medical laboratory technology, nursing, radiology, respiratory, admission standards, selective admission, and entrance standards. Key words and phrases were combined to create different searches in each database. Selection of specific articles was initially conducted using the abstracts presented in the online database results. Delimiters included undergraduate programs resulting in a two- or four-year college degree and dependent variables that could be quantified across multiple programs and schools, including state or national board examinations, final grade point averages, or program completion resulting in degree attainment in one of the selected health professions. Additionally, only health programs accredited in the United States were used to assure continuity in programmatic content and outcome standards within each profession.

Professions selected for final study were chosen from the electronic search. Professions selected had to satisfy the selected delimiters and have research available for
evaluation. The five professions selected were: dental hygiene, medical technology, nursing, radiologic technology, and respiratory therapy.

**Manual Search**

Articles obtained from the online database research were reviewed for bibliographic references. Those references were also limited to publication dates between 1980 and 2008. Articles were retrieved from online database sites. Older research articles not available online were gathered from local institutional libraries including Kent State University library and Lakeland Community College library, or requested through OhioLINK services, an online source shared by institutions within the state of Ohio. This search followed and supported the electronic search. All articles identified through databases searches and references were accessible for investigation.

**Personal Contacts**

An attempt to contact accredited educational programs identified through the national accreditation boards was done electronically via e-mail. An account was set up on the Yahoo.com site to allow for large numbers of electronic letters to be distributed and responses received. Educational programs and directors were identified through the accreditation sites for each profession. No follow-up emails were sent unless the respondent communicated with the researcher. One program sent usable data for study inclusion.

Additionally, individual authors were contacted electronically for clarification or completion of data when published information was incomplete. One author complied with a request for clarification allowing for article inclusion in the study. Two additional
studies were gathered from a health profession program within the author’s institution.

The four data sets gathered through personal contact were not published in peer reviewed journals (Helm, 2008; Taydus, 2007; Thomas, 1998, 2006).

**Study Inclusion and Exclusion**

Studies were included in the final analysis when they satisfied the following evaluation criteria. First, studies had to result in a two- or four-year college degree in one of the five health professions chosen for this study. Second, studies had to be published or if unpublished, completed between January 1, 1980, and December 31, 2008. Third, studies had to use an outcome measure that could be compared to other programs including: professional board examinations, final cumulative grade point averages, final professional grade point averages, or graduation. Fourth, studies had to have statistical data that was consistent with the software and would allow for computation of effect sizes. Studies using regression analysis were excluded in the final database as they were not compatible with the software and this statistical format (Borenstein, Hedges, Higgins, & Rothstein, 2009). Results from these studies are included in the discussion in chapter 2. A total of 48 studies were selected for the final study inclusion providing a total of 253 effect sizes. Statistical formats included correlations with sample size, $t$-value for correlation, independent groups’ means and standard deviations, and $F$ for difference in change.

**Subgroups**

Two sub-groups were identified for evaluation. Two- and four-year programs are both considered undergraduate and in all but one profession have the same professional
board exam at graduation. The exception is medical technology where students graduating from a two-year program sit for a professional board examination that is different from that given a four-year degree graduate. For the remaining professions, the outcome measured is the same with different levels of educational preparation. Subgroup analysis allows for differentiation in the effects of entrance standards according to the levels of education.

**Moderators**

Moderators are variables that might affect the validity of the research outcomes and were recorded for each study. These included: the profession, the time point at publication or in the case of internal documents, the date of final computation; whether the results were published or not; and whether the research was taken from data gathered in one year or longitudinally defined as two or more contiguous years.

The time points were broken down into decades beginning in 1980, and dummy coded as 1, 2, or 3 to determine if there was a difference in the efficacy of entrance standards over time. Dummy coding was also used for evaluation of the length of time used to gather data, and was recorded as 1 or 2. The longitudinal coding identified single versus multiple years of data gathering to denote the possibility of change within a program over time. There was no separation for two years or more of data gathering.

Allied health and nursing specialties were evaluated initially as a group to identify core variables leading to successful program completion and then individually to determine if differences existed. Two- and four-year degrees were grouped initially as
successful completion of these degrees prepares the students for the same professional specialty board exams.

**Coding**

Coding is an important part of meta-analytic research and includes both the study characteristics and results. This part of the process is important for reliability and requires consistency (Glass et al., 1981). Identification and classification of characteristics and findings across all samples is important as this is the method of measurement in a meta-analysis (Glass et al., 1981). Research was reviewed first for inclusion in the study, and second as it was entered into the database. A third review was done with a coding sheet (see Appendix B). The coding sheet was then compared to the database for consistency. Research was consulted when differences were identified, and studies excluded if data was unclear. Coding included the following.

**Publication**

If the article appeared in a peer-reviewed journal, the year of publication was noted and also dummy coded by time point. If the research was from Dissertation Abstracts, or unpublished as an internal document, the year of completion was noted and dummy coded by time point. Dummy coding was also used to denote whether a research paper was published or unpublished.

**Health Profession**

Coding identified each of the five health professions: dental hygiene, medical technology, registered nurse, radiologic technology, and respiratory therapy. Each study
was then coded further denoting the type of undergraduate degree awarded by the program.

**Sample Size**

Research sample size was taken from the abstracts for final tally, although sample size within each measure was used for statistical calculations and weighting within the database. For example, the total number of students evaluated in a study may have been 200, but only 175 of those reported SAT results. The tally used for the study is 200 and that number is included in the final participant tally. The 175 is used internally in the software for statistical weighting on that predictor variable.

Additionally when sample independence was at risk due to multiple predictors as seen with Chemistry I, II, III, the first predictor, Chemistry I was used for the analysis.

**Time Point**

Date of publication or if non-published, date of completion was recorded. Dummy coding was used for the corresponding decade with 1980-1989 as 1; 1990-1999 as 2; 2000-2008 as 3.

**Data Format**

The health professions research utilized a number of different statistical techniques. The meta-analysis software allowed for a number of different data input formats. Coding was set up using the formats identified in the research and allowed by the software. Coding included: correlations with sample size; $F$ for difference in change; $t$-value for correlation; and independent groups with means and standard deviations.
**Predictor Variable**

The research held a number of different predictors. Each predictor was classified and separated according to the data identified in the research. Classifications were used for multiple evaluation formats including interview, specialty examinations, science and math coursework. Standardized tests, ACT and SAT, were recorded by section: math, science, social science, English or verbal, and composite scores. Modifier variables were included in this section of the coding.

**Outcome Variable**

Criterion values are defined as outcome variables and four outcomes were used in the coding including: professional grade point average, cumulative grade point average, professional board exam score, and graduation.

To prevent sample size from affecting the statistical outcome, studies are weighted. Exact numbers were pulled from the research for each predictor/criterion variable and recorded in the software. “In the unweighted case, many studies with small samples that contain results inconsistent with most studies in a meta-analysis could exert a much stronger influence on the results than warranted” (Wolf, 1986, p. 40). Statistical weighting is calculated by the meta-analysis software.

The meta-analysis software allows for calculation of fixed and random effects models. Both are shown in the results, although the underlying assumption for this model is that studies used in the analysis are random, representative of all the possible studies conducted in the time period on this topic. Studies conducted, but not published, are assumed to exist but are not available for the research. Therefore, the final sample is not
the total population of studies conducted. The random effect assumption decreases the
risk of Type I error (Hunter & Schmidt, 2004). The software calculated weights for the
random effect analysis giving more relative weight to smaller studies to allow for
statistical influence and prevent one large study from dominating the results.

In this study, fixed effects were run with the random effects for comparison, as
fixed effects assume the population standard deviation to be zero and all studies in
existence are included in the final analysis (Hunter & Schmidt, 2004). When the two
types of studies resulted in the same effect size values, indicating a shared variance, the
results are noted as homogeneous. When the values are not the same, tau-squared
represented by the sample value \( T^2 \) is presented as a measure of the variance. This
calculation is carried one step further to determine the amount of the variance due to
actual differences in the studies \( I^2 \).

**Limitations**

1. Meta-analysis is dependent upon accurate reporting of results in the studies
   used (Rosenthal, 1991). If the original researcher documents data inaccurately
   there is no way of knowing and the incorrect data will become part of the
   meta-analysis.

2. Peer-reviewed journals may only publish studies with significant results
   (Wolf, 1986). As non-significant results may hide effects that can be
   strengthened with increased sample size, locating research with non-
   significant results was conducted through professional requests of non-
   published work and dissertation abstracts. However, only one program
submitted valid data for inclusion following personal requests to programs across the nation.

3. There are few published studies in each allied health specialty. The bulk of research studies are from nursing programs. This may limit inference of results to other health specialties.

**Delimitations**

1. Research studies are limited to four allied health specialties and nursing programs leading to undergraduate college degrees. The allied health specialties include dental hygiene, medical laboratory technology, radiologic technology, and respiratory therapy. Undergraduate nursing programs resulting in a degree and the ability to sit for the NCLEX-RN are included.

2. Dates of publication or completion are limited to a 28-year span between January 1, 1980, and December 31, 2008, as defined by outcome criterion, specifically professional board examinations.

3. Research formats are limited to those compatible with the software and this statistical format. This exempts regression analyses.

**Validity**

**Internal Validity**

1. Internal validity will be dependent upon the quality of the reported results. Errors recorded by the original researchers will become a part of the meta-analysis and may influence outcome data. Additionally, selective omission of
data by original researchers may influence outcomes and effect sizes used as part of the meta-analysis.

2. Due to the nature of specialties in allied health and limitations on clinical practice within hospitals, numbers of students in each sample is small compared to the entire sample. Grouping allied health into one large category may overshadow specific findings in each specialty.

3. The majority of studies are from nursing programs, and the large number may influence results nullifying variables that might better suit the allied health programs. Statistical weighting gives larger studies more weight in the final assessment.

4. Characteristics of participants including student age, race, gender, and level of education may influence a criterion. As most of the research did not report demographic specifics for comparison, these values may be underlying moderators. Glass et al. (1981) noted that validity is confirmed when substantive differences in the research reviewed do not alter the general conclusions. Unknown or unreported variables may influence the validity of the studies.

**External Validity**

1. External validity may be influenced by the number and sample sizes of nursing studies. Generalization of results may be hampered if nursing outcomes weigh heavier in the statistical evaluation than any one allied health profession.
2. Lack of demographic specifics in the research may limit external validity.

3. Sampling bias, as with a lack of unpublished data on a topic, may affect external validity.

**Reliability**

1. Reliability of results depends upon the accuracy of reporting the original research.

2. Access to articles contributes to reliability. Results are accessible for published work through journals and electronic resources. Access to unpublished work may be influenced by accessibility to authors.

**Summary**

This research uses proprietary online statistical software to evaluate 28 years of literature on entrance standards for each of five selected undergraduate health professions. Professions were selected following a review of the published literature, and data were further supplemented with manual reviews and personal contacts. Effect size was calculated using standardized mean differences of predictors and outcomes with separate measures for evaluation of bias. Samples were weighted by the software to minimize the effect of larger studies. Random effects are calculated as heterogeneity is assumed a priori. Additional measures determine the amount of variance and whether the variance is due to chance. Fixed effect models were calculated to identify those predictor/criterion comparisons with a shared variance.
CHAPTER IV

RESULTS

This chapter is organized into three separate sections. The first section reviews results from the broadest perspective, using the criterion as the standard of evaluation. All the predictors are grouped together to assess their impact on each of the four criterion variables. This type of general assessment creates the risk of loss of sample independence, as each study used for the analysis assessed multiple predictors with the same sample participants. Sample independence is an assumption necessary to evaluate a mean effect size, the variable used to assess the impact of each predictor on the criterion (Biostat, 2005). Thus, results in the first section are presented for effect size range, number of studies, and number of participants. Studies used in the final analysis are noted with an asterisk (*) in the reference section of this paper.

The second section reviews results for each profession against the selected criterion. This assessment still uses multiple predictors from each sample preventing the use of a mean value; however effect size range is presented along with a discussion of the subgroups and modifiers used by the professions to assess each criterion. The number of studies used by each profession to assess the individual criterion is also presented.

The third section is the most detailed as it assesses each predictor against each criterion. In addition to providing a range, standardized mean difference, and statistical significance, results are presented with a discussion of the subgroups, two- and four-year programs, and moderators including: the five professions; the time point, defined as when the study was published or completed; the length of each study, coded for single or
multiple year assessment; and whether the study was published. Random effects analysis is used and studies are weighted to minimize variance. Random effects provides for a more equitable weighting of studies giving smaller studies more influence in the mean value. This method allows for differences in effect size, computing a more generalized mean, but will equal a fixed model when effect sizes between the studies are the same (Borenstein et al., 2009).

Sample heterogeneity is assessed using an estimate of tau-squared, the true variance, using the between-studies variance (\(T^2\)) computed from the observed values. To determine what proportion of the variance is real and not due to chance, the ratio of heterogeneity to the observed variance (\(I^2\)) provides a number similar to a percentage. The closer this latter number is to zero, the more likely differences are due to chance. Neither of these values is sensitive to the number of studies (Borenstein et al., 2009).

Study characteristics including protocol and quality affect heterogeneity (Harbord et al., 2008; Terrin, Schmid, & Lau, 2005). Heterogeneity may affect the internal validity of the study and thus if present is included in the discussion of the predictor.

A standardized mean difference (\(d\)) is used to represent effect size and is presented for each variable. To account for the possibility of publication bias, Hedge’s \(g\) (\(g\)) is also presented for each calculation of \(d\). Hedge’s \(g\) assumes only statistically significant studies are published and corrects for this to provide an unbiased effect size (Hunter & Schmidt, 2004). Probability of \(d\) is presented to determine the statistical significance of the predictors for each criterion.
Additional measures are used to assess the effectiveness of the data when three or more studies are available for measure with a criterion. When $d$ is statistically significant a fail safe number ($N_{fs}$) is reported for the predictor/criterion measure. The $N_{fs}$ value is important as it serves as a reflection of bias as seen when only significant data is published in the research literature. This number represents the number of null studies that would be needed to bring $p > .05$. “If the overall level of significance . . . will be brought down to the level of just significant by the addition of just a few more null results, the finding is not resistant to the file drawer threat” (Rosenthal, 1991, p. 104). In other words, if only statistically significant data has been reported in peer review journals and the $N_{fs}$ is small, results may be due to the lack of statistically non-significant studies in the published literature.

$Z$-values for the observed studies are presented in comparison with the $Z$-value for alpha .05 of 1.95996 and the corresponding $p$-value. A larger $Z$-value reflects a larger effect on the criterion. Each value is calculated using Comprehensive Meta-analysis software, version 2 (Biostat, 2005).

Forty-eight studies gathered from professional journals, dissertations, master’s theses, and in-house documents yielded a total of 253 effect size variables. Some predictor and criterion variables are not included in all the final analyses for reasons including loss of independence as when more than one predictor existed under the same classification and was measured with the same sample, or when classification variables were assessed only once as with the criterion, failure. The final 230 effect size variables
used in the analysis are separated by outcome, subgroups, and moderators to assess their usefulness in predicting success for students in five undergraduate health professions.

The first analysis is the largest, evaluating all the predictors against the criterion. Four criterion, board scores, cumulative and professional grade point average, and graduation or completion are set as the unit of measure. Results are presented here.

**Outcome Results**

Table 1 identifies the number of studies, sample sizes, range, and number of effect sizes used to evaluate the criterion variables. Board examinations are listed by profession as the examinations differ among professions. For evaluation purposes this paper considers graduation and program completion as one criterion. This section is presented to identify the outcome criteria used in the literature to determine success. Four general outcomes were identified. A summary of their use is presented.

The criterion, board examinations, is presented most often in the literature creating more effect size variables than the other measures. Cumulative and professional grade point averages are separated for evaluation as noted in the literature. The criterion, graduation, has the largest effect size range, indicating that the predictors were not as reliable with this outcome as they were with the other three measures. Following is a descriptive review of each of the outcomes, identifying the professions and whether the outcome was assessed over all three time points.
Table 1

*Number of Studies and Participants, Effect Size Range, and Number for Each Criterion Variable*

<table>
<thead>
<tr>
<th>Criterion variable</th>
<th>k/N</th>
<th>LL</th>
<th>UL</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board examinations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dental Hygiene</td>
<td>4/435</td>
<td>-0.389</td>
<td>0.939</td>
<td>12</td>
</tr>
<tr>
<td>Medical Technology</td>
<td>3/417</td>
<td>-0.400</td>
<td>2.612</td>
<td>16</td>
</tr>
<tr>
<td>Nursing</td>
<td>17/3440</td>
<td>-0.586</td>
<td>2.118</td>
<td>87</td>
</tr>
<tr>
<td>Radiologic Technology</td>
<td>4/383</td>
<td>-0.324</td>
<td>3.096</td>
<td>20</td>
</tr>
<tr>
<td>Respiratory Therapy</td>
<td>3/446</td>
<td>-0.120</td>
<td>1.283</td>
<td>12</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>12/1655</td>
<td>-0.413</td>
<td>2.346</td>
<td>39</td>
</tr>
<tr>
<td>Professional GPA</td>
<td>6/568</td>
<td>-0.221</td>
<td>3.214</td>
<td>28</td>
</tr>
<tr>
<td>Graduation/completion</td>
<td>9/1410</td>
<td>-1.622</td>
<td>3.371</td>
<td>36</td>
</tr>
</tbody>
</table>

*Note.*  

Note. *k* = number of studies; *N* = number of participants; LL = lower level; UL = upper level; *n* = number of effect sizes generated for that criterion.

**Board Examinations**

A total of 147 effect sizes were calculated against the criterion, board scores, with a range of $d = -0.586 (g = -0.583)$ for the predictor, ethnicity to $d = 3.096 (g = 3.064)$ for the predictor, SAT cumulative score. All five professions contained research articles using this variable as an outcome. Board examinations differ for each profession, reflecting the specific knowledge required of graduates upon completion of the program. All examinations are administered by national organizations and some vary with relation
to education level as seen with medical technology. Assessments were made in each of the three time points.

**Grade Point Average**

This value represents all the grade point averages, both the cumulative and profession-specific averages. A total of 67 effect sizes were generated for all studies selecting grade point average as a criterion variable. The range of effect sizes is \( d = -0.413 \) (\( g = -0.400 \)) for cumulative grade point average, to \( d = 3.214 \) (\( g = 3.148 \)) for professional grade point average. The large number of effect sizes and the substantial range warrant a closer look by separating the professional from the cumulative grade point average. All five professions used this criterion as an outcome measure.

**Cumulative grade point average.** Twelve studies identified cumulative grade point average as a criterion variable creating 39 effect sizes with a range of \( d = -0.413 \) (\( g = -0.400 \)) for a problem solving inventory to \( d = 2.346 \) (\( g = 2.331 \)) for entrance grade point average. This variable was measured in each of the three time points and represents the final grade point average measured for participants including grades received in general degree work as well as professional coursework. All five professions are represented in this value.

**Professional grade point average.** Six studies identified professional grade point average as a criterion variable creating 28 effect sizes with a range of \( d = -0.221 \) (\( g = -0.219 \)) for an occupational work survey to \( d = 3.214 \) (\( g = 3.148 \)) for science and math cumulative grade point average. This criterion accounts for fewer course hours but is more reflective of a student’s ability to learn course material related to the major. This
variable is measured in all three time points for four professions: dental hygiene, medical laboratory technology, radiologic technology, and respiratory therapy.

**Graduation**

Nine studies identified graduation as a criterion variable creating 36 effect sizes with a range of $d = -1.622$ ($g = -1.614$) for age to $d = 3.371$ ($g = 3.307$) for a specialty entrance exam. This criterion is responsible for the largest effect size range. It is measured in each of the three time points and was evaluated by registered nursing, radiologic technology, and respiratory therapy.

**Profession Results**

**Dental Hygiene**

Four studies were identified for Dental Hygiene. Both two- and four-year programs were included in the analysis with studies conducted in time points 1 and 3. Three criterion variables were assessed including professional board scores, cumulative grade point average and professional grade point average.

**Board scores.** Four studies evaluated predictors against the National Board for Dental Hygiene Examinations (NBDHE) creating 12 effect size variables. Three studies used more than one predictor to assess this outcome. The effect sizes range from $d = -0.389$ ($g = -0.378$) for a problem solving inventory to $d = 0.939$ ($g = 0.934$) for science grade point average. Two two-year programs accounted for six effect size variables; the other six variables were created by the four-year programs. Studies were conducted in time points 1 and 3. One study was not published and three studies were conducted over two or more years.
**Grade point average.** Three studies assessed grade point average creating seven effect size variables. Two four-year studies used more than one predictor, resulting in a range $d = -0.413 (g = 0.400)$ for a problem solving inventory and cumulative grade point average to $d = 1.860 (g = 1.849)$ for entrance grade point average and professional grade point average. One two-year program accounted for one effect size variable. All studies were conducted in time point 3.

**Medical Technology**

Three studies were identified for medical technology. Both two- and four-year programs were assessed and studies were conducted in all three time points. Criteria include professional board scores, final or cumulative and professional grade point average.

**Board scores.** Medical Technology utilized three separate board scores in the literature. The first exam is administered to graduates of two-year institutions. The second and third board exams are administered to graduates of four-year programs; however, graduates are not required to take both exams and may select one of the exams offered. As the exams are offered by different accrediting agencies and graduates of a four-year program may choose which exam they take, the two exams are not differentiated in this analysis. Two- and four-year assessments are evaluated separately here. One study was not published; all studies were completed in two or more years.

One study assessed the exam given to two-year graduates creating seven effect sizes ranging from $d = -0.120 (g = -0.119)$ for entrance grade point average to $d = 1.855$
(g = 1.820) for the ACT composite score. In the four-year programs two studies were conducted using the board exams as the criterion variable. Effect sizes range from $d = -0.746$ ($g = -0.741$) for science grade point average to $d = 2.612$ ($g = 2.513$) for a specialized examination, the AHPAT, presented in more detail in chapter 2. Each study was conducted in a separate time point giving this profession representation in all three time points for this measure.

**Grade point average.** Two- and four-year results are compared for the outcome, grade point average. Two studies evaluated this outcome resulting in 10 effect sizes. Seven effect size variables were calculated for cumulative grade point average and three for professional grade point average. Effect sizes range from $d = 0.697$ ($g = 0.694$) for entrance grade point average in a four-year medical technology program, to $d = 1.540$ ($g = 1.511$) for the ACT composite score in a two-year program. Studies were conducted in time points 2 and 3.

**Radiologic Technology**

Eight studies were identified for the radiologic technology profession. Three criteria were assessed including board scores, cumulative and professional grade point average, and graduation. Studies were conducted for both two- and four-year programs and were represented in all three time points.

**Board scores.** Four studies assessed the criteria, board scores, with articles spanning the full 28-year study resulting in 20 effect sizes. Only one study was conducted by a four-year program; the other three studies comprising 18 effect sizes were conducted on two-year programs. The effect size range is $d = -0.324$ ($g = -0.319$) for
gender in a two-year program to \( d = 3.096 \) (\( g = 3.064 \)) for the SAT cumulative score in a four-year program. Three studies were published; all studies were conducted over two or more years.

**Grade point average.** Two studies identified cumulative grade point average as an outcome and one study used the professional grade point average as an outcome variable. The effect size range is \( d = -0.221 \) (\( g = -0.219 \)) for a specialized occupational work exam to \( d = 2.346 \) (\( g = 2.129 \)) for entrance grade point average, both variables measured in two-year programs. The third study is a four-year program and accounts for four effect size variables. Each study was conducted in a separate time point giving this profession presence in all three time points.

**Graduation.** Two studies used graduation as the outcome variable. Both studies were conducted on four-year programs and were conducted in time point 2. The effect size range is \( d = -0.370 \) (\( g = -0.368 \)) for ACT composite score to \( d = 0.327 \) (\( g = 0.324 \)) for high school graduation.

**Registered Nurse**

Twenty-six studies were identified for registered nursing. Both two- and four-year degree programs are included and the profession is represented in all three time points. The criterion variables include board scores, final or cumulative grade point average, and graduation or completion.

**Board scores.** Seventeen studies used the nursing board exam as an outcome variable creating 87 effect sizes with a range of \( d = -0.586 \) (\( g = -0.583 \)) for ethnicity to \( d = 2.118 \) (\( g = 2.056 \)) for entrance grade point average. Three studies were conducted on
two-year programs creating 14 effect sizes. The other 14 studies were conducted on
four-year programs accounting for the other 73 effect sizes. Assessments covered all three
time points for both the two- and four-year programs. Nursing had more studies, a larger
participant sample, and more effect size variables than the other four health professions.
Four studies were not published; three studies were conducted in one year.

**Grade point average.** Six studies used final grade point average as a criteria
variable creating 18 effect sizes with a range of $d = -0.387 (g = -0.378)$ for age to
$d = 1.536 (g = 1.531)$ for entrance grade point average. Variables covered all three time
points with one study conducted on a two-year program, the other five studies on four-
year programs. The two-year program accounted for five effect size variables; the other
13 effect sizes were created by four-year programs.

**Graduation.** Five studies used graduation or completion as the criterion variable
creating 17 effect sizes with a range of $d = -1.622 (g = -1.614)$ for age to $d = 1.585$
($g = 1.576$) for the second anatomy and physiology course in a two-course sequence. This
is the second finding denoting age as creating the lowest effect size in nursing. Two
studies were conducted on two-year programs accounting for six effect size variables;
three studies were conducted on four-year programs creating 11 effect size variables.
Two studies identified completion as a criterion but one of those studies also measured
graduation against the same predictors. All studies were conducted in time points 1 and 3.

**Respiratory Therapy**

Seven studies were identified for Respiratory Therapy. Both two- and four-year
programs are represented with studies conducted in all three time points. Four criteria
variables were assessed including board scores, cumulative and professional grade point average, and graduation. All studies were published and all were conducted over two or more years.

**Board scores.** Three studies identified board scores as a criterion variable creating 12 effect size variables with a range of $d = -0.120$ ($g = -0.117$) for age to $d = 1.283$ ($g = 1.247$) for entrance grade point average. All studies used the first of three national examinations as the criterion. As with nursing, age created the smallest effect size indicating that for nursing and respiratory board examinations, age has the smallest effect for the variables measured. One study was conducted on a two-year program creating five effect size variables, two studies were conducted on four-year programs creating the remaining seven effect sizes. All studies were conducted in time points 2 and 3 and all used the first of three national board examinations as the outcome measure.

**Grade point average.** Four studies identified grade point average as a criterion variable creating 21 effect size variables with a range of $d = 0.040$ ($g = 0.040$) for interview to $d = 3.214$ ($g = 3.148$) for a science and math cumulative grade point average. One study was conducted for a two-year program creating six effect sizes; three studies were conducted on four-year programs for a total of 15 effect size variables. One program used cumulative grade point average as the criterion; the other three programs used the professional grade point average. All studies were conducted in time points 1 and 2.

**Graduation.** Two studies identified graduation as a criterion variable creating eight effect size variables with a range of $d = 0.387$ ($g = 0.384$) for an arithmetic portion
of a specialized examination, the AHAT, discussed in chapter 2 to $d = 3.371$ ($g = 3.307$) for a specialized entrance examination, the HOBET, discussed in more detail in chapter 2. Both studies were conducted on two-year programs with one study evaluating graduation in time point 1 and the other in time point 3.

**Predictor Results**

Table 2 identifies the number of studies used in each assessment ($k$), the number of participants tallied from those studies (N), and the number of effect sizes ($n$) produced for each predictor. The predictor variables used in the analysis are identified on the coding sheet presented in Chapter 3. Some studies evaluated predictors against more than one criterion resulting in effect sizes in excess of the number of studies noted.

Predictor and criterion variables assessed only once in the literature were not eligible for inclusion in the study. Predictors assessed once include ACT reading, committee rank, essay, marital status, number of children, physics, and pathophysiology. The criterion variable, failure, was assessed once and included as part of the range for a predictor, but could not be included in any statistical analysis.

This section reviews the predictors against each criterion and provides a discussion of the subgroups and moderators as they affect the overall standardized mean difference. Random analysis is used to assess results as the effects presented are assumed to be a sample of the population effects (Borenstein et al., 2009). Predictor variables are presented in alphabetical order.
Table 2

Number of Samples, Participants, and Effect Sizes for Each Predictor Variable

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>$k$</th>
<th>$N$</th>
<th>$n$</th>
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</table>

Note. $k =$ number of studies. $N =$ number of participants. $n =$ number of effect sizes.
ACT Examination

**Composite score.** Eleven studies evaluated ACT composite scores creating 12 effect sizes. To prevent the loss of independence, one effect size was eliminated as one study evaluated ACT composite against two outcomes. The range of effect sizes is $d = -0.336$ ($g = -0.334$) for the criterion, graduation, to $d = 1.855$ ($g = 1.820$) for the criterion, board scores. Outcomes used to assess this predictor were varied and included professional board scores, professional and cumulative grade point averages, and graduation.

**Board scores.** Six studies used the criterion variable, professional board scores, to assess the predictor resulting in $d = 0.948$ ($g = 0.938$), $p = 0.000$. The $N_{fs} = 123$ with a $Z$-value of 9.07818. The observed variance is $T^2 = 0.074$, with the amount of variance attributable to real differences in the studies, $I^2 = 53.186$. Five of the assessments were conducted on two-year programs with a mean of $d = 0.964$ ($g = 0.951$), $p = 0.000$.

Studies using board scores as the criterion covered all three time points identified for this research. There was no difference in statistical significance for time points 1 and 2, and both were statistically significant at $p = 0.000$; however time point 3 contained only one study with non-significant results, $d = 0.314$ ($g = 0.305$), $p = 0.438$.

Four professions used board scores as the criterion with dental hygiene, medical technology, and radiologic technology each represented by one study, all statistically significant. Nursing had three studies, one in each time point, and one four-year program, with a combined mean effect of $d = 0.894$ ($g = 0.881$), $p = 0.000$. Five studies were published with a mean effect of $d = 0.905$ ($g = 0.895$), $p = 0.000$. Publication did
not make a difference in statistical significance as the non-published study was also statistically significant.

The moderator, length of study, did make a difference in statistical significance. One two-year study was conducted within one year and was not significant. This study is the same study conducted in time point 3. Five of the studies were conducted over two or more years with a mean of $d = 1.016$ ($g = 1.007$), $p = 0.000$.

**Cumulative grade point average.** Three studies identified cumulative grade point average as the criterion, with a mean effect of $d = 0.711$ ($g = 0.702$), $p = 0.041$. The mean effect size for the criterion, grade point average, was lower than the effect size for the criterion, board scores, although both were statistically significant. The $N_{fs} = 17$ with a Z-value of 5.05697. The fail safe number is much lower for grade point average than for board scores reflecting the smaller effect and increased chance of statistical non-significance with the addition of 17 null studies. The observed variance is $T^2 = 0.300$, with the amount of variance attributable to the studies, $I^2 = 87.432$.

Subgroup analysis reveals two-year program results to be non-significant with $d = 0.788$ ($g = 0.775$), $p = 0.256$. One four-year study was statistically significant with $d = 0.723$ ($g = 0.718$), $p = 0.001$. Additionally, one moderator created a difference in statistical significance. Two studies were published in time point 1 with non-significant findings $d = 0.403$ ($g = 0.400$), $p = 0.158$. One study was conducted in time point 2 with $d = 1.540$ ($g = 1.511$), $p = 0.000$. All three studies were published and conducted over two or more years. Three studies were represented in this analysis, medical technology and nursing are two-year programs, and radiologic technology is a four-year program.
Summary. The statistical significance of this predictor varied with the criterion measure used to assess outcome. When evaluated against the criterion, board scores, the ACT cumulative score is a good predictor for both two- and four-year programs and is statistically significant across professions and time points. The criterion, grade point average, is not a statistically significant criterion for two-year programs. Only one four-year program evaluated this predictor against the criterion, graduation, and while it was statistically significant, the effect size was a negative number and indicates that the mean score of those graduating from the program was less than the mean score of those that did not graduate (Schultz & Rakow, 1999).

English/verbal score. Eight studies assessed ACT English/verbal scores generating nine effect sizes. Overall effect size range is $d = 0.408$ ($g = 0.404$) for the criterion, board scores, to $d = 1.387$ ($g = 1.361$) for the criterion, cumulative grade point average.

Board scores. Six studies identified professional board scores as the criterion, with a mean effect size of $d = 0.694$ ($g = 0.689$), $p = 0.000$. The $N_f = 80$ with a $Z$-value of 7.41763. The observed between studies variance $I^2 = 0.031$, with $I^2 = 33.751$ attributable to real differences in the studies. Five of these studies were conducted on two-year institutions with a mean effect size of $d = 0.802$ ($g = 0.791$), $p = 0.000$. One four-year program had an effect size of $d = 0.606$ ($g = 0.604$), $p = 0.000$. Three studies were conducted in nursing, $d = 0.818$ ($g = 0.809$), $p = 0.001$, with the other three studies conducted for dental hygiene, medical technology, and radiologic technology.
Studies were conducted in each of the three time points, with the same results for both fixed and random study formats indicating a shared variance in each time point. Time point 1 had three studies with a mean effect of $d = 0.611$ ($g = 0.607$), $p = 0.000$. Time point 2 had two studies with a mean effect of $d = 1.127$ ($g = 1.113$), $p = 0.000$. Only one study was conducted in time point 3 and this study by itself was not statistically significant with $d = 0.556$ ($g = 0.540$), $p = 0.180$. The moderator, time point, did make a statistical difference in the results and created a shared variance within time points 1 and 2.

Five studies were published with a mean effect of $d = 0.730$ ($g = 0.722$), $p = 0.000$. One study, a two-year radiologic technology program, had an effect size of $d = 0.837$ ($g = 0.829$), $p = 0.001$. For this predictor/criterion measure, publication did not have a statistically significant effect. However, length of study did make a difference in statistical significance. One study conducted in a single year for a two-year nursing program revealed a $d = 0.556$ ($g = 0.540$), $p = 0.180$. Five other studies were conducted over two or more years with a mean effect of $d = 0.765$ ($g = 7.58$), $p = 0.000$.

**Cumulative grade point average.** Three studies identified grade point average as the criterion, two using cumulative and one study using the professional grade point average. Three studies were represented: medical technology, nursing, and respiratory therapy. The two studies identifying cumulative grade point average had a mean effect size of $d = 0.691$ ($g = 0.679$), $p = 0.279$. Both studies conducted for two-year programs were published and conducted over two or more years. The between studies variance is
$I^2 = 0.741$, with $I^2 = 90.224$ indicating that most of the variance is due to the studies.

Cumulative grade point average is a statistically non-significant finding for this predictor.

**Professional grade point average.** One study was conducted for a four-year Respiratory Therapy program using the professional grade point average as the criterion. The standardized effect size is $d = 0.977$ ($g = 0.957$), $p = 0.008$. For this study, the ACT English component was a statistically significant predictor for professional grade point average.

**Summary.** Most assessments for ACT English were made with the criterion, board scores, and were statistically significant across two- and four-year programs as well as professions. When grade point average was used as a criterion, findings were mixed. Cumulative grade point average was not statistically significant across the professions, and only one study was assessed against the professional grade point average. While this latter study was significant, further investigation is needed to adequately assess the usefulness of this criterion.

**Math score.** Eight studies evaluated the math component of the ACT exams resulting in nine effect sizes with a range of $d = -0.132$ ($g = -0.131$) for the criterion, graduation, to $d = 1.461$ ($g = 1.434$) for the criterion, cumulative grade point average. Six of those studies used board scores as the criterion. Additionally, the criterion measures, cumulative and professional grade point average were assessed.

**Board scores.** The mean effect size for board scores is $d = 0.541$ ($g = 0.543$), $p = 0.000$. The $N_{fs} = 42$ with a Z-value of 5.53457. The between studies variance is
$T^2 = 0.014$, with the amount of variance attributable to differences in the studies, $I^2 = 51.360$.

Five studies were conducted on two-year programs with a mean effect size of $d = 0.588 \ (g = 0.580), \ p = 0.002$. The one four-year program had an effect size of $d = 0.430 \ (g = 0.428), \ p = 0.003$. The subgroup analysis did not make a statistically significant difference.

Three studies were conducted in the first time point with a combined effect of $d = 0.479, \ (g = 0.475), \ p = 0.008$, two studies in the second time point with $d = 0.831 \ (g = 0.818), \ p = 0.031$, and one in the third time point $d = 0.234 \ (g = 0.227), \ p = 0.580$. The moderator, time point, did make a statistically significant difference when evaluated with the criterion, board scores.

Three studies were conducted on nursing programs with a mean effect of $d = 0.434 \ (g = 0.431), \ p = 0.000$. Fixed and random results are exactly the same for this statistic indicating a shared variance within the nursing profession for this measure. Additionally, these three studies were conducted over all three time points. Three other professions had one study each, dental hygiene, medical technology, and radiologic technology, all two-year programs. The dental hygiene study was the only non-significant finding with $d = 0.161 \ (g = 0.159), \ p = 0.491$.

The moderator, publication, had no effect on statistical significance. Five studies were published with a mean effect size of $d = 0.463 \ (g = 0.502), \ p = 0.001$. One study not published had an effect size of $d = 0.886 \ (g = 0.878), \ p = 0.000$. Length of study did make a statistical difference. Five studies were conducted over two or more years for a
mean effect of $d = 0.575 \ (g = 0.570), \ p = 0.000$. One study conducted over one year was statistically non-significant with an effect size of $d = 0.234 \ (g = 0.227), \ p = 0.562$.

**Grade point average.** Three additional studies used grade point average as the criterion measure. Two of these studies used cumulative grade point average as the criterion, with $d = 0.725 \ (g = 0.712), \ p = 0.286$. Both studies were conducted on two-year programs. The one study using professional grade point average as the criterion was a four-year program and was also statistically non-significant $d = 0.530 \ (g = 0.519), \ p = 0.125$. Grade point average is a statistically non-significant criterion for ACT math.

**Summary.** The statistical significance of ACT math varied with the criterion measure and profession. This was not a significant predictor for the profession, dental hygiene. It was significant for medical technology, nursing, and radiologic technology for both two- and four-year programs when assessed against the criterion, board scores. Grade point average was not a statistically significant criterion for this measure.

**Science score.** Eight studies assessed ACT science as a predictor variable generating nine effect sizes. One variable was dropped from the overall effect size analysis to prevent the loss of independence as one author evaluated the predictor against two criterion variables. The overall range of effect sizes is $d = -0.370 \ (g = -0.368)$ for the criterion, graduation, to $d = 1.855 \ (g = 1.820)$ for the criterion, board scores. Criterion variables included all four outcome measures: board score results, final or cumulative grade point average, professional grade point average, and graduation. Studies were conducted over all three time points.
Board scores. Five studies measured this predictor against the criterion, board scores, for a mean fixed effect of $d = 0.820$ ($g = 0.811$), $p = 0.000$. The $N_{fs} = 63$ with a Z-value of 7.21440 for the five studies. The between studies variance is $I^2 = 0.073$ with the proportion of that variance attributable to real differences, $I^2 = 52.436$.

Four of the studies were conducted for two-year programs with a mean effect size of $d = 0.884$ ($g = 0.871$), $p = 0.001$. One study was conducted for a four-year nursing program with an effect size of $d = 0.723$ ($g = 0.720$), $p = 0.000$. The subgroup analysis did not make a statistically significant difference in the results for the criterion, board scores.

Three studies were conducted in time point 1 with a mean effect size of $d = 0.738$ ($g = 0.733$), $p = 0.000$. Studies were conducted for three different professions in this time point: dental hygiene, nursing, and radiologic technology. Fixed and random effect size values are identical indicating a shared variance for the studies conducted in this time point.

One study was conducted for each time point 2 and 3. A two-year medical technology program in time point 2 had an effect size of $d = 1.855$ ($g = 1.820$), $p = 0.000$. The study in time point 3 was conducted for a two-year nursing program with a statistically non-significant finding $d = 0.347$ ($g = 0.337$), $p = 0.393$. The moderator, time point, had a statistically significant effect on the criterion, board scores; however, a limited number of studies left two of the time points represented by one study each.

Two studies were conducted for nursing programs with $d = 0.678$ ($g = 0.672$), $p = 0.000$. The other three studies were conducted for dental hygiene, medical laboratory
technology, and radiology. All three studies are statistically significant. The predictor ACT science is a good predictor for four different professional board exams.

The moderator, length of study, created a statistically significant difference. Five studies were conducted over two or more years with a mean effect size of \( d = 0.893 \) \( (g = 0.884), p = 0.000 \). One study was conducted in one year with an effect size of \( d = 0.347 \) \( (g = 0.337), p = 0.393 \). The moderator, length of study, made a statistically significant difference in the findings for the criterion, board scores.

The moderator, publication, did not make a statistically significant difference. Five studies were published with a mean effect of \( d = 0.803 \) \( (g = 0.792), p = 0.000 \). One study was not published with an effect size of \( d = 0.939 \) \( (g = 0.930), p = 0.000 \).

**Cumulative grade point average.** Two studies identified cumulative grade point average as the criterion with a mean effect size of \( d = 0.713 \) \( (g = 0.702), p = 0.214 \). Both of these studies were conducted on two-year programs, one each for medical laboratory technology and nursing. Studies were conducted in time points 1 and 2.

**Professional grade point average.** One study conducted for a four-year Respiratory Therapy program in time point 1 assessed professional grade point average. The standardized effect size is \( d = 0.312 \) \( (g = 0.305), p = 0.355 \). This criterion was statistically non-significant for ACT science.

**Graduation.** One study conducted for a four-year radiologic technology program in time point 2 was statistically significant. The standardized effect size is \( d = -0.370 \) \( (g = -0.368), p = 0.032 \). ACT science is a statistically significant predictor for graduation; however, only one study was used for assessment.
Summary. All criterion measures were assessed against ACT science with mixed findings. Board scores and graduation resulted in statistically significant results; however, the effect size for graduation reflected a better mean score on this variable for students not graduating from the program than for those that graduated. The best criterion measure for this predictor is the professional board score as it was significant across professions and for both two- and four-year programs. The criterion, grade point average, was not statistically significant.

Social science score. Four studies identified ACT social science as a predictor variable creating five effect sizes with a range of $d = 0.822$ ($g = 0.812$) to $d = 1.218$ ($g = 1.195$) both for the criterion, board scores, but for different professions. Three studies used board examination results as the criterion, one study used final grade point average, and another used professional grade point average. Results calculated for board scores will be discussed here.

Board scores. Three studies evaluating board scores had a combined mean effect of $d = 1.034$ ($g = 1.027$), $p = 0.000$. The $N_{p} = 61$ with a Z-value of 7.87470. The data reflects three different professions: medical technology, nursing, and radiologic technology, and were conducted time points 1 and 2. Two studies were conducted for two-year programs with a standardized mean difference of $d = 0.938$ ($g = 0.927$), $p = 0.000$, and one study for a four-year program with $d = 1.094$ ($g = 1.090$), $p = 0.000$. All studies were conducted over two or more years. Random and fixed results are the same indicating a shared variance ($T^{2} = 0.000$) in the values.
Two studies were published with a mean effect size of $d = 1.113 \ (g = 1.107)$, $p = 0.000$; one study was not published with an effect size of $d = 0.822 \ (g = 0.814)$, $p = 0.001$. Publication had no statistical effect on the criterion, board scores. Two studies were in time point 1, $d = 1.011 \ (g = 1.005)$, $p = 0.000$. One study in time point 2 had an effect size of $d = 1.218 \ (g = 1.195)$, $p = 0.001$.

**Cumulative grade point average.** One study conducted for a two-year medical technology program was statistically significant with a standardized difference of $d = 0.980 \ (g = 0.961)$, $p = 0.006$. This same study used the criterion, board scores, with similar results. The study was conducted in time point 2.

**Professional grade point average.** One study conducted for a four-year respiratory therapy program was also statistically significant with a standardized difference of $d = 0.829 \ (g = 0.812)$, $p = 0.022$. This study was conducted in time point 1.

**Summary.** The predictor, ACT social science, was statistically significant across two- and four-year programs and professions regardless of the outcome measure. Additionally, when assessed against the criterion, board scores, this predictor resulted in a shared variance, an indication of its strength as a shared measure for the health professions.

**Age**

Fourteen studies identified age as a predictor accounting for 15 effect size variables with a range of $d = -1.622 \ (g = -1.614)$ against the criterion, graduation, to $d = 1.352 \ (g = 1.326)$ also for graduation. Both studies were conducted on two-year
programs at different time points. Board scores and graduation were both reported in the
literature with assessments run in all three time points.

**Board scores.** Nine studies used board scores as the criterion variable for a mean
effect of $d = 0.137$ ($g = 0.136$), $p = 0.335$. The between study variance, $T^2 = 0.143$ with
the amount of variance attributable to real differences, $I^2 = 85.345$. The variable, age, is
not a statistically significant predictor for the criterion, board scores.

Six of these studies were conducted on nursing for a combined effect of $d = 0.075$
($g = 0.075$), $p = 0.696$. Two health professions, radiologic technology and respiratory
therapy, accounted for the other three studies assessing the criterion, board scores. Two
studies were conducted on two-year programs in radiologic technology with a mean
effect of $d = 0.147$ ($g = 0.146$), $p = 0.643$. The two-year respiratory program also had a
low effect size and non-significant finding $d = -0.120$ ($g = -0.117$), $p = 0.747$. Age is a
statistically non-significant finding for board scores across the professions.

Four studies were conducted on two-year programs and five studies were
conducted on four-year programs again with statistically non-significant results.
Moderators, publication and length of study were also statistically non-significant. There
was one exception to this finding in a two-year nursing program, the only study
conducted in time point 2. Results indicate a statistically significant finding, $d = 0.605$
($g = 0.602$), $p = 0.001$.

**Graduation.** Four studies identified graduation or completion as the criterion
variable with a mean effect size is $d = 0.022$ ($g = 0.018$), $p = 0.967$. The between studies
variance is $T^2 = 1.060$ and the amount attributable to real differences in the studies,
$I^2 = 95.841$. Studies were equally divided between two- and four-year programs and fell within all three time points. Age is not a statistically significant predictor for graduation.

Two studies were conducted for each subgroup with non-significant findings. Two two-year programs had a mean effect size of $d = -0.152$ ($g = -0.160$), $p = 0.918$. Two four-year programs had a mean effect size of $d = 0.206$ ($g = 0.204$), $p = 0.466$.

When studies were divided by profession, nursing had two studies and radiologic technology and respiratory therapy each had one study. The respiratory therapy study was conducted for a two-year program and was statistically significant $d = 1.352$ ($g = 1.326$), $p = 0.000$. The other studies evaluated with the moderator, profession, were not statistically significant.

Studies were conducted over all three time points with one study conducted in time point 1 for a two-year nursing program that was statistically significant $d = -1.622$ ($g = -1.614$), $p = 0.000$. Two studies conducted in time point 3 were statistically significant $d = 0.871$ ($g = 0.858$), $p = 0.0333$. Studies in this time point were conducted for a two-year respiratory therapy program and a four-year nursing program, both statistically significant on their own. Time point 2 had one statistically non-significant study. The other moderators, publication and length of study were statistically non-significant. All studies were published and conducted over two or more years.

**Summary.** The predictor, age, has mixed findings in the literature and its significance appears to be tied to moderators. When compared against the criterion, board scores, it is non-significant. When compared against graduation, it was not statistically non-significant from an overall perspective. The moderator, time point,
created smaller groupings of studies with the result that time points 1 and 3 became statistically significant for the criterion, graduation.

**Algebra/Math**

Five studies used algebra as a predictor, two studies noted a science-math grade point average. Both studies using the science-math grade point average are respiratory therapy programs. The effect size range for algebra/math as a predictor is $d = -0.088$ ($g = -0.088$) for the criterion, graduation, to $d = 3.214$ ($g = 3.148$) for the predictor, science-math, and criterion, professional grade point average. The two studies including science in the assessment had the largest effect sizes, $d = 2.075$ ($g = 2.055$) and $d = 3.214$ ($g = 3.148$) and both were statistically significant at $p = 0.000$. With those studies removed, three studies measured algebra against board scores.

**Board scores.** The standardized mean effect size for the predictor, algebra is $d = 0.351$ ($g = 0.348$), $p = 0.125$. Three studies were conducted one in each time point with a two-year radiologic technology program statistically significant at time point 2 with $d = 0.730$ ($g = 0.726$), $p = 0.000$. Two two-year studies were conducted for one radiologic technology program in time points 2 and 3. The standardized mean effect size for radiologic technology is $d = 0.422$ ($g = 0.418$), $p = 0.219$. One study was conducted on a four-year nursing program with $d = 0.165$, ($g = 0.164$), $p = 0.523$. The four-year study was published the two-year studies were not published.

**Cumulative grade point average.** A four-year respiratory therapy program cited cumulative grade point average as the criterion. The predictor was a combination of science and math grade point average. The study was conducted in time point 2 for a
standardized difference of $d = 2.075$ ($g = 2.055$), $p = 0.000$. For this study, the combination of science and math grade point average was statistically significant.

**Professional grade point average.** A four-year respiratory therapy program cited professional grade point average as the criterion for the predictor, science and math. This study was conducted in time point 1 with a standardized difference of $d = 3.214$ ($g = 3.148$), $p = 0.000$. For this study, the combination of science and math grade point average was statistically significant.

**Graduation.** Two studies identified graduation as the criterion for a mean effect of $d = 0.076$ ($g = 0.076$), $p = 0.668$. The predictor, algebra, used in these two studies, one conducted for a two-year nursing program and one for a four-year radiologic technology program, is statistically non-significant.

**Summary.** Algebra was evaluated against four criterion measures. Board scores, cumulative and professional grade point averages, were statistically significant overall. When the moderator, profession, was added to the assessment for board scores, both radiologic technology and a four-year nursing program were found to be statistically non-significant. Graduation was a non-significant criterion measure for this predictor. Both moderators and the criterion chosen for outcome measure made differences in the statistical results for algebra/math.

One of the most significant issues affecting this predictor may be related to study design, specifically the data included in the report and the method of reporting. Results did not appear to reflect a specific course as might be seen if reported as something like
“Algebra I.” Given the inconsistency in results, and questionable research design, this predictor needs further definition and study.

**Anatomy**

Seven studies identified anatomy as a predictor variable with a total of 12 effect sizes. Three studies evaluated more than one anatomy course creating the possibility of a lack of independence in the sample. Effect size range for all variables is $d = 0.175$ ($g = 0.173$) for the criterion, board score, to $d = 1.585$ ($g = 1.576$) for graduation. All predictor variables had a positive effect on the criterion. Removing all but the first anatomy courses resulted in one effect size for each study.

**Board scores.** Six studies identified a professional board examination as the criterion. Effect size ranges are $d = 0.175$ ($g = 0.173$), $p = 0.705$ to $d = 0.899$ ($g = 0.894$) $p = 0.000$, with a mean difference of $d = 0.567$ ($g = 0.564$), $p = 0.000$, and a between studies variance of $T^2 = 0.031$. The amount of variance attributable to real differences in the studies is $I^2 = 41.642$. The $N_f = 60$, with a Z-value of 6.46497.

Four studies were conducted for nursing programs, all four-year programs, with a mean difference of $d = 0.481$ ($g = 0.479$), $p = 0.000$. Additional studies were conducted for a four-year dental hygiene program and a two-year radiologic technology program. The radiologic technology program was the only non-significant finding using the moderator, profession, with $d = 0.539$ ($g = 0.530$), $p = 0.081$.

Five studies were conducted for four-year programs with a mean effect of $d = 0.569$ ($g = 0.566$), $p = 0.000$. Two studies were conducted in time point 1 with a mean effect of $d = 0.666$ ($g = 0.633$), $p = 0.000$ and four studies in time point 3 with a
mean effect of \( d = 0.508 \) (\( g = 0.504 \)), \( p = 0.008 \). The moderator, publication, did show a slight difference in effect size; however, both published and non-published studies were statistically significant. Two studies were not published with a mean effect size of \( d = 0.662 \) (\( g = 0.658 \)), \( p = 0.000 \), and four studies were published with a mean effect size of \( d = 0.522 \) (\( g = 0.519 \)), \( p = 0.005 \). Additionally, five studies were conducted over two or more years and held a mean effect of \( d = 0.526 \) (\( g = 0.522 \)), \( p = 0.000 \). A four-year nursing program conducted a study in a single year with significant results, \( d = 0.686 \) (\( g = 0.684 \)), \( p = 0.000 \).

**Graduation.** A two-year nursing program identified graduation as a criterion variable for Anatomy and Physiology I and II. To prevent loss of independence results are reviewed for the first course only. The study was conducted in time point 3 and created a standardized difference of \( d = 0.426 \) (\( g = 0.424 \)), \( p = 0.018 \). Results are statistically significant for this program when predicting graduation with the first anatomy and physiology course in a sequence.

**Summary.** A number of different courses were assessed for the predictor, anatomy; most were assessed more than once with the same student selection creating a risk of loss of sample independence. Assessment was performed for the first course in a series in an effort to compare similar coursework. Two criteria were used for outcome assessment and both were statistically significant. The moderator, profession, did make a difference as this predictor was non-significant for radiologic technology. However, only one study represented this profession.
Biology/Science

Seventeen studies identified biology or science as a predictor variable creating 25 effect sizes with a range of \( d = -0.746 \) (\( g = -0.741 \)) for a board score to \( d = 2.143 \) (\( g = 2.129 \)) for cumulative grade point average. Studies were divided into those specifically designating biology and science as predictors.

**Biology.** Three professions measured biology as a predictor including dental hygiene, nursing, and radiologic technology. All four criterion measures were used to assess outcomes. Board scores had the largest number of studies with all three professions represented in the measure.

**Board scores.** Eight studies identified biology as a predictor variable for a total of nine effect sizes. Five of those studies used board scores as the criterion with a mean effect size of \( d = 0.809 \) (\( g = 0.805 \)), \( p = 0.000 \). The \( N_{fs} = 155 \) with a Z-value of 11.07945. The between studies variance is \( T^2 = 0.128 \) with the amount of variance attributable to real differences in the studies, \( I^2 = 85.093 \). According to the studies used in this analysis, biology is a good predictor of board scores.

Four studies were conducted on four-year programs with board scores as a criterion, and a mean effect of \( d = 0.626 \), (\( g = 0.624 \)), \( p = 0.000 \). The two-year program had a standardized effect size of \( d = 1.610 \) (\( g = 1.600 \)), \( p = 0.000 \). Effect size differed between two- and four-year program results but the statistical significance was the same. Studies were conducted at all three time points although only one study conducted for a two-year program was conducted in time point 2. Time point 1 consisted of two studies conducted in nursing for four-year programs and resulted in a mean effect size of
$d = 0.643 \ (g = 0.640), \ p = 0.001$. Time point 2 had one study, conducted on a two-year radiologic technology program with an effect size of $d = 1.610 \ (g = 1.600), \ p = 0.000$. Time point 3 held two studies, one in dental hygiene and one in nursing, both four-year programs. The mean effect size is $d = 0.636 \ (g = 0.633), \ p = 0.005$.

Three studies were conducted for nursing programs using the board scores as criterion, all four-year programs. The mean effect size for biology as a predictor is $d = 0.557 \ (g = 0.556), \ p = 0.000$. Both radiologic technology and dental hygiene had one study each and both were statistically significant. The data from the radiologic technology study have already been given, but the dental hygiene effect size is $d = 0.896 \ (g = 0.892), \ p = 0.000$.

Two studies identifying board scores as the criterion variable were not published. They included a four-year nursing program and a two-year radiologic technology program. The mean effect size is $d = 1.014 \ (g = 1.008), \ p = 0.081$. Published studies consisted of three four-year programs, two in nursing, one in dental hygiene. The mean effect size for the published studies is $d = 0.699 \ (g = 0.696), \ p = 0.000$. The moderator, publication, made a difference in effect size and statistical significance of the findings.

Four studies were conducted over two or more years. These covered all three time points and all three professions included in this analysis. The four studies had a mean effect size of $d = 0.015 \ (g = 0.910), \ p = 0.000$. One study was completed within one year and had a standardized effect size of $d = 0.448 \ (g = 0.446), \ p = 0.002$. Length of the study did not have a statistically significant effect on the study outcome.
**Cumulative grade point average.** One study conducted for a two-year radiologic technology program identified cumulative grade point average as the criterion with a standardized effect size of \( d = 2.143 \) \( (g = 2.129) \), \( p = 0.000 \). This study was not published and was conducted in time point 2.

**Professional grade point average.** One study conducted for a four-year dental hygiene program identified professional grade point average as the criterion with a standardized effect size of \( d = 1.077 \) \( (g = 1.070) \), \( p = 0.000 \). This study was published and conducted in time point 3.

**Graduation.** Two studies identified graduation as the criterion for the predictor, biology. Mean effect size is \( d = -0.221 \) \( (g = -0.220) \), \( p = 0.087 \). Both studies were statistically non-significant, one conducted for a two-year nursing program, the second for a four-year radiologic technology program in time points 1 and 2, respectively. Biology is not a statistically significant predictor for graduation.

**Summary.** Biology was assessed against all four outcome measures and was statistically significant for all but graduation. The moderator, publication, had an effect on significance; however, this predictor is significant across professions.

**Science.** Ten studies identified science as a predictor creating 15 effect sizes with board scores, cumulative, and professional grade point averages as the criterion variables. Four professions assessed this predictor and it is represented in all three time points. Studies were conducted for both two- and four-year programs.

**Board scores.** Eleven studies identified science as a predictor and board scores as the criterion variable for a mean fixed effect size of \( d = 0.529 \) \( (g = 0.527) \), \( p = 0.000 \) with
a $N_{fs}$ of 398 and a $Z$-value of 11.94833. The between studies variance, $T^2 = 0.110$ with the amount of variance due to real differences in the studies, $I^2 = 83.011$.

Ten studies were conducted for four-year programs with a mean effect size of $d = 0.587$ ($g = 0.584$), $p = 0.000$. The one study conducted for a two-year medical laboratory technology program had an effect size of $d = -0.040$ ($g = -0.040$), $p = 0.842$, a non-significant finding.

Four studies, all four-year programs, were conducted in time point 1 with a mean effect size of $d = 0.497$ ($g = 0.496$), $p = 0.052$. Two studies were conducted in time point 2 with a mean effect of $d = 0.292$ ($g = 0.291$), $p = 0.347$. Five studies were conducted in time point 3 with a combined mean effect size of $d = 0.623$ ($g = 0.619$), $p = 0.000$. The moderator, time points had a statistical effect on the results. Only time point 3 was statistically significant.

Four professions measured science as a predictor with board scores as the criterion. Two four-year dental hygiene programs have a mean effect size of $d = 0.583$ ($g = 0.580$), $p = 0.089$. One two-year medical technology program had an effect size of $d = -0.040$ ($g = -0.040$), $p = 0.842$. Two four-year programs in medical technology have 3 effect sizes with independence as students graduating from the four-year programs take one of two exams. The mean effect size for the four-year programs is $d = 0.144$ ($g = 0.140$), $p = 0.774$. One four-year respiratory therapy program had an effect size of $d = 0.730$ ($g = 0.729$), $p = 0.000$. Four four-year nursing programs had a mean effect of
\[ d = 0.755 \ (g = 0.753), \ p = 0.000. \] The professions dental hygiene and medical technology, both two- and four-year, were not statistically significant for this variable; however, nursing and respiratory both presented with statistically significant results.

Three studies were not published and represented three separate professions but all were four-year programs, with a statistically non-significant mean effect size of \[ d = 0.163 \ (g = 0.163), \ p = 0.676. \] Eight studies were published and shared a mean effect size of \[ d = 0.645 \ (g = 0.642), \ p = 0.000. \] The moderator, publication, had a statistically significant effect.

**Cumulative grade point average.** Two studies used cumulative grade point average as the criterion variable with a mean effect size of \[ d = 0.665 \ (g = 0.661), \ p = 0.000. \] Studies were conducted for a two-year medical technology program and a four-year dental hygiene program in time points 2 and 3 respectively.

**Professional grade point average.** Two additional studies used professional grade point average as the criterion variable for a mean effect size of \[ d = 0.912 \ (g = 0.908), \ p = 0.000. \] Both studies were conducted for four-year programs in time point 3, one in dental hygiene, one in medical technology.

**Summary.** The predictor, science, was measured against three separate outcomes including board scores, cumulative, and professional grade point average. All outcomes were statistically significant when viewed overall; however moderators and subgroups did have an effect. One study was conducted for a two-year program and found to be non-significant. As this is only one study representing a subgroup, additional studies are
needed for verification. The moderators time points, publication, and profession also affected the statistical significance of results for the criterion measure, board scores.

The category, science, is general and may include various types of science classes. While science as a category is a significant predictor for the health professions, the effect of moderators on the outcome warrants further investigation and better definition of coursework contained under this title. Discrepancies may be related to study design differences.

Chemistry

Five studies identified chemistry as a predictor variable with seven effect sizes. There is a risk of lack of independence as one study looked at a sequence of chemistry courses. To prevent this, Chemistry 1 is the unit of measure included in the mean sample when multiple sequential classes were used in the original study. However, Chemistry 3 although not included in the mean sample, had the lowest effect size with $d = 0.223$ ($g = 0.206$), $p = 0.739$, a statistically non-significant finding. The range of effect sizes extended to $d = 1.835$ ($g = 1.823$), $p = 0.000$ for the criterion, cumulative grade point average.

Board scores. Three studies identified chemistry as a predictor with board scores as the criterion with a resulting mean effect size of $d = 0.618$ ($g = 0.607$), $p = 0.027$, the $N_{j*} = 13$ with a Z-value of 4.46990. Whereas statistical results indicate a significant finding, only 13 null studies would be needed to reverse the statistical significance of the results. However, as only three studies were identified for this measure it is reasonable to assume that the chances of finding another 13 studies is low, and thus chemistry can be
considered a good predictor for board scores for nursing and radiologic technology. The between studies variance is $T^2 = 0.147$ with the amount of variance attributable to real differences in the studies, $I^2 = 71.658$.

Two studies were conducted for four-year programs, both nursing, revealing $d = 0.345$ ($g = 0.342$), $p = 0.017$. Both studies were also conducted in time point 2. The third study was conducted for a two-year radiologic technology program and was conducted in time point 1. The effect size for this study is $d = 1.013$ ($g = 1.007$), $p = 0.000$. The moderator, profession, is not statistically significant.

Two studies were not published and had a mean effect size of $d = 0.956$ ($g = 0.907$), $p = 0.000$. Unpublished studies were conducted for a four-year nursing and two-year radiologic technology programs in time points 1 and 2, respectively. Fixed and random findings were identical for these two studies indicating a shared variance.

The published study had a smaller effect size, $d = 0.345$ ($g = 0.344$), $p = 0.019$, but is still statistically significant. The modifier, publication, makes no difference in statistical significance.

**Cumulative grade point average.** One study conducted for a two-year radiologic technology program identified cumulative grade point average as the criterion variable with statistically significant results, $d = 0.992$, ($g = 0.982$), $p = 0.000$. This study was conducted in time point 2 and was not published.

**Graduation.** A separate study conducted for a four-year radiologic technology program identified graduation as the criterion variable with statistically non-significant
results, \( d = 0.232 \) (\( g = 0.229 \)) \( p = 0.329 \). This study was also conducted in time point 2 and was not published.

**Summary.** Chemistry was assessed with three outcome measures. Board scores and cumulative grade point average were statistically significant; graduation was not. Moderators and subgroups had no effect on the results.

**Entrance Grade Point Average**

Thirty-one studies identified entrance grade point average as a predictor with 40 effect size variables and a range of \( d = -0.120 \) (\( g = -0.119 \)), for a board score to \( d = 2.346 \) (\( g = 2.331 \)), for cumulative grade point average. All four criterion variables were included in the assessment.

**Board scores.** Twenty-one studies compared the predictor to board scores with a mean effect of \( d = 0.839 \) (\( g = 0.834 \)), \( p = 0.000 \), \( N_{fe} \) of 2571, a Z-value of 21.27652. One study created two independent variables as graduates selected one board exam from two different providers. The between study variance is \( T^2 = 0.064 \) with the amount of variance attributable to real differences in the studies, \( I^2 = 67.975 \). Four studies were conducted for two-year programs with \( d = 0.956 \) (\( g = 0.949 \)), \( p = 0.013 \) and 18 studies were conducted for four-year programs with \( d = 0.821 \) (\( g = 0.817 \)), \( p = 0.000 \).

Studies were conducted over all three time points yielding statistically significant results and similar effect size values for all three time points. Ten studies were conducted in time point 1, \( d = 0.936 \) (\( g = 0.932 \)), \( p = 0.000 \); eight were nursing, with one each for medical technology and radiologic technology. Four studies were conducted in time point 2, \( d = 0.922 \) (\( g = 0.912 \)), \( p = 0.023 \), for four different professions: medical
technology, nursing, radiologic technology, and respiratory therapy. Eight studies were conducted in time point 3, \( d = 0.705 \) (\( g = 0.702 \)), \( p = 0.000 \) for four professions: dental hygiene, medical technology, nursing, and respiratory therapy. Entrance point average remained a statistically significant predictor for the criterion, board scores, over all three time points.

All five professions evaluated this predictor against board scores. Table 3 outlines mean effect sizes for each profession. Medical technology is separated by two- and four-year as graduates of those programs take different board exams.

Table 3

*Standardized Mean Difference and Hedge’s g for Entrance Grade Point Average Versus Board Scores*

<table>
<thead>
<tr>
<th>Profession</th>
<th>( k )</th>
<th>( d )</th>
<th>( g )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental Hygiene</td>
<td>2</td>
<td>0.722</td>
<td>0.718</td>
<td>0.000</td>
</tr>
<tr>
<td>Medical Laboratory Technology(^a)</td>
<td>1</td>
<td>-0.120</td>
<td>-0.119</td>
<td>0.549</td>
</tr>
<tr>
<td>Medical Technology(^b)</td>
<td>3</td>
<td>0.671</td>
<td>0.666</td>
<td>0.000</td>
</tr>
<tr>
<td>Radiologic Technology</td>
<td>2</td>
<td>1.397</td>
<td>1.387</td>
<td>0.000</td>
</tr>
<tr>
<td>Respiratory Therapy</td>
<td>2</td>
<td>0.979</td>
<td>0.976</td>
<td>0.000</td>
</tr>
<tr>
<td>Registered Nurse</td>
<td>12</td>
<td>0.858</td>
<td>0.855</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Note.* \( k = \) number of studies; \( d = \) standardized mean difference; \( g = \) Hedge’s g.

\(^a\)Medical Laboratory Technology represents a two-year degree; \(^b\)Medical Technology represents a four-year degree.
The four-year medical technology examinations, radiologic technology and respiratory therapy examinations, have shared variances with this measure as their fixed and random standardized mean differences are identical. The medical laboratory technology examination is the only non-significant finding and consists of one measure. The largest effect size was for radiologic technology and both variables included in the measure were from two-year programs.

Six studies were not published and have a mean effect size of $d = 0.946$ ($g = 0.941$), $p = 0.000$. Fifteen studies were published with a mean effect size of $d = 0.794$ ($g = 0.790$), $p = 0.000$. The moderator, publication, did not have a statistical effect on the criterion, board scores.

Only one study was conducted in a single year. This study was statistically significant with $d = 0.763$ ($g = 0.760$), $p = 0.000$. Twenty-one studies were conducted over two or more years with a mean effect size of $d = 0.826$ ($g = 0.822$), $p = 0.000$.

**Cumulative grade point average.** Nine studies identified cumulative grade point average as the criterion variable for a mean effect size of $d = 1.401$ ($g = 1.391$), $p = 0.000$, and $N_{fs} = 774$ with a Z-value of 18.27613. The between studies variance is $T^2 = 0.258$ with the amount of variance attributable to real differences in the studies, $I^2 = 85.057$.

Two two-year studies had a mean effect size of $d = 1.524$ ($g = 1.514$), $p = 0.060$, a statistically non-significant finding. Seven four-year studies had a combined mean effect of $d = 1.365$ ($g = 1.354$), $p = 0.000$. Studies were conducted in all three time points with multiple studies in each time point. Three studies were conducted for four-year programs.
in time point 1 with a mean effect size of $d = 1.471$ ($g = 1.464$), $p = 0.000$. Time point 2 had four studies for a mean effect of $d = 1.479$ ($g = 1.467$), $p = 0.002$. This time point was evenly divided with two- and four-year programs. Time point 3 had two studies conducted for four-year programs with a combined mean effect of $d = 1.095$ ($g = 1.076$), $p = 0.004$. All studies were conducted for two or more years. Entrance grade point average has been a statistically significant predictor over time for the criterion, cumulative grade point average.

All five professions assessed the criterion, cumulative grade point average. Three professions had one study each and all were statistically significant. Two professions had two or more studies. Radiologic Technology had two studies for a combined mean effect of $d = 2.073$ ($g = 2.058$), $p = 0.000$. Nursing had four studies conducted over all three time points with a mean fixed effect of $d = 1.223$ ($g = 1.215$), $p = 0.000$.

Two studies were not published and had a mean effect size of $d = 1.564$ ($g = 1.555$), $p = 0.040$. The remaining seven studies were published and had a mean effect size of $d = 1.360$ ($g = 1.349$), $p = 0.000$. Publication made a small difference in effect size but no difference in statistical significance.

**Professional grade point average.** Four studies cited professional grade point average as the criterion variable with a mean effect size of $d = 1.382$ ($g = 1.368$), $p = 0.000$ and $N_{50} = 113$ with a Z-value of 10.55831. The between studies variance is $T^2 = 0.378$ with the amount of variance attributable to real differences in the studies, $I^2 = 86.881$. 
Three of these studies were conducted on four-year programs for a mean effect of $d = 1.572 \ (g = 1.555), \ p = 0.002$. Two studies were conducted on Respiratory Therapy programs with a mean effect size of $d = 1.600 \ (g = 1.573), \ p = 0.021$. These studies were also the only two studies conducted in time point 1. Studies were conducted in time points 1 and 3. Two studies were conducted in time point 3 for a mean effect of $d = 1.264 \ (g = 1.257), \ p = 0.030$, one study each for dental hygiene and medical technology.

**Graduation.** Three studies identified graduation as the criterion. Each study was conducted in a different time point and the resultant mean effect size is $d = 0.231 \ (g = 0.229), \ p = 0.155$. Three professions, nursing, radiologic technology, and respiratory therapy, assessed this criterion. The predictor, entrance grade point average, is not a statistically significant predictor for the criterion, graduation.

**Summary.** Entrance grade point average was assessed against all four criterion with statistically significant results for all but graduation. Subgroup analysis and moderators had no effect on the statistical significance of the results. All five professions assessed this predictor.

**Ethnicity**

**Board scores.** Two studies identified ethnicity as a predictor for the criterion, board scores. Both programs are four-year nursing programs and the studies were completed in time point 1. The mean effect size is $d = -0.455 \ (g = -0.453), \ p = 0.000$, indicating that ethnicity is a good predictor for nursing board scores. One study was published and the other was not; both were statistically significant on their own. As only
two studies were available for inclusion in this study and both conducted in the 1980s; this variable warrants further research.

**Summary.** Ethnicity is a statistically significant predictor for nursing board scores; however, this predictor has not been studied since the 1980s. Further research is indicated.

**Gender**

**Board scores.** Three studies identified gender or sex as a predictor for the criterion, board scores. One study was conducted on a two-year program; the other two on four-year programs. Two professions, nursing and radiologic technology, were represented in the analysis. Studies were conducted in time points 1 and 3, were not published, and all held statistically non-significant results. Standardized mean difference is $d = -0.103$, $(g = -0.102)$, $p = 0.179$. The values share a variance as fixed and random results are the same. Gender or sex is not a statistically significant predictor for board scores.

**Summary.** Gender was assessed by two professions for both two- and four-year programs against board scores. It is not a statistically significant predictor for results on the board scores.

**High School Grade Point Average**

Six studies identified high school grade point average as a predictor variable with eight effect sizes ranging from $d = -0.140$ $(g = -0.139)$ for the criterion, professional grade point average, to $d = 7.980$ $(g = 7.830)$ for the criterion, failure. This latter criterion has no other studies for evaluation and is only mentioned here.
**Board scores.** Two studies identified board scores as the criterion, with a mean effect of $d = 0.081$ ($g = 0.081$), $p = 0.577$. Results are statistically non-significant. Studies were conducted in time points 1 and 3 for a two-year respiratory program and a four-year nursing program.

**Cumulative grade point average.** One study identified cumulative grade point average as a criterion variable. This study was published for a four-year radiologic technology program and conducted in time point 1. Results are statistically non-significant with $d = 0.291$ ($g = 0.289$), $p = 0.156$.

**Professional grade point average.** One study identified professional grade point average as a criterion variable. This study was not published and was conducted for a two-year radiologic technology program in time point 3. Results are statistically non-significant with $d = -0.140$ ($g = -0.139$), $p = 0.588$.

**Graduation.** Two additional studies identified graduation as the criterion, for a standardized mean effect size of $d = 0.504$ ($g = 0.501$), $p = 0.000$. These latter studies were conducted in time points 1 and 2 and for two four-year programs, nursing and radiologic technology. One study was published.

**Summary.** High school grade point average was assessed against all four outcomes and found to be statistically significant for graduation. This finding is interesting as it contrasts findings for the other predictors and may be a good assessment tool for predicting the graduation success of recent high school students.
High School Rank

Seven studies identified high school percent or rank as a predictor with a range of $d = -0.219$ ($g = -0.219$) for the nursing board exams to $d = 2.865$ ($g = 2.836$) for the radiologic technology board exams. Three criterion variables were used to assess this predictor, board exams, cumulative grade point average, and one study used graduation.

Board scores. Four studies evaluated the criterion, professional board examinations, three for nursing and one for radiologic technology with a mean effect size of $d = 0.679$ ($g = 0.674$), $p = 0.080$. The nursing studies were conducted in time point 1, the radiologic technology in time point 2. One of the nursing studies was a two-year program and on its own was the only statistically non-significant finding with $d = 0.178$ ($g = 0.177$), $p = 0.367$. The other three studies were conducted for four-year programs.

Cumulative grade point average. Two studies identified cumulative grade point average as the criterion, with a standardized mean effect size of $d = 0.528$ ($g = 0.524$), $p = 0.030$. Both studies were conducted in time point 1, for four-year programs, one for nursing and one for radiologic technology. Both studies were published.

Graduation. One two-year nursing program identified graduation as the criterion variable. This study was conducted in time point 1 and published. The standardized effect size is $d = 0.338$ ($g = 0.336$), $p = 0.050$.

Summary. High school rank was assessed against three outcomes with statistically significant results for cumulative grade point average and graduation. It was non-significant when measured against board scores. There is limited research available
on this predictor with grade point average and graduation. In fact, only one study represents the evaluation with graduation. Additional study is needed for this predictor.

**Interview**

Three studies assessed the predictor, interview. All three were conducted in time point 2, one study for radiologic technology and two for respiratory therapy. All studies were conducted for four-year programs and each identified a different criterion. The values ranged from $d = 0.040 (g = 0.040), p = 0.862$ for cumulative grade point average to $d = 0.161 (g = 0.156), p = 0.683$ for a professional board examination. The third criterion was graduation. All three studies were statistically non-significant.

**Summary.** The predictor, interview, was assessed against all four criterion, but with only one study representing each outcome. All four studies were statistically non-significant. The research design varied with each study indicating that the lack of significance may be related to the interview methods. Further study is needed for this predictor as there is no current proof of its efficacy.

**SAT Examination**

**Cumulative score.** Five studies identified SAT cumulative score as a predictor creating six effect size variables. The range of standardized mean differences is $d = 0.777 (g = 0.774)$ for cumulative grade point average, to $d = 3.096 (g = 3.064)$ for a professional board score. All studies were conducted in time points 1 and 2.

**Board scores.** All five studies used board scores as the criterion, for a standardized mean effect size of $d = 1.504 (g = 1.490), p = 0.000$. The between studies variance is $T^2 = 0.248$ and the amount attributable to real differences in the studies is
$I^2 = 84.520$. The $N_{fs} = 247$ with a Z-value of 13.89282. All studies were conducted on four-year programs.

Two studies were not published with a mean effect size of $d = 1.231 (g = 1.206)$, $p = 0.001$, and three were published with a mean effect size of $d = 1.727 (g = 1.714)$, $p = 0.000$. The moderator, publication, made no difference in statistical significance. Studies presented the same division when the moderator, length of study, was used. The studies not published were conducted within one year where the studies that were published were conducted over two or more years.

Four studies were conducted on the nursing profession and all of these were conducted in time point 1 for a standardized mean effect of $d = 1.130 (g = 1.123)$, $p = 0.000$. One study was conducted for radiologic technology in time point 2 with an effect size of $d = 3.096 (g = 3.064), p = 0.000$.

**Cumulative grade point average.** One study conducted for a four-year nursing program used cumulative grade point average as a criterion. The same sample was used with the criterion, board scores, and is included in the results for that outcome. This study was conducted in time point 1 for a standardized difference of $d = 0.777 (g = 0.774), p = 0.000$.

**Summary.** SAT cumulative score was assessed against two outcome variables, board scores and cumulative grade point average. It was found to be statistically significant regardless of moderators but was studied in four-year programs only.

**Math score.** Ten studies identified SAT math as a predictor with 12 effect size variables ranging from $d = 0.292 (g = 0.291)$ to $d = 1.509 (g = 1.469)$. Both extremes
were for the same criterion, nursing board examinations, with both values coming from four-year programs. All studies but one were conducted in time point 1. One study conducted for a four-year nursing program was conducted in time point 2.

**Board scores.** Nine studies identified board scores as the criterion variable, with a standardized mean effect size of $d = 0.519$ ($g = 0.517$), $p = 0.000$. All of these studies were conducted on nursing programs, with only one study conducted on a two-year program. With the two-year program removed, $d = 0.533$ ($g = 0.531$), $p = 0.000$. The two-year program was also statistically significant with $d = 0.407$ ($g = 0.404$), $p = 0.042$. The $N_{fs} = 199$ with a Z-value of 9.41599. The between-studies variance is $T^2 = 0.016$ with the amount of variance attributable to real differences in the studies, $I^2 = 37.699$.

Three studies were not published with a standardized mean effect size of $d = 0.570$ ($g = 0.566$), $p = 0.000$, the other five studies were published with a mean effect size of $d = 0.505$ ($g = 0.503$), $p = 0.000$. Publication made no difference in statistical significance.

Eight studies were conducted in time point 1 with a standardized mean effect size of $d = 0.562$ ($g = 0.559$), $p = 0.000$. One study was conducted in time point 2 with an effect size of $d = 0.303$ ($g = 0.303$), $p = 0.010$. The moderator, time point, made no difference in statistical significance.

**Cumulative grade point average.** One study identified cumulative grade point average as a criterion variable, with a standardized effect size of $d = 0.613$ ($g = 0.611$),
This study was conducted for a four-year nursing program in time point 1 and also identified the board score as a criterion measure. The results of this study were published.

**Graduation.** One study identified both graduation and completion as criterion variables. As the values differed, the graduation variable is used here. The standardized effect size is \( d = 0.464 \) (\( g = 0.463 \)), \( p = 0.000 \). This study was conducted in time point 1 for a four-year nursing program and was published.

**Summary.** SAT math was assessed against three outcome variables. It was statistically significant for all three outcomes: board scores, cumulative grade point average, and graduation. Results identified with the criterion, board scores, were not affected by subgroups or moderators. The latter two outcomes, cumulative grade point average and graduation, were represented by one study each indicating a need for further investigation.

**Verbal.** Ten studies identified SAT verbal as a predictor variable creating 12 effect size variables with a range of \( d = 0.428 \) (\( g = 0.427 \)) for the criterion, completion, to \( d = 1.609 \) (\( g = 1.597 \)) for the nursing board exam. All studies were conducted on four-year programs except one, and nine studies were conducted in the first time point.

**Board scores.** Nine studies used the nursing board scores as the criterion variable, with a mean standardized effect size of \( d = 1.061 \) (\( g = 1.057 \)), \( p = 0.000 \). The \( N_{fs} = 736 \) with a Z-value of 17.82505. The between studies variance is, \( T^2 = 0.034 \) with the amount attributable to real differences in the studies, \( I^2 = 51.279 \).
Subgroup analysis revealed eight studies conducted on four-year programs with a mean effect size of $d = 1.059$ ($g = 1.054$), $p = 0.000$. One two-year nursing program had an effect size of $d = 1.609$ ($g = 1.597$), $p = 0.000$. There was no statistical significance between two- and four-year programs for this predictor.

Moderators influenced the effect size but did not have any statistical effect. Eight studies were conducted in time point 1 with a mean effect size of $d = 1.067$ ($g = 1.130$), $p = 0.000$. One study was conducted in time point 2 with an effect size of $d = 1.036$ ($g = 1.034$), $p = 0.000$.

Three studies were not published with a mean effect size of $d = 1.036$ ($g = 1.029$), $p = 0.000$. Six studies were published and have a mean effect size of $d = 1.159$ ($g = 1.153$), $p = 0.000$. Two studies were conducted within one year and had a mean effect size of $d = 1.204$ ($g = 1.198$), $p = 0.000$. The fixed and random effect variables are the same indicating a shared variance between the two studies. Seven studies were conducted over two or more years for a mean fixed effect of $d = 1.094$ ($g = 1.089$), $p = 0.000$.

The predictor SAT verbal is a statistically significant predictor for the nursing board exams. While effect sizes differed slightly when moderators were considered, this did not change the statistical significance of the results. The majority of analysis was done in time point 1 for four-year nursing programs. Only one study was conducted in time point 2 and one study was conducted for a two-year nursing program. No other health professions assessed this predictor against a board exam.
**Cumulative grade point average.** One study identified cumulative grade point average as the criterion variable, with a standardized effect size of $d = 0.752$ ($g = 0.750$), $p = 0.000$. This study was published, and conducted for a four-year nursing program in time point 1.

**Graduation.** One study identified graduation as a criterion variable, with a standardized effect size of $d = 0.462$ ($g = 0.464$), $p = 0.000$. This study was published, and conducted for a four-year nursing program in time point 1.

**Summary.** SAT verbal was assessed against three outcome variables, board scores, cumulative grade point average, and graduation. The latter two outcome criteria were assessed with only one study each. All outcomes were statistically significant and all studies were conducted on nursing programs. No other profession is represented in this category.

**Specialty Examinations**

Fourteen studies evaluated a specialty exam resulting in 35 effect sizes. As specialty examinations differ and can not be combined, statistics are presented for each examination separately. Criterion variables used to assess this predictor include board scores, cumulative and professional grade point average, and graduation.

**Board scores.** Eight studies used the criterion, board scores, to assess this predictor creating 11 effect sizes. One specialty exam, the AHPAT, was evaluated against the same board exam in two studies by two separate four-year medical technology programs in time points 1 and 3. Fixed and random results are the same indicating a shared variance in the two studies with $d = 0.918$ ($g = 0.913$), $p = 0.000$. 
Four professions were represented by two studies each, two two-year programs in dental hygiene, two four-year programs in medical technology, two nursing programs, one two- and one four-year program, and two respiratory therapy programs, one two- and one four-year. Table 4 shows effect sizes for the remaining examinations against the professional board scores.

Table 4  

*Specialty Exam Versus Board Score Standardized Mean Values and Statistical Significance*

<table>
<thead>
<tr>
<th>Specialty exam</th>
<th>Board</th>
<th>k</th>
<th>d</th>
<th>LL / UL</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.S.I.</td>
<td>NBDHE</td>
<td>1</td>
<td>-0.389</td>
<td>-1.188 / 0.4101</td>
<td>0.340</td>
</tr>
<tr>
<td>DHAT</td>
<td>NBDHE</td>
<td>1</td>
<td>0.847</td>
<td>0.352 / 1.342</td>
<td>0.001</td>
</tr>
<tr>
<td>AHPAT</td>
<td>BOR</td>
<td>2</td>
<td>0.918</td>
<td>0.627 / 1.209</td>
<td>0.000</td>
</tr>
<tr>
<td>AHPAT</td>
<td>NCA</td>
<td>1</td>
<td>2.612</td>
<td>1.133 / 4.091</td>
<td>0.001</td>
</tr>
<tr>
<td>NET</td>
<td>NCLEX</td>
<td>1</td>
<td>0.886</td>
<td>0.354 / 1.418</td>
<td>0.001</td>
</tr>
<tr>
<td>CLAST</td>
<td>NCLEX</td>
<td>1</td>
<td>1.907</td>
<td>0.823 / 2.990</td>
<td>0.001</td>
</tr>
<tr>
<td>HOBET</td>
<td>CRT</td>
<td>1</td>
<td>0.629</td>
<td>-0.134 / 1.392</td>
<td>0.106</td>
</tr>
<tr>
<td>Watson-Glaser</td>
<td>CRT</td>
<td>1</td>
<td>0.953</td>
<td>0.101 / 1.804</td>
<td>0.028</td>
</tr>
</tbody>
</table>

*Note.*  
k = number of studies;  
d = standardized mean difference;  
LL = lower limit;  
UL = upper limit;  
p = probability where alpha = 0.05.

*a*Problem solving inventory.
Cumulative grade point average. Two studies evaluated cumulative grade point average. Neither study was statistically significant. One study was conducted for a two-year dental hygiene program and evaluated a problem solving inventory with a standardized effect size of $d = -0.413, p = 0.312$. The second study was conducted for a four-year nursing program and evaluated the TOEFL with a standardized effect size of $d = 0.036, p = 0.920$.

Professional grade point average. Three studies evaluated professional grade point average with a resultant 10 effect sizes. Two studies accounted for eight effect sizes as various parts of the pre-tests were compared with the professional grade point average. Seven measures were statistically significant. Studies were conducted across all three time points. Table 5 presents the results of specialty examinations and professional grade point average. Each classification of specialty examination represents results from one study. The varying parts of the HOAE and AHAT examinations were measured using the same samples.

Graduation. Three studies evaluated graduation creating six effect sizes as one study evaluated graduation against different parts of one test. One study was conducted in time point 3, the other two studies in time point 1. Table 6 shows the effect sizes for specialty examinations measured with graduation as the criterion variable.
Table 5

*Specialty Examinations Versus Professional Grade Point Average*

<table>
<thead>
<tr>
<th>Specialty exam</th>
<th>$d$</th>
<th>$LL$</th>
<th>$UL$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHPAT</td>
<td>0.878</td>
<td>0.559</td>
<td>1.197</td>
<td>0.000</td>
</tr>
<tr>
<td>Occupational work inventory</td>
<td>-0.221</td>
<td>-0.730</td>
<td>0.288</td>
<td>0.394</td>
</tr>
<tr>
<td>HOAE academic</td>
<td>0.873</td>
<td>0.242</td>
<td>1.503</td>
<td>0.007</td>
</tr>
<tr>
<td>HOAE reading</td>
<td>0.652</td>
<td>0.044</td>
<td>1.260</td>
<td>0.036</td>
</tr>
<tr>
<td>HOAE science</td>
<td>0.873</td>
<td>0.242</td>
<td>1.503</td>
<td>0.007</td>
</tr>
<tr>
<td>HOAE spelling</td>
<td>0.262</td>
<td>-0.321</td>
<td>0.845</td>
<td>0.378</td>
</tr>
<tr>
<td>HOAE vocation</td>
<td>0.561</td>
<td>-0.039</td>
<td>1.161</td>
<td>0.067</td>
</tr>
<tr>
<td>AHAT arithmetic</td>
<td>0.652</td>
<td>0.238</td>
<td>1.067</td>
<td>0.002</td>
</tr>
<tr>
<td>AHAT numeric</td>
<td>0.747</td>
<td>0.327</td>
<td>1.168</td>
<td>0.000</td>
</tr>
<tr>
<td>AHAT reading</td>
<td>0.847</td>
<td>0.419</td>
<td>1.275</td>
<td>0.000</td>
</tr>
<tr>
<td>AHAT science</td>
<td>1.250</td>
<td>0.785</td>
<td>1.715</td>
<td>0.000</td>
</tr>
<tr>
<td>AHAT verbal</td>
<td>0.873</td>
<td>0.443</td>
<td>1.303</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Note.* $d =$ standardized mean difference; $LL =$ lower limit; $UL =$ upper limit; $p =$ probability where alpha $= 0.05$. 
Table 6

*Specialty Examinations Versus Graduation*

<table>
<thead>
<tr>
<th>Specialty exam</th>
<th>d</th>
<th>LL</th>
<th>UL</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLN pre-test</td>
<td>0.620</td>
<td>0.428</td>
<td>0.812</td>
<td>0.000</td>
</tr>
<tr>
<td>AHAT arithmetic</td>
<td>0.387</td>
<td>-0.014</td>
<td>0.788</td>
<td>0.059</td>
</tr>
<tr>
<td>AHAT numeric</td>
<td>0.676</td>
<td>0.260</td>
<td>1.091</td>
<td>0.001</td>
</tr>
<tr>
<td>AHAT reading</td>
<td>0.430</td>
<td>0.027</td>
<td>0.833</td>
<td>0.037</td>
</tr>
<tr>
<td>AHAT science</td>
<td>0.676</td>
<td>0.260</td>
<td>1.091</td>
<td>0.001</td>
</tr>
<tr>
<td>AHAT verbal</td>
<td>0.451</td>
<td>0.047</td>
<td>0.855</td>
<td>0.029</td>
</tr>
<tr>
<td>HOBET</td>
<td>3.371</td>
<td>2.141</td>
<td>4.601</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Note.* $d =$ standardized mean difference; $LL =$ lower limit; $UL =$ upper limit; $p =$ probability where alpha = 0.05.

**Summary.** The predictor, specialty examinations, is too large and varied to summarize as a whole. Few published studies are presented in the literature for any of the tests. Additionally, the tests do not appear to have a long life once introduced, limiting the number of studies that could be done. This predictor adds cost to the incoming student, but may be of value when students enter programs early in their college coursework, as with the two-year programs. Further assessment is needed before one test is adopted for any or all of the professions.
Transfer

Three studies identified transfer as a predictor with three different criterion variables. No cumulative analysis could be run as the criterion variables included board scores, cumulative grade point average, and program completion. Two studies were conducted for four-year programs in nursing, and one for a two-year program in radiologic technology. One study conducted for a four-year nursing program against program completion was statistically significant with $d = 0.433, p = 0.027$; the other two studies were not statistically significant. The radiologic technology study was not published.

Summary. Three different criterion measures were assessed against the predictor, transfer. One study was significant; the other two were not. Further investigation of this predictor is needed from all professions.

Discussion

This chapter presented results from three separate viewpoints. The first identified the number of predictors and effect sizes for each criterion. The second assessed the number of studies and effect sizes for each profession. The third section evaluated predictors against criterion and assessed the impact of subgroups and moderators. Twenty-one predictors including academic, non-academic, and demographic variables were identified in the literature and used as classifications for analysis. Each predictor is evaluated with one or more criterion as noted in the literature.

The criterion variables include professional board scores, cumulative grade point average, professional grade point average, and completion or graduation. The
professional board exams were cited most often as a criterion variable, professional grade point average eliciting the fewest comparisons. The criterion, graduation, has the fewest statistically significant results, indicating that it is the weakest outcome measure of the four.

Two professions, radiologic technology and respiratory therapy, evaluated all four criterion variables. Nursing had more studies and effect sizes than the other four health professions but did not measure the criterion, professional grade point average. This may have contributed to the lack of evaluation for this criterion. Additionally, two professions, dental hygiene and medical technology, did not evaluate the criterion, graduation.

Studies were also assessed by predictor. When three or more studies identified the same predictor/criterion assessment, subgroup and moderator analysis was used to elicit differences. There are two subgroups, two- and four-year programs, noted in the research for undergraduate programs. Additionally the literature identified four moderators including: five professions, three time points, publication status, and length of the study. Both subgroup and moderators analysis accounted for statistically significant differences in the predictor/criterion measures. However, as the number of studies is often small, there are instances where one study represents a category.

Random analysis is used to evaluate standardized mean differences as the assumption of different variances is assumed *a priori*. The following seven comparisons resulted in a shared variance: ACT math, science, and social science; chemistry; entrance grade point average; SAT verbal; and the AHPAT specialized examination. All shared
variance results were run against professional board scores. Shared variance resulted in \( T^2 = 0.000 \), where results from the random analysis equaled that from a fixed analysis reflecting a homogeneous sample. In this instance the population variance is assumed to be the same for all studies, reducing the standard error (Borenstein et al., 2009).

To account for the possibility of publication bias, Hedge’s \( g \) was run with each assessment of \( d \) (Hunter & Schmidt, 2004). Publication bias made very little difference in any of the effect size values and no difference in statistical significance. To further assess for bias with statistically significant results, \( N_{fs} \) and \( Z \)-score were run when three or more studies were evaluated for one predictor/criterion measure. \( Z \)-score for alpha .05 is 1.95996. The larger these two numbers, the more sure the results from the sample reflect the population (Borenstein et al., 2009).

Statistically significant results were identified for 19 of the predictors when compared with the criterion, board scores. This criterion measure was assessed more frequently and had more significant results than any other outcome measure. The non-significant results include age, algebra, gender, high school grade point average and rank, interview and some of the specialty examinations.

When predictors were assessed against cumulative grade point average, nine findings were statistically significant including: ACT cumulative and social science sections; biology and science; chemistry; entrance grade pint average, high school rank; SAT math and verbal sections. Cumulative and final grade point averages are included under the same classification for this study. They are separated from professional grade point average as some studies measured predictors against both classifications.
Professional grade point average had the fewest comparisons but resulted in 14 statistically significant findings. Eight of those comparisons were done for two specialty examinations where the study separated each section. When each specialty examination is considered as one measure, eight predictors were statistically significant against this criterion. The predictors include: ACT English and social science; biology and science; entrance grade point average, and three specialty exams, the AHPAT, HOAE, and AHAT.

The criterion, graduation, had 10 statistically significant comparisons. One of the specialty examinations, the AHAT, was evaluated in sections resulting in four measures. Using this exam as one measure, graduation, was statistically significant for seven predictors including: high school grade point average and rank; SAT math and verbal sections; and the specialty examinations, NLN, AHAT, and HOBET.
CHAPTER V

DISCUSSION

The purpose of this project was to statistically review research conducted on admission standards for undergraduate degree-granting health professions and to identify core standards that would satisfy all professions as well as standards specific to each profession. It is hoped that application of the results will help colleges control costs, resource allocation, and identify those students most likely to succeed within the individual professions (Billson & Terry, 1987).

Five professions were selected following a review of the literature. The professions share characteristics including the granting of both two- and four-year undergraduate degrees, and nationally standardized board examinations as outcome measures. Included in the final study are: dental hygiene, medical technology, radiologic technology, registered nursing, and respiratory therapy. Twenty-eight years of published and non-published research were evaluated using random format meta-analysis.

This chapter first reviews results as they address the initial research questions. Second, a summary of the findings with core standards and implications for the professions is discussed. The chapter concludes with suggestions for further research.
Research Questions

1. Are there differences in predictive effectiveness of entrance standards for allied health and nursing programs when grouped as a whole under the name health professions?

Twenty-one predictors were assessed by two or more programs. The ACT English, math, and science scores; biology; and entrance grade point average were measured by all five professions. Of these, ACT English, biology, and entrance grade point average were identified as statistically significant for all professions. Criterion measures varied with only one predictor, entrance grade point average, assessed against the criterion, board scores, found to be statistically significant for all. However, results were heterogeneous with between studies variance of $T^2 = 0.064$. Although variance is small, it may be a concern when considering the external validity of the results.

Part of the issue with grade point average stems from the two-year degree standards that require a student to be able to complete an academic program within two years. A recent study conducted for a baccalaureate respiratory therapy program found a higher correlation with the number of prerequisite courses completed and graduation, than the entrance grade point average. While this finding is significant, it is more applicable to a four-year degree as it is difficult to implement when working within the two-year guidelines (Wittnebel, Murphy, & Vines, 2009).

Studies evaluating ACT English used three criterion measures, with board scores and professional grade point average indicating statistical significance. Cumulative grade point average was evaluated by two professions but found to be statistically
non-significant. The latter assessments were conducted on two-year programs with most of the variance attributable to differences between the studies $I^2 = 90.224$.

The predictor, biology, was evaluated against all four outcome criteria and found to be statistically significant for all but graduation. When included under the umbrella classification, science, all five professions measured this predictor with statistically significant results for board scores, and cumulative and professional grade point averages.

When moderators were considered, a shared variance was calculated for eight comparisons indicating homogeneous measures. Table 7 identifies the predictors and the moderators creating the shared variance, the professions involved in the assessment, effect size, and statistical significance of the findings.

Each of the predictors generating a homogeneous variance was measured against board scores. The board examinations are nationally standardized for each profession. Six of the predictors also came from nationally standardized examinations, the ACT and SAT examinations and the AHPAT. Noted portions of the nationally standardized examinations, chemistry, and entrance grade point average are valid measures across professions when assessed against the board examinations. ACT English warrants further investigation as it resulted in homogeneous results at two different time points over two professions, indicating validity, but results in the third time point were not statistically significant. This time point contained only one study. It is impossible to determine whether the non-significance was due to research design or another factor as a change in the curriculum. Further study is needed.
Table 7

*Measures of Shared Variance With Professions, Effect Size, and Statistical Significance*

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Professions</th>
<th>Effect size</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT English</td>
<td>DH</td>
<td>0.611</td>
<td>0.607</td>
</tr>
<tr>
<td></td>
<td>Rad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time point 1</td>
<td>MT</td>
<td>1.127</td>
<td>0.000</td>
</tr>
<tr>
<td>Time point 2</td>
<td>Rad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACT math</td>
<td>RN</td>
<td>0.434</td>
<td>0.000</td>
</tr>
<tr>
<td>ACT science</td>
<td>DH</td>
<td>0.738</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Rad</td>
<td></td>
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<tr>
<td></td>
<td>RN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time point 1</td>
<td>MT</td>
<td>0.738</td>
<td>0.000</td>
</tr>
<tr>
<td>ACT social science</td>
<td>Rad</td>
<td>1.034</td>
<td>0.000</td>
</tr>
<tr>
<td>Two-year</td>
<td>RN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>Rad</td>
<td>0.956</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>RN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrance G.P.A.</td>
<td>MT</td>
<td>0.671</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Rad</td>
<td>1.397</td>
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<tr>
<td></td>
<td>Resp</td>
<td>0.979</td>
<td>0.000</td>
</tr>
<tr>
<td>SAT verbal</td>
<td>RN</td>
<td>1.204</td>
<td>0.000</td>
</tr>
<tr>
<td>AHPAT</td>
<td>MT</td>
<td>0.918</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Note.* G.P.A. = grade point average; DH = Dental Hygiene; MT = Medical Technology; Rad = Radiologic Technology; RN = Registered Nurse; Resp = Respiratory Therapy; p-value is probability where alpha = 0.05.
2. Are there differences in predictive effectiveness of entrance standards for the health professions in the level of the undergraduate degree?

This question refers to an overall measure for the health professions and differences between two- and four-year degrees. Nine predictors were measured for both two- and four-year programs with at least one of the degree levels found to be statistically significant and include: ACT cumulative, English, math, and science scores; age; entrance grade point average; SAT math and verbal scores; and science. Two predictors, ACT science and entrance grade point average, were found to differ by level of education within professions, when measured against board scores. Both predictors were found to be statistically significant when measured by four-year degree programs and non-significant for the two-year degree programs.

An additional predictor, ACT cumulative score, was found to differ between two- and four-year degrees but this finding was not as clear. Two-year programs in medical technology and registered nursing were not statistically significant. A single four-year program in radiologic technology was significant against this measure. As the professions differ, it is not possible to differentiate between the influence of the degree level and the profession. Additionally, all these same professions measured the ACT cumulative score against the criterion, board scores, and all were statistically significant, indicating it may also be the influence of the criterion used in measurement.
3. Are there differences in predictive effectiveness of entrance standards for individual allied health professions and nursing?

This answer is divided into three sections. First, Table 8 is presented with predictor and criterion measures found to be statistically significant for each profession. Professions resulting in statistically significant results are noted next to the predictor and under a column denoting the criterion measure used. This presentation is used to help identify the measures shared by the health professions. Second, each profession is summarized independently to identify the specific measures found to be statistically significant. Third, a discussion is presented to identify differences in predictive effectiveness of entrance standards for the individual health professions.

**Dental hygiene.** Dental Hygiene identified six predictors as statistically significant. They included: ACT composite and science scores; biology; science; and entrance grade point average. All measures were evaluated against board scores and three measures were also found to be significant when measured against grade point averages. One specialty exam was also identified as statistically significant but was evaluated only once in the literature.

**Medical technology.** Eight predictors were identified as statistically significant for medical technology. The included: ACT composite, English, math, science, and social science scores; science; entrance grade point average; and the AHPAT, a specialty test. The specialty test is mentioned here as it was evaluated twice and resulted in a shared variance for this profession. Seven measures were significant when measured against board scores and six measures were significant with grade point average.
Table 8

*Statistically Significant Predictors for Each Health Profession*

<table>
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<tr>
<th>Predictor</th>
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<th>Cum. GPA</th>
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<tr>
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</tr>
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</tr>
<tr>
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</tr>
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<td>Rad</td>
<td></td>
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*(table continues)*
Table 8 (continued)

*Statistically Significant Predictors for Each Health Profession*

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<tr>
<th>Predictor</th>
<th>Board score</th>
<th>Cum. GPA</th>
<th>Prof. GPA</th>
<th>Graduation</th>
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<td>Resp</td>
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<td>Resp</td>
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</tbody>
</table>

*Note.* DH = Dental Hygiene, MT = Medical Technology, Rad = Radiologic Technology, Resp = Respiratory Therapy, RN = Registered Nurse.

*Professions noted identified at least one specialty examination to be statistically significant.*
Radiologic technology. Ten predictors were identified as statistically significant for radiologic technology and included: ACT composite, English, math, science, and social science scores; biology; chemistry; entrance grade point average; high school rank; and SAT composite score. Nine predictors were measured against the criterion, board scores, with four predictors measured against multiple outcomes resulting in significant findings including: ACT science; biology; chemistry; and entrance grade point average. Both ACT composite and social science were statistically significant for graduation. Radiologic technology is the only profession that did not identify one specialty examination as statistically significant.

Registered nurse. All 20 predictors were found to be statistically significant for registered nursing. Sixteen measures were evaluated against board scores with cumulative grade point average and graduation also serving as outcomes. Five predictors were measured against multiple outcomes with significant results including: ACT science; anatomy; entrance grade point average; and SAT verbal scores. This difference in the significance of the predictive ability of the two exams is supported in a previous meta-analysis of nursing literature in which the ACT examination was a better predictor of scores on the NCLEX-RN exam, yet the SAT exam is measured more often (Campbell & Dickson, 1996). Additionally, this study identified three specialty exams as statistically significant although each exam was measured only once. In the study by Campbell and Dickson, “the NLN prenursing examination was predictive of success 100 per cent of the time” (p. 56).
**Respiratory therapy.** Five predictors were identified as statistically significant for respiratory therapy including: ACT English; science; entrance grade point average; age; and a science and math combination. Outcome criteria were divided with only two predictors significant for board scores. Three studies used professional grade point average, two studies used graduation, and one study used cumulative grade point average. Respiratory Therapy identified four specialty exams as statistically significant, either in part or whole. Each exam was reported only once in the research.

**Summary.** The previous sections in research question 3 identified which predictors were statistically significant for each profession. What is not mentioned is whether a profession examined a particular entrance standard and found it to be statistically non-significant. This summary discusses those differences and relates them to the professions. Sixteen predictors were examined by professions but not mentioned in this analysis as they were associated with non-significant results. They are discussed here.

Dental hygiene assessed ACT English and found it to be non-significant when assessed against the board scores. This finding is in conflict with the other four professions and the overall finding of statistical significance. Further study is suggested as this measure was only assessed once for this profession.

ACT math was evaluated by all five professions and found to be significant for three. Both respiratory and dental hygiene conducted research on this measure with non-significant results. Each of these professions was represented by one study. It is
impossible to tell whether the non-significant findings are related to research design or are true without further research.

Radiologic technology identified algebra as a non-significant finding. The assessment was made by three separate studies with differing outcome criteria. Based on the research available for this study, algebra is not an effective predictor for radiologic technology.

Three separate studies were conducted on high school grade point average by radiologic technology programs. Each study identified a different outcome measure but all three found this predictor to be statistically non-significant. High school grade point average is not a good predictor of success for radiologic technology.

Radiologic technology also identified the demographic variables, age and gender, as non-significant factors. Additionally, transfer was non-significant in determining a successful outcome for students in this profession, a reflection of the cohesiveness of the educational programs within this profession (JRCERT, 2002). The interview was also non-significant for radiologic technology as it was for all selected professions; however this may have more to do with research design as questions and methods varied with each assessment of this predictor.

Respiratory therapy identified ACT science as non-significant. Both the math and science sections of the ACT were assessed against professional grade point average and are represented by only one study. This profession needs to evaluate the predictors against another outcome, or try to replicate the above findings before any final decision about the efficacy of these ACT sections is made.
Respiratory therapy also found high school grade point average and age to be non-significant predictors. Again, these findings are based on single study results and need further evaluation before general conclusions can be made.

As noted previously, three predictors noted on the coding sheet were only evaluated once and were not included in the final analysis or discussion for the health professions. They are: essay, marital status, and physics. These three did not qualify for evaluation with the meta-analysis software and are for narrative review only.

The benefit of a meta-analysis is that it combines studies and allows for non-significant results to contribute to the effect size and significance. It allows for some differences in research design as it combines all studies to come up with an average value (Borenstein et al., 2009). This last section has identified non-significant results for particular professions. The predictors discussed were found to be significant for other professions, or as with the interview, found to be non-significant for all the professions. Findings may be related to the outcome criteria selected, or if results are only predicated on one study for a profession, they may relate to research design. It is suggested that health profession educators use the information provided to further assess their own standards and contribute to the current knowledge base.
4. Are there differences in the predictive effectiveness of entrance standards for the different degree levels of undergraduate academic preparation for the specific professions?

Four professions measured nine predictors where at least one level of education was statistically significant. Two professions identified differences in measures at the degree level. All four criterion measures were included in the findings.

**Medical technology.** Science was a statistically significant predictor for both levels of medical technology education. One other predictor, entrance grade point average, was found to be effected by the level of education. Four programs measured it against board scores with three four-year programs identifying statistical significance, and one two-year degree program non-significant.

**Radiologic technology.** Radiologic technology identified only one measure at both degree levels. Entrance grade point average measured against cumulative grade point average was statistically significant for both two- and four-year degree programs. Other measures were assessed at both the two- and four-year degree levels but did not share outcomes.

**Registered nurse.** Seven predictors were identified as statistically significant for both two and four-year degree nursing programs and they include: ACT composite, English, and math scores; age; entrance grade point average, SAT math and verbal. ACT science scores were significant for four-year programs and non-significant for two-year programs.
Respiratory therapy. Entrance grade point average assessed with professional grade point average was the only statistically significant measure for both two- and four-year respiratory therapy programs.

5. Are there differences in predictive significance of entrance standards for allied health and nursing based on sample size?

This study utilized a random-effects model to assess the five professions. Random format meta-analysis is used when the sample under investigation is thought to represent a sample of the population as a whole. Sample size is adjusted so that there is more equitable weighting, giving smaller samples a larger influence over the results. Variance between studies is added to variance within each study to determine weight. This is in contrast to fixed format meta-analysis where between studies variance is assumed to be zero and therefore not considered when weighting each sample (Borenstein et al., 2009). Therefore, sample size did not have a significant effect on the predictive significance of the entrance standards evaluated in this study.

6. Are there differences in the predictive significance of entrance standards for allied health and nursing due to the design method, specifically the length of time used to gather data?

Studies conducted in a single year were differentiated from studies collecting data from two or more years. The increased length of time used to gather data assisted in increasing the sample size for most studies. When data is collected in this manner it reduces consistency in the sample as students may have different instructors and educational experiences especially in the clinical setting, course content might change to
reflect changes in health professions practice or accreditation standards, or the sample itself might change due to changes in the applicant pool.

The length of time used to gather the data did have an effect on outcomes associated with the ACT examination. Four ACT predictors were significant when evaluated by studies lasting two or more years as compared with studies completed within one year. The predictors are: the cumulative score, English, math, and science sections of the exam. They were all measured against board scores. The cumulative score also found identical results when paired with cumulative grade point average.

7. **Are there differences in predictive significance of entrance standards when considering time points?**

The moderator, time point, assessed the studies from a longitudinal perspective. Twenty-eight years were broken into two decades, 1980–1989 and 1990–1999. The last eight years, 2000–2008, represented the third time point. As all the health professions re-assess their standards of care every few years, separating the time by decades allowed for the evaluation of predictor/criterion measures over time. Eight predictors demonstrated a change in statistical significance including: ACT cumulative, English, math, and science scores; science; entrance grade point average; high school rank; and age. The criterion measures included board scores and graduation. The moderator, time point, did have a statistically significant effect on some of the predictor/criterion measures. This effect could represent changes in knowledge needed for the professions, changes in how the education is provided including changes in clinical experiences, or changes in the students over time.
No studies currently exist relating the predictors to changes over time. Further study is needed to maintain predictor validity for each of the professions. Relying on older research is not necessarily good practice as professions change to meet the needs of the current environment.

8. **Are there differences in the predictive significance of entrance standards for allied health and nursing dependent upon the method of dissemination?**

   The moderator, publication, had an effect on two measures, biology and science. Both predictors were evaluated with board scores and both were statistically significant when published and non-significant for those studies not published. Generally a published article is thought to be more precise with fewer errors, creating a greater possibility of statistical significance (Rosenthal, 1991; Wolf, 1986). These two measures reflected that understanding; however, what is of more interest is the number of predictors that were not affected by professional publication.

9. **Are there differences in the predictive significance of entrance standards for allied health and nursing due to the statistical method used to evaluate results?**

   Correlation was the most common statistical format used in the independent studies selected for this analysis. Three other methods were identified in the literature and used to input data including $F$ tests, $t$-tests, and means with standard deviations (Wolf, 1986). Eleven studies used one or more of these three statistical formats. As these tests and predictors were scattered throughout the data, their effects were often averaged into the larger summary. There were, however, instances where the type of test may have factored into the interpretation of the data. This was complicated by the fact
that in these instances the study may have been the only analysis representing a category, as in the breakdown of data associated with the subgroups or moderators. Interpretation was limited as it was impossible to decipher whether the effect was caused by the statistical format or the category. Additionally there were instances where two authors reported results in the same format but the statistical significance was not the same. Whether this related to differences in study design or error is unclear. As there were no clear markers denoting absolutes with differences in statistical format, the conclusion can be made that in this study, statistical format did not have a significant effect on the criterion variables.

10. Are there differences in the predictive significance of entrance standards for allied health and nursing due to the criterion variables used to evaluate program success?

The criterion, board scores, was the outcome variable reported more than any other variable and was also the outcome associated with more statistically significant results including eight instances of predictor/criterion homogeneity. This homogeneity was identified across professions and often with the influence of moderators.

The professions chosen for this study are all nationally accredited and standardized meaning that they share outcome examinations for the profession across the country. As the professional education must follow guidelines or matrices identified by the national accrediting organizations, and the educational institutions are held accountable for the success of their graduates on these examinations, there is consistency across programs for this measure.
When consideration is given to individual college missions and policies, it is understandable that exit grade point averages and graduation are more specific to one institution and therefore less accountable to quantifiable external validity measures. In a study recently conducted for a baccalaureate respiratory therapy program, completion of prerequisites proved to be a better predictor of graduation than prerequisite grade point average (Wittnebel et al., 2009). Additionally, non-cognitive variables as student personality and interest may also influence graduation results, a finding consistent with that identified in a meta-analysis conducted for graduate education (Kuncel et al., 2005). Further study is warranted as graduation as a criterion variable appears to include factors other than the traditional cognitive predictors.

**Discussion**

Entrance grade point average is the only measure that is statistically significant for all five professions when measured against a single criterion, board scores. Additionally, three professions measured this in multiple studies and identified a shared variance within their professions. As a predictor, this measure is the strongest across the professions. This finding supports research in other medically related programs that correlated entrance grade point average with other medical professions (Evans & Dirks, 2001; Kulatunga-Moruzzi & Norman, 2002). There is an issue with this measure though, as two-year programs often admit students into the professional program in the first semester of study, thus negating its efficacy.

A biology/science course combination used as a predictor in some of the research was found to be significant for all five professions but suffered significance and validity
issues when considering the method of measure and moderators. Science was not clearly defined within studies leaving some concern over the validity of its measure. Descriptions within the research led to its inclusion under biology; however the internal study weight given to the biology grade in the science average was not always clear.

Eight predictors resulted in shared variance, a reflection of homogeneity within the results. The criterion for each of these measures was board scores. None of the predictor/criterion measures included all five professions and the homogeneity for three of the measures resulted from the influence of the subgroups and moderators considered for this study. The external validity of these measures is enhanced as they demonstrated a shared variance across professions.

Some predictors were not clearly identified in the literature and need to be clarified by the professions to be considered externally valid predictors. These included the math and science courses that were not adequately described within the studies and were combined in various ways. Non-cognitive variables also fell into this category. For example, there was no consistency in the method of interview and this may have contributed to its statistical non-significance. This lack of reliability and validity was also identified in a narrative review of the health professions literature, which identified the need to find measures of non-cognitive factors to help predict clinical performance (Salvatori, 2001).

All moderators selected for analysis did create an effect on the statistical significance of multiple predictor/criterion measures. For the software to run a thorough analysis, three or more studies had to be present. Many evaluations had just three studies
leaving one study to represent a category. As a result, one study could change the statistical significance of a predictor for that moderator. Whether this was really reflective of the larger population could not be deciphered given the limited number of studies available for inclusion in this research paper.

**Implications**

The single largest result associated with this analysis was the paucity of research available for the undergraduate health professions. Nursing, the oldest profession included, and the profession associated with more graduate degree opportunities, contained more research than any of the other professions. This alone is significant for the health professions, and indicates a need to encourage research on education within allied health. Additionally, not all the research was clear, and required the author to contact groups for clarification. As the meta-analysis format grows, it would be helpful for research journals to require statistical information and data about the samples from potential authors.

Twenty-one different predictor variables were identified through the literature search. One of these variables, specialty examinations, had many different examples but only one repeat study. Most of the examinations have been discontinued. If there are current standardized tests in use by undergraduate programs, it would benefit the health professions if individual programs evaluated them statistically and published their conclusions.

Allied health is not alone in this issue as a meta-analysis of a similar pretest for pharmacy, the Pharmacy College Admission Test (PCAT), indicated widespread national
use since 1975 with much controversy over its ability to predict successful outcomes although its results are similar to entrance grade point average. The authors noted that while these two measures were significant academic measures, they could not account for persistence which might be better measured through non-cognitive assessments (Kuncel et al., 2005).

Results from this research indicate that the board examinations produce the best measure of outcome assessment. This held true for all professions with the exception of respiratory therapy. Authors in this field chose grade point average as the most often used criterion. This profession needs additional research published regarding entrance standards and might consider using a national board examination as the outcome criterion. The board examinations are nationally standardized for each profession and offer the most objective measure of outcome success.

**Further Research**

This study identified predictors that were statistically significant for the health professions as a whole and also for each individual profession. A national survey of entrance standards currently in use is needed for each profession. Following a survey, research to identify the successful standards would set a base of knowledge for entrance into particular fields of study. The overlap of successful standards would reduce the cost to institutions as a core set of standards could be used for all allied health professions within an institution.

Additional standards for each profession could be added to the core as assessed, including those measures assessing bedside skills and laboratory abilities. Above all, the
individual college will play a role as institutional mission is considered. The mission is tied to resource allocation and its inclusion will help identify successful candidates for a particular educational environment.

Each profession, with the possible exception of nursing, needs additional research made available to educational program chairpersons. Establishing a clearinghouse or network through the professional associations would allow educational practitioners access to additional research on this topic to guide their studies. Mentors familiar with statistical methods would also be of value to assist programs with research techniques.
APPENDICES
APPENDIX A

NUMBER OF HEALTH PROFESSION PROGRAMS IN THE U.S.

AND THE TYPE OF DEGREE OFFERED
### Appendix A

**The Number of Health Profession Programs in the United States of America and the Type of Degree Offered**

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<th>Profession</th>
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<th>4 year</th>
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APPENDIX B
CODING SHEET
### Appendix B

#### Coding sheet

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