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Demographic Characteristics and Academic Measures as Predictors of Success on the American Society for Clinical Pathology (ASCP) Medical Technologist Certification Examination

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DEMOGRAPHIC CHARACTERISTICS AND ACADEMIC MEASURES AS PREDICTORS OF SUCCESS ON THE AMERICAN SOCIETY FOR CLINICAL PATHOLOGY (ASCP) MEDICAL TECHNOLOGIST CERTIFICATION EXAMINATION

A Dissertation

Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

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ABSTRACT

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ABSTRACT OF GRADUATE STUDENT RESEARCH

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Title: DEMOGRAPHIC CHARACTERISTICS AND ACADEMIC MEASURES AS PREDICTORS OF SUCCESS ON THE AMERICAN SOCIETY FOR CLINICAL PATHOLOGY (ASCP) MEDICAL TECHNOLOGIST CERTIFICATION EXAMINATION

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Date completed: June 2005

Purpose

This study was undertaken to address the utility of demographic characteristics and academic measures as predictors of success for the American Society for Clinical Pathology Board of Registry Medical Technologist Certification Examination (Certification Examination) Total Score and six Subscores and to find predictive models with relevance to an ethnically and racially-diverse student population.

Method

The research population was the graduates of the Andrews University Program for Clinical Laboratory Sciences. The 233 subjects were from 53 different birth countries. The relationships between Certification Examination scores and both demographic characteristics and

academic measures were analyzed by chi square, analysis of variance, Pearson product-moment correlation, and multiple regression with post hoc tests where appropriate.

Results

Four of the five demographic characteristics — ethnicity, geographic region of birth, English as a first or second language, and completion of the first degree or as a post-baccalaureate while attending the Program — were found to have significant relationships with Certification Examination success. Gender was significant only with the Imunology Subscore.

All of the 31 academic measures variables were significantly correlated with the Total Score. The measures with the highest correlations, all above .60, with Total Score in descending order were Immunohematology and Transfusion Medicine GPA, Clinical-year Didactic GPA, Clinical Year GPA, Clinical Chemistry GPA, Cumulative Graduating GPA, and Hematology and Hemostasis GPA. Most of the academic measures variables also showed significant relationships with the six Certification Examination Subscores and with passing and failing. Correlations between the Certification Examination and academic measures variables were lower for some of the demographic subgroups, particularly Blacks, Asians, Hispanics, Pacific Islanders, those born outside the United States, and those who speak English as a second language.

The predictive model for the Certification Examination Total Score included two predictors: Admission science GPA and Clinical-year didactic GPA.

Conclusion

Relationships were found between Certification Examination success and both demographic characteristics and academic measures. Because lower correlations were found in many analyses for demographic subgroups, educators must use caution when using models as tools to identify students at risk of failing the Certification Examination since the models do not apply equally to all groups.

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ACKNOWLEDGMENTS

How do I adequately express my appreciation to Dr. Jerome Thayer, who served both as dissertation chair and methodologist? His enthusiasm and extraordinary gift of his time whenever it was needed were continually inspiring. I am in awe of his cheerful patience in mentoring me through the wonders of statistics, the development of the dozens of tables required to complete this study, and his proof-reading ability.

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CHAPTER 1

INTRODUCTION

Academic and professional success is important not only to graduating students but to society, its educational systems, and to the teachers that nurture, educate, and prepare students to take their places in the professional world. Increasing pressure on academic institutions is coming from government, accrediting bodies, alumni, families of students, and students, all of whom are demanding and expecting documentation that the various resources invested in education are resulting in appropriate outcomes (Jackson, 2005). Universities, colleges, and institutions engaged in teaching and learning can no longer trundle along in a bliss of academic isolation expecting that good intentions will satisfy the various stakeholders in the educational process.

Outcomes such as retention and graduation rates and the success rate of students on post-baccalaureate certification/licensure examinations are required by governmental agencies and accrediting organizations. The percentages of students employed in the respective fields of their academic preparations and percentages of students accepted to post-baccalaureate programs are noted. These outcomes are subjected to scrutiny, censure, and to the mandate that appropriate corrective action will occur where unacceptable performance is noted (Gore, 1991; *Guide to Accreditation*, 2001; *Handbook of Accreditation*, 2003; Parker, Humphrey, Short, Clemens, & Gambon, 2004; Schwabbauer, 1997, 2000 a, b; Weithaus & Fauser, 1991).

Hovde (1963), over 40 years ago, eloquently encapsulated the responsibility of an educator as:

> To provide the best background in preparation of graduates for jobs, for continuation of self-education, for further graduate study teachers in Medical Technology have an obligation, indeed it is a necessity, to provide the learning experience which will give the firm foundation of fundamental knowledge and application of theory on which the graduate can then build his skills and expand his knowledge. (p. 67)

The necessity to review and make the educational experience relevant to meet outcome expectations with a well-designed curriculum continues and is ever before the educator (Beck, 1994; "Educating the Medical Technologist," 2002; Elder, Nick, & Fowler, 1997; Horton, 2003; Karni & Duckett, 1998, Karni et al., 1998; Kimball, 2001; Lacroix, Bean, & Chandler, 1993; Ryman & Leach, 2000). Indeed the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) Standard 19 for clinical laboratory scientist/medical technologist (CLS/MT) program accreditation stipulates: "A review of outcomes measures (e.g. external certifying examination results, results from capstone projects) from the three preceding years must be documented, analyzed and used in the program evaluation" (*Guide to Accreditation*, 2001, p. III-10).

A number of professions require documentation of entry-level knowledge and mastery of a particular skill-set through success on a state or national certification/licensure examination. The admissions committees and educators for those programs are also faced with the challenge of selecting individuals who are not only likely to successfully complete the programs, but are also expected to successfully pass certification examinations for professional-entry eligibility.

Educators must establish sound admissions practices that are based on the best criteria that are well grounded and defensible (Laudicina, Legrys, & Beck, 1995). Particularly in programs where there is a fixed admissions quota, the admissions process must use criteria that have a high degree of prediction of student success. Not only is failure to complete a program painful for the student, but the program faculty and the other members of the student's class are also demoralized. Once a student has started a program, the impact of dismissal can be emotionally and legally horrendous (Legrys, Beck, & Laudicina, 1995). Additionally, one must be mindful that for the program applicants who were not admitted, the educational experience they sought were lost to them because those places were wasted by the individuals who were accepted but who failed to complete the program.

Although many factors influence clinical laboratory program student enrollment (Stuart, 2002), recruiting strategies to find interested applicants must be linked to good admissions decisions in order to increase the probability of students' successful matriculation through the academic preparation required and then on into the profession (Stewart, Pool, & Winn, 2002; Stuart & Fenn, 2002; Ward-Cook, 2002; Stuart, 2003). The admissions process must be reliable in its ability to predict success both in the program and professionally (Agho, Mosley, & Williams, 1999; Beck, 1994; Crocker, 1978; Garza, Adams, & Skinner, 1978; Rifken, Maturen, Bradna, Brace, & Jacobs, 1981). Students whose aptitude, interests, academic strengths, and personality are clearly at odds with the characteristics and skill set required by a particular profession should not be recruited or admitted. The challenge is how to determine if there is dissonance between the student's attributes and the profession's requirements.

Garza, Adams, and Skinner (1976) performed a national survey of medical technology admissions practices and found that a grade point average of 2.50, separate evaluation of science grades, references, and an interview were the most common criteria used by admissions committees. Almost 20 years later, Scott et al. (1995) determined in a national survey of the programs for six other allied health disciplines, that the most frequent admissions criteria were *still* grade point average, references, interviews, and science grade point average with the addition of a writing sample.

Other studies have tried to address what happens after students are admitted. A number have tried to analyze the causes of attrition (Blume & Krefetz, 1996; Gupta, 1991; Laudicina, 1997). Laudicina (1997, 1999b) noted that there is a difference in students' persistence behaviors that vary by ethnic group. She found, as did Gupta (1991), that African-Americans are more likely to leave for academic reasons. Asians have the highest graduation rates.

To stem the outflow, educators are attempting retention-intervention strategies (Ciesla, 1993; Laudicina, 1995, 2001). Although it is an unassailable responsibility of conscientious educators to develop and use intervention methods, all too often these intervention measures are necessitated because of ill-advised admission decisions. The intervention processes may well be too little and too late for the more vulnerable students. Strategies for remediation of an inappropriate admissions decision where intervention cannot occur does no one, particularly the failing student, a service.

Purpose of the Study

This study was to address the utility of both demographic characteristics and academic measures as predictors of success on the American Society for Clinical Pathology Board of Registry Medical Technologist Certification Examination. Those characteristics and measures will be assessed for relevance to an ethnically and racially-diverse student population.

As applicant demographics change to include more applicants who are older, more ethnically diverse, or are applying to begin a second-career as noted by Scott et al. (1995), researchers need to take a fresh look at the continued relevance of the research conclusions of the past (Conrad, 1991). Although a number of studies over the years have focused on predictors of success in medical technology programs (Elberfield & Love, 1970; Millstead, 1992; Rifken et al., 1981; Wells, 1956; Williams, 1963) and on predictors of success on a national certification examination (Crews, 1980; Downing, Mann, & Towlinson, 1982; Lanier & Lambert, 1981;

Watkins, 1989), most of the studies did not differentiate whether the students were minority, international, or spoke English as a second language.

A few researchers, particularly Somma (1988) and Conrad (1991), did, however, try to address this deficiency. Somma included race, whereas Conrad included birth origin, noting whether a student was American-born or international-born as part of the demographic variables analyzed. Unfortunately, Somma's sample population was small, while Conrad's population of 451 had 407 American-born students and only 44 international-born individuals. Handley, Hudson, Goodwin, and Lux (1995) followed with a predictive study on minority student success with a small study population of 89 students, 20 identified as minority and 69 as non-minority. Weed's (1996) study looked at whether English was the native language.

Among national universities, Andrews University is currently ranked in the top 17 for having a racially and ethnically-diverse student body (McGrath, 2005, p. 127). This student population affords a unique research opportunity. The Andrews University Program for Clinical Laboratory Sciences mirrors the University's diversity. The majority of each class is comprised of international and minority students. Since graduation of its first class in 1989, this Program has graduated students from 55 different birth countries. See Appendix A.

This study is designed to answer the following questions for an ethnically and racially-diverse clinical laboratory science student population:

Question 1: Is there a relationship between student demographic characteristics and success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Question 2: Is there a relationship between academic measures and success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification

Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Question 3: Is there a combination of academic measures that may be a predictor of success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Significance of the Study

This study should be beneficial to leadership in clinical laboratory science programs, in certification agencies, and in accrediting bodies because it addresses various demographic characteristics and academic measures as predictors of success on the American Society for Clinical Pathology Board of Registry Medical Technologist Certification Examination (Certification Examination) in the context of an ethnically and racially-diverse student population. Knowing which predictors are relevant for various demographic groups may assist in selecting students for admission to clinical laboratory science programs and may also help to identify students at risk of failing the Certification Examination who would profit from early intervention. With additional learning assistance, the probability that the at-risk students will be successful may be increased.

Definition of Terms

This study utilizes the following definitions:

Accreditation: "The primary self-regulatory means of quality educational assessment; it gathers appropriate information on programs and has knowledgeable professionals appraise them" (Weithaus & Fauser, 1991, p. 968). It identifies programs and institutions that acceptably meet educational standards (Spence, 1975).

American Society for Clinical Pathology (ASCP): Formerly called the American Society of Clinical Pathologists, a national professional organization representing pathologists, medical technologists, and other laboratory personnel. The name change went into effect January 1, 2002 ("ASCP Name Change Approved," 2001).

Board of Registry (BOR): A separate entity within the American Society for Clinical Pathology that serves as a certifying body.

Certification: "The process by which a nongovernmental agency or association grants recognition of competence to an individual who has met certain predetermined qualifications, as specified by that agency or association" (ASCP Board of Directors, 1978, p. 9).

Certification examination: An examination used to assess an individual's competence against a predetermined standard that is established to reflect the competence required of an entry-level practitioner to meet professional expectations (Engel, 1977).

Clinical laboratory technician: Analogous term to "medical laboratory technician." Credentials CLT(NCA) denotes that the individual has met the requirements established by the National Certification Agency for Laboratory Personnel.

Clinical laboratory scientist: Analogous term to "medical technologist." Credentials CLS(NCA) denotes that the individual has met the requirements established by the National Certification Agency for Laboratory Personnel.

Clinical practica: The portion of the clinical (senior) year program in which students work with practicing professionals in a hospital or reference clinical laboratory.

Didactic: The theory portion of the clinical (senior) year program that includes lectures, student laboratories, and other learning activities.

Medical laboratory technician (MLT): An individual who performs general tests in all areas of the laboratory, working under the supervision of a medical technologist. Credentials

MLT(ASCP) denotes that the individual has met the requirements established by the American Society of Clinical Pathology; it is an analogous term to "clinical laboratory technician."

Medical technologist (MT): An individual who performs the full range of laboratory tests from the basic to the highly complex and is responsible for confirming the accuracy of test results and reporting the results to physicians. Credentials MT(ASCP) denotes that the individual has met the requirements established by the American Society of Clinical Pathology; it is an analogous term to "clinical laboratory scientist."

National Accrediting Agency for Clinical Laboratory Sciences (NAACLS): A nonprofit organization established in 1973 that independently accredits clinical laboratory scientist/medical technologist (CLS/MT) programs that is recognized by the Council for Higher Education Accreditation (CHEA) (*Guide to Accreditation*, 2001).

National Credentialing Agency for Laboratory Personnel, Inc. (NCA): is a nongovernmental national organization that conducts certification of medical laboratory personnel through "peer-developed and peer-administered examinations for medical laboratory personnel" (NCA, 2004, p. 1).

Prerequisite: A required course that must be completed before entry into the clinical (senior) year program.

Scope and Delimitations of the Study

Although there are other certification examinations that have been deemed equivalent (Carrigan, 1997a, 1997b), the American Society for Clinical Pathology (ASCP) Board of Registry Medical Technologist Certification Examination is the oldest and has certified the most applicants. It is the most widely recognized examination for the profession and typically is the certification requested for evidence of professional competency. "ASCP BOR certification is the gold standard in the field" *(The Board of Registry*, 2004, p. 2). Therefore, this study limited its analysis to the results of that examination.

The study population represents students from only one medical technology program, the Andrews University Program for Clinical Laboratory Sciences, Andrews University, Berrien Springs, Michigan 49104, from its first graduating class of 1989 through the present.

Organization of Study

This study is organized into five chapters followed by an appendix and a reference list.

Chapter 1 includes the following topics: (a) an introduction to relevant issues in medical technology education, (b) purpose of the study, (c) significance of the study, (d) scope and delimitations of the study, (e) definition of terms, and (f) organization of the study.

Chapter 2 surveys the literature relevant to this study pertaining to the history of the American Society for Clinical Pathology, development of the medical technologist certification examination, predictors of student success in medical technology programs, predictors of student success on the Medical Technologist Certification Examination, and summarization of the literature.

Chapter 3 discusses the methodology that was selected for this study and describes the research design, subjects, measures, and procedures. The research questions and statistical methodology are addressed.

Chapter 4 of this study contains the presentation and analysis of the data and a presentation of the results.

Chapter 5 presents a summary of the study, a discussion of the results, conclusions, and recommendations for future studies.

CHAPTER 2

REVIEW OF RELATED LITERATURE

History of the Medical Technologist Certification Examination

When a small group of clinical pathologists met in Denver, Colorado, in 1921 to organize the Denver Society of Clinical Pathologists and the Colorado Society, they decided that a national society should also be formed. Invitations were sent to all physicians listed by the American Medical Association as clinical pathologists to attend a special session to be held during the annual American Medical Association meeting scheduled for May 22 and 23, 1922. The American Society of Clinical Pathologists (ASCP) was formed at that May meeting.

At that time those early clinical pathologists typically had individuals working with them who were more or less highly trained, nearly always through some form of an apprenticeship style of training experience. Not only were there no standards in existence to evaluate the laboratory workers' qualifications, but there was no agency to recognize them either (Montgomery, 1970).

Four years later, in April 1926, at the annual ASCP meeting in Dallas, Texas, a resolution was passed to appoint a "Committee on the Registration of Laboratory Technicians." The function of the committee was to define what a technician was and to develop different classes of technicians as Class A, Class B, and Class C. The committee was to formulate the "Rules and Regulations of the American Registry of Medical Technicians" (Ikeda, 1940, p. 223). After careful consideration to arrive at a classification scheme that would be satisfactory, the committee finally agreed on three classes that they named: Medical Technologist, Laboratory Technician, and Laboratory Assistant.

They also conducted a study to analyze the data from the 350 applications for the recently formed registry. They found that the applicants ranged from 35% who were college graduates to 3.5% who had no high-school education at all. Some of those individuals had participated in a laboratory training course. Others had not. The length of the training courses ranged from 1.5 months to 96 months duration, while the individuals' experience ranged from 2 weeks to 18 years (Ikeda, 1940). Many of the training programs were short courses of dubious value and were open to students irrespective of their personal attributes or academic backgrounds. Not only was there documentation of injury to patients from testing performed by inadequately trained workers, but competent workers were discredited because of the actions of the incompetent ones (Scott, 1937).

It was clear that there were individuals engaged in performing laboratory tests with widely varying qualifications, and with all levels of training, education, and experience. The committee recognized that minimum standards for individuals and schools must be established.

In 1928, the committee specifically recommended:

> (1) the creation of a permanent Board of Registry with functions, (a) to conduct a Registry, (b) to issue certificates of registration, (c) to conduct a placement bureau, (d) to investigate and register the schools of laboratory technicians acceptable to the Board of Registry, and (2) the adoption of the classification of Laboratory Technician and Medical Technologist, based upon the minimum standards of qualifications as defined by the A. S. C. P. (Ikeda, 1940, p. 225)

In 1933, it was established that all applicants applying to the Board of Registry must take both a written and practical examination (*The Board of Registry*, 2004). The committee began work on a "model curriculum" and contacted universities and colleges to make the medical technology 4th year of a degree program to be "entirely practical and spent in an approved hospital laboratory" (Ikeda, 1940, p. 226).

The actual administration of the examination was carried out by more than 100 clinical pathologists, who had their own clinical practices, but provided this service on behalf of ASCP. Although generally the system worked, with most pathologists approaching their responsibility with care, there were instances reported in which the examination was administered in a less than professional manner. Additionally, the burden of trying to grade the examinations by so many individuals in a consistent manner led to appointing, in 1935, an official examiner to correct the examination papers.

To assist schools in preparing students for the examination, the Registry Board published the "Model Curriculum for Training Students in Medical Technology" in 1937 (Montgomery, 1970, p. 439). Standards were established so that only schools dedicated to education could meet the expectations. The schools set up for profit— the so-called "commercial schools"— could not meet those standards (Bodansky, 1939).

The Board of Registry took an uncompromising stance against two types of schools: the "commercial schools" and those schools that the American Medical Association did not approve. The schools were castigated for the inadequacy of instruction and the undesirable, unethical practices employed in many of them (Ikeda, 1946).

Bodansky (1939) wrote:

> In fixing the educational requirements for admission to the laboratory training schools, in supervising the work in such schools and in examining eligible applicants the American Society of Clinical Pathologists through its Board of Registry has rendered a very valuable service to medicine. (p. 21)

Approved clinical laboratories and colleges offering courses in medical technology were inspected by the Council on Medical Education and Hospital of the American Medical Association to assure that they were equipped and directed in a manner to offer an acceptable medical technology course (Ikeda, 1940).

World War II brought about a need for more medical laboratory workers, so in 1941 a national recruitment began to increase substantially the number of laboratorians. With the increase came additional challenges to administer the certification examination. By 1944, the travel restrictions imposed by the war brought about the first major change in examination format. It was proving virtually impossible to arrange for and carry out the practical part of the examination in geographically scattered locations. Something had to change.

When evaluating the merits of the two segments of the examination, the practical and the written, it was determined that the practical section was "essentially ineffective and that only about 2% of those who passed the written examination failed the practical" (Montgomery, 1970, p. 441). In 1946, the practical examination was officially discontinued as a certification requirement and only the written part of the examination remained (Montgomery, 1970).

The Board of Registry was also becoming disenchanted with the written "essay-type" examination. Grading was slow and labor intensive. The ability to test more than limited areas of candidate knowledge was not possible. With more experience in examination content, grading, and evaluation, in 1946, some "True-False" questions were used on one section of the examination. The results of the remainder of the examination of the standard "essay" questions were compared with the results from the trial "true-false" questions. The results encouraged the Board to move toward changing to the "objective" style examination.

In 1948 only "multiple-choice" and "true-false" sections were offered. The Board then decided that the "multiple-choice" items were more "dependable," and by Spring 1949 the examination was comprised exclusively of 200 "multiple-choice" questions (Montgomery, 1970, p. 441).

One notable benefit of moving to this examination configuration was that machine grading could be done for the first time. Not only did this result in time efficiency in scoring the examination, but it allowed for evaluation of the efficacy of test questions. It was now possible to provide the medical technology schools with beneficial and greatly needed statistical information in detail about their programs. A wealth of information was now available for analysis and was finally in a usable form (*The ASCP Board of Registry*, 2003; Montgomery, 1970).

The same 200-question multiple-choice format remained until examination administration was changed from paper and pencil to computer-based testing in the 1990s. As of 1995, computer adaptive testing, in which each question of the examination is based upon the individual's response to the previous questions, was used exclusively to administer all Board of Registry examinations (*The ASCP Board of Registry*, 2003; Tatum, 1999).

Education and Investigation in the Predictors of Success: The Early Years

In 1955 Sister M. Alcuin Arens decried the state of medical technology curricula and education, calling it "in a very primitive and chaotic state" (Arens, 1955, p. 65). She urged that the educational process be based on the same pedagogical principles that were in place in any educational system. She stated she could not find a written record of educational objectives for the field of medical technology and noted that, previously, medical technology education had been "education without educators" (Arens, 1955, p. 65).

She noted that the Board of Registry's primary objective was not education, but to protect patients by certifying the clinical laboratory worker, to identify and judge "approved schools," and to enforce the ethical practice of medical technology (pp. 70-71). Her plea was that in the same education program for medical technologists, the medical interests of patient care and academic interests should be so merged that students would be educated, not just "trained" (Arens, 1955).

Sister Charles Adele Wells (1956) appealed to the entire medical technologist community to rise to the challenge for teachers and for good teaching. Sister Charles Miriam Strassell (1956) stressed the obligation that educators have to teach students both the theoretical and technical aspects of the profession. Strassell also noted that educators have "opportunity in the training of personality which will develop into good character" (p. 379). However, she was not concerned only with teaching but with the evaluation of applicants to medical technology schools before their acceptance. She determined to protect the individual student, the profession, and herself from admitting students who later had to be dismissed. In doing so she become the pioneer in medical technology education in looking for a valid way to determine applicant suitability for entry into the profession. She selected the American Council of Education (ACE) test, the Flanagan Aptitude Classification Battery for a Biological Scientist, and the Guilford-Zimmerman Temperament Survey to try to predict student success and concluded in the first published work on aptitude tests for medical technologists that aptitude testing was more valuable in medical technology schools based in hospitals than those associated with universities. She urged that her work be only the beginning of what might be accomplished in the future in testing potential students in the field (p. 382).

Williams (1963) followed Strassell's appeal by studying the General Aptitude Test Battery (GATB) scores of the students at entry as a valid predictor of success in training. She was unable to demonstrate this due to the small sample she had available for study. She also attempted to correlate the students' GATB scores with their registry scores. Although she was frustrated in her attempt because of the long time period that would elapse before she could collect enough data for statistical reliability, she appears to be the first to publish a comparison of the registry examination grades with any type of predictor. It should be noted that this was more than 30 years after the first medical technologist registry examination was written.

Another 4 years passed before Williams and two co-authors, Konecny and Champion (1967), published their work on their investigation of the relationship between success in medical technology training programs and success on the certification examination. The authors used the General Aptitude Test Battery (GATB) and the Specific Aptitude Test Battery (SATB) to predict medical technology training program success and found that, when used as the sole instrument for assessment of a potential student, neither the GATB nor the SATB should be used. Although they still were pursuing the use of aptitude measurements, they also studied the students' cumulative grade point average (GPA) and found it to be the best single predictor of scores on the Registry Examination.

Studies that followed continued to emphasize the investigation of aptitude testing as indicators or predictors of program success. In 1922, the University of Minnesota began the first university-based program in medical technology that led to a baccalaureate degree (McKenzie,1992). That program served as the site where two studies were exclusively conducted. In the first study, Lundgren (1968) found that the American College Testing (ACT) Program was the best single predictor for students in medical laboratory assistant programs. Then McCune and Rausch (1969) studied the Strong Vocational Interest Blank (SVIB) and concluded that the examination should not be used as a single basis for admission or rejection of applicants but that it had its greatest utility in the counseling of individual prospective students.

Elberfield and Love (1970), after reviewing previous studies, contended that the critical difference for success and non-success is academic ability, not a student's expressed interest. The study they conducted demonstrated that a student's interest level in the profession has little value in determining potential for success and that "a student's past academic performance appears to be the best single indicator of success in the clinical year, but this criterion alone does not account for all aspects of a student's potential" (p. 398).

Other researchers of the period—Schimpfhauser and Broski (1976), Katzell (1977), and Broski, Schimpfhauser, and Cook (1977)—assessed the utility of the Allied Health Professions Admissions Test (AHPAT). Katzell (1977) found the AHPAT useful, whereas Broski et al. (1977) seriously questioned its utility. Leiken and Cunningham (1980) noted, after reviewing Broski's and Katzell's work and conducting their own study, that AHPAT results did improve predictions of success and that it could serve "acceptably" as a uniform test for admissions consideration for allied health students. However, they softened their recommendation by noting that the admissions committees still need to consider recommendations and interviews when considering applicants (p. 138).

Zufall (1974) found that most educators continued to select students on the basis of GPA, letters of reference, college affiliations, and personality, but ascertained that the educators were also concerned that a candidate with good potential would be turned down. She observed that a battery of selective tests of proven efficacy would be most welcome. Until that could be identified, she concluded that GPA was still the most effective predictor of success.

Maynard, Larimore, and Seaton (1974) took a different approach by promoting the development and use of a student database to aid in student selection, management decision making, and program evaluation. Feeley (1975) proposed using a stepwise regression computer program to aid in the selection process.

Wise (1983) attempted to correlate success in specific preprofessional courses with success in related professional course work. He also studied the correlation of academic success in clinical chemistry with success on the chemistry section of the certification examination. He suggested that preprofessional chemistry grades, rather than either overall or science grades, be used to screen students for admission. However, Lehmann, Leiken, and Firestone (1984) were unable to predict student success in the clinical chemistry laboratory with GPA and AHPAT scores.

Jeff and West (1988) also evaluated prerequisite courses to determine which were high predictive indicators for success in the University of Alabama at Birmingham medical technology program. The greatest correlations were in the Microbiology, Mammalian Physiology, and Genetics courses. Those with the lowest correlations were General, Analytic, and Organic Chemistry, Physics, Survey of Calculus, and Computer Science. They proposed that the required prerequisite courses with low-predictive values should be considered in student selection but with less emphasis than those with higher predictive measures. They also suggested that the low-predictive performance courses should be evaluated for their necessity in the curriculum, which would allow for curriculum redesign with courses more germane to the changing role of the professional medical technologist.

Previous grade point average and completing a preprofessional CLS curriculum were determined by Thomas and Wilson (1992) to significantly predict the learning of didactic theory of the profession. Interview scores and in-residence semester units did not predict learning of either theory or of success in laboratory practice.

Weed (1996) examined 14 preadmission variables which included: an overall GPA; GPAs for biology, chemistry, math, and English; Scholastic Aptitude Test (SAT) or Graduate Record Examination (GRE) verbal and math scores; age at entry; highest academic degree at entry; whether English was spoken as the native language; and numbers of courses with D, F, and W. English as the native language, SAT/GRE math scores, SAT/GRE verbal scores, and English GPA had the highest predictive values for success in completing the medical technology program.

The importance of attaining a college degree, age of the student, and grade point average were characteristics found to be different for those who completed a program and those who were dismissed or voluntarily withdrew. Program outcomes did not appear to be affected by gender, father's educational level, enrollment status, and amount of education prior to enrollment (Laudicina, 1999a).

Predictors of Success on the Medical Technologist and the Medical Laboratory Technician Certification Examinations

As the 70s waned, researchers finally turned from almost exclusively studying predictors of program success to focusing their investigations on looking at student success in passing the national certification examination. Holt (1978) elected to study the predictive value of pre-college and college academic indicators with national certification examination scores. Ratings by work supervisors as a means of predicting both success in college and occupational success for medical laboratory technicians were also included in the investigation. He found that the top five predictors for certifying examination success were clinical grades, birth order, socio-economic level, grade point average, and age. He recommended that there be an intensive follow-up study of older students and minority students.

Wright (1982) studied the correlation between preprofessional grade point averages and the scores achieved on the ASCP certification examination by the graduates of the Board of Rhode Island Schools of Medical Technology, an organization of five Rhode Island Hospital Schools of Medical Technology and four area colleges and universities. She found that there was a significant correlation between pre-professional grade point average and the examination score.

Ahlstrom (1980) investigated whether students' grades in analogous medical laboratory technician courses and College Level Examination Program (CLEP) subject examinations in medical technology were related to the clinical chemistry, hematology, immunohematology, and microbiology sub-scores on the Board of Registry medical laboratory technician examination. Students' grades in the respective medical laboratory technician courses and the students' scores on the CLEP subject examinations were found to be significantly related to the subject-related subscores on the Board of Registry Medical Laboratory Technician Examination.

Crews (1980) studied Department of Medical Technology students at the University of Southern Mississippi to determine whether total GPA, science GPA, grades earned in select courses (MTC 302 Clinical Bacteriology I, MTC 306 Fundamentals of Hematology, and MTC309 Clinical Chemistry I), and the scores on a departmental comprehensive examination correlated with success on the national certification examination. He found that the departmental comprehensive cumulative score was the best predictor of success on the overall certification examination score.

The efficacy of five aptitude measures and two pre-professional achievement measures was examined by Lanier and Lambert (1981) to predict three academic performance measures: professional GPA, certification examination performance, and performance on a program comprehensive examination. They determined that the single best predictor of professional GPA was science GPA and that the most efficient combination was that of the Nelson-Denny Reading Test, Form A, (NDRT) Combination sub-score, comprised of a combination of vocabulary and comprehension subscores, and science GPA. The single best predictor of the national certification examination performance was the Otis Quick-Scoring Mental Ability Test, Gamma, Form C (Otis Test), whereas the single best predictor of the program comprehensive examination performance was the science GPA. The best predictive combination for both examinations was the science GPA and the Otis test score.

Love, Holter, and Krall (1982) compared the cumulative and science GPAs of students upon professional program completion with the program's comprehensive examination and the Board of Registry examination scores. They concluded that GPA was the significant predictor for both examinations: the program comprehensive examination and the Board of Registry Certification Examination. They also noted that students with GPAs below 2.5 at graduation from the program tended to score below 70% on both the program comprehensive test and the Certification Examination.

Rather than analyzing individual student predictors, Floyd (1982, 1987) took a different approach by studying whether the academic program configurations described as either '3 + 1' or '2 + 2' affected graduate performance on the ASCP medical technologist certification examination. Floyd found that student performance on the certification examination was not a function of the program type—whether '3 + 1' or '2 + 2.'

The effect of the college attended and academic program length, 3 years versus 4 years, prior to entry into a medical technology program on ASCP Board of Registry certification examination scores was investigated by Downing et al. (1982). They concluded that there was a difference in the college attended but that the length of the academic program, 3 versus 4 years prior to entry into a medical technology program, had little effect. They also noted that females performed better academically than males, but that exam scores are not sensitive to the sex of the examinee.

Aldag and Kling (1984) found that the student's age and ACT composite score were the best predictors for college GPA, whereas the college GPA and the ACT natural science score contributed to predicting the Medical Laboratory Technician Registry examination performance.

Using the Leadership Behavior Description Questionnaire (LBDQ), Blagg, Gaspartich, and Guiles (1986) studied whether two personality styles, cognitive and leadership, would contribute significantly to the ability to predict applicant success in grade point average and ASCP Board of Registry scores. As with other studies, they found the cumulative GPA was the strongest predictor of success in both the certification examination and in clinical coursework. They also found that the LBDQ consideration scale did provide a small statistically significant prediction for clinical GPA but provided a much larger contribution to the prediction of certification examination results. The authors determined that personality variables were particularly important in students with application GPAs less than 3.0. They stated that despite the fact that some of the students with lower GPAs will struggle academically through the clinical year, the personalities of some of the students helped them cope with and adapt to the stresses of the program and the challenges of the clinical practica.

Lin, Snyder, Agriesti-Johnson, and Powers (1987) designed a study to evaluate the effect of various configurations of preprofessional science courses on certification examination success and student achievement in the professional courses. They found there was no significant difference between the preprofessional science courses configurations on student achievement in either the professional courses or on the Certification Examination. They did find a correlation between the four content areas of the Certification Examination studied and the specific prerequisite chemistry course selected.

Heilman (1988, 1991) collected data on 105 students from 11 Texas community and junior colleges to determine that historically-used predictors of success can be used to predict success in medical laboratory technician programs. He utilized 11 predictor variables, including NDRT scores, ACT test scores, and pre-professional overall and science GPAs, and found that all 11 were significantly correlated with the final professional GPA. However, only 6 had a significant correlation with the medical laboratory technician certification examination score. These were the Nelson-Denny vocabulary and total scores and the ACT math, social science, natural science, and composite scores, indicating that verbal and math skills were important factors in success. Interestingly, unlike that found by other researchers, pre-professional GPA was not significantly correlated with certification examination success.

Somma (1988) was interested in a comparison of how well the Allied Health Professions Admissions Test (AHPAT), overall grade point average, and science grade point average predicted success on the Board of Registry exam as a means of assessing utility as an admission criteria to upper level medical technology programs. In his study, he determined that the AHPAT scores proved to be the best predictor of success on the examination. It was also concluded that there was no significant difference in how males, females, or different races scored on the AHPAT, the ASCP exam, or in their science or overall grade point averages. He also found that the AHPAT verbal ability subscore was both the most important and only numerical predictor of success on the ASCP exam for Blacks.

Baines (1990) studied the differences in learning outcomes in two categories of Medical Laboratory Technology (MLT) programs. One type of program used off-campus clinical experiences, usually in hospital-based laboratories; the other type used on-campus simulated laboratories. She found that there was a difference in total score between the groups, which was determined to be a higher total score for students from simulated programs, which resulted from higher scores on only one part of the examination, the chemistry subsection.

Watkins (1989) questioned the predictive relationship between coursework in an MLT program with the performance on the certification examination, the mean GPA in four courses, and the corresponding subject subtest score on the MLT certification examination. He found that the strongest single predictor was for the body fluids course. There was also a relationship between achievement on academic coursework and the subsections scores for blood banking, chemistry, hematology, immunology, and microbiology, but not for the total MLT certification examination score.

Conrad (1991) attempted to identify factors that affected traditional and nontraditional students on their performance on the ASCP Board of Registry examination. Age, family obligations, gender, whether the student worked full time or part time, nationality, entering GPA, and GPA in the professional program were analyzed. Conrad agreed with previous investigators that both entering and professional GPA were valuable predictors of a passing score on the ASCP certification examination. She also concluded that the age of the student (traditional versus nontraditional), marital status, family obligations, and whether the student was working full- or part-time did not have a significant effect on success in the program or on certification examination success. Of particular interest is that she appears to be the first researcher studying medical technology students to particularly report that international students had a higher fail rate than American-born students on the certification examination. It should be observed that her conclusion came from a population that was primarily American-born (407) with only 44 international students. Of the 22 countries/geographic areas other than the United States identified, only the following areas had more than one student from that region: Asia (3), France (2), Germany (2), India (2), Iran (12), Puerto Rico (3), and Vietnam (2). Conrad recommended that additional investigation be carried out on the high fail rate of international students.

Millstead (1992) attempted to identify personality characteristics that were related to performance when considering applicants and found that judgment, comprehension, and initiative/originality correlate highly with success on the certification examination. She also noted that there did not seem to be a significant correlation between intelligence quotient (IQ) and certification examination score.

Sultan (1992) assessed 17 students' professional-year performance variables to determine if these variables could predict the students' scores on the MT-ASCP certification examination. He was interested in the relationship between students' work in the specific subject areas of blood bank, hematology, microbiology, and clinical chemistry with the corresponding certification examination content area subscores and the relationship between the 17 predictor variables and the examination total scores. He determined that, with one exception (hematology and the combined theory and practicum hematology grade), the numerical grades in specific curriculum content areas were good predictors of both total scores on the examination and of the related subsection scores.

When using entering GPA, science GPA, final program GPA, and a program comprehensive examination score to predict a student's success on either the MT(ASCP) Board of Registry Examination or the CLS(NCA) Examination, Faubion (1993) determined that the final grade point average and the program comprehensive examination score were the best predictors of the MT(ASCP) examination, whereas the best predictor for the CLS(NCA) examination was the program comprehensive examination.

Stone (1994) examined the relationship between the rotation length, number of lecture (didactic) hours, and the type of clinical rotation. She found that there was a significant correlation between the number of lecture hours and the Board of Registry examination score. There was no significant correlation between the total number of clinical contact hours and the examination score. She also found that there was no significant correlation between the microbiology, blood bank, clinical chemistry, or immunology clinical hours and the respective subsection scores of the examination. She did find a significant correlation between the number of hematology and body fluid clinical contact hours and the scores from the respective subsections of the examination. She also determined that the curriculum configuration in which the students' clinical rotation is at the end of the classroom preparation resulted in the highest examination mean scores.

The first study to specifically examine the validity of predictors of success for minority (African-American) and non-minority (Caucasian) students in medical technology students was carried out by Handley et al. (1995). For the nonminority subgroup, the cumulative ACT score and the in-house comprehensive examination were the significant academic predictors. For the minority subgroup, the significant predictors were the final GPA and the cumulative ACT scores. The authors determined that there was a marked difference in the personal demographic variables that were predictive between the two groups. For the minority subgroup, gender, age, and curriculum were predictors. This was not the case for non-minority students for which gender and age were not significant. When using the predictive model, the authors reported a higher percentage of correct classification into examination pass and fail categories for minority students than for non-minority students.

Regarding the predictive model presented by Handley et al. (1995), Doig (1996) challenged the authors noting that although the predictive accuracy is higher for minority students, the same is not the case for non-minority students. Doig also stated that the equation was good at identifying non-minority students that would pass, but that there would be a number of students predicted to pass that would actually fail. Those students, who were expected to pass and did not, would not receive intervention that could have been beneficial for them.

Wiggers and Holton (2001) revisited whether a departmentally-constructed senior comprehensive examination had predictive merit as to the success of students on the certification examination. They found a clear demarcation between students who scored greater than 74.36% on the senior examination and those who scored below that level. Of those who scored higher, 100% passed the national MT (ASCP) Certification Examination on the first attempt. Those who scored below showed mixed results.

Goodyear and Lampe (2002, 2004) revisited the utility of the AHPAT examination as a predictor of program success and success on the national certification examination and found that the AHPAT was a better predictor of success than either the science GPA or cumulative GPA. They determined that the biology subsection of the AHPAT was the most predictive of program completion and that the verbal subsection of the AHPAT was the only significant predictor for Certification Examination success on the first attempt.

The Board of Registry Medical Technologist Certification Examination

The Board of Registry stance has been to ensure that the ASCP medical technologist examination is appropriate and fair. To do so, the validity of the examination is monitored rigorously.

In 1986, Lunz, Gaines, and Saylor conducted a concurrent validity assessment of the examination in that they evaluated the relationship between cognitive and practical performance of students in medical technology programs and the Certification Examination Total Score and the Subscores. The authors concluded:

> The correlations they found clearly support the assumption that the BOR Medical Technologist Certification Examination measures the same underlying base of knowledge and skill that the medical technology programs assess. . . .These findings support the interdependence of the educational and examination processes and establish concurrent validity between them. (pp. 98-99)

From its paper-and-pencil format, the medical technology certification examination moved exclusively to a standardized computer-adapted examination in 1995 (*The ASCP Board of Registry*, 2003). In two pilot projects in 1991 and 1992, the validity and reliability for this examination were determined ("From the Board of Registry," 1993). By June 2004, 218,784 individuals have been certified as medical technologists since 1931 ("January-June 2004 Examination Statistics," 2004).

Summarization of the Clinical Laboratory Science Literature

The search of the literature reveals a heavy focus on academic information as predictors of success both in the professional program and on the national certification examination. In most studies, grade point average was determined to be the best predictor alone or in combination with other predictors.

Tables 1 - 4 summarize the literature reviewed. Asterisks indicate variables reported as significant in some studies and not significant in others.

Review of Related Literature

Clinical Laboratory Science represents only one of many health-care disciplines that requires certification/licensure examinations. A limited review of the literature was conducted for other health-care professional areas to determine if the research findings correspond to those previously discussed. The review was not intended to be exhaustive but was directed to relevant studies.

Nursing

The literature is replete with articles addressing predictors for success in various areas of nursing practice. A number of studies have focused on the National Council Licensure Examination for Registered Nurses (NCLEX-RN) and its relationship with student scholarship and academic achievement. They have demonstrated that grades in specific courses and grade point averages (GPAs), either cumulative or in the major, have significant correlation with

Table 1

Predictors of Program Success Found to Be Significant

Type	Predictor	Study
Demographic Information	Age	Aldag & Kling, 1984 Holt, 1978 Laudicina, 1999a
	Birth order	Holt, 1978
	English as the native language	Weed, 1996
	Employed fewer hours per week	Laudicina, 1999a
	Friends more supportive of their academic activities and goals	Laudicina, 1999a
	Gender	Downing, Mann, & Tomlinson, 1982 Holt, 1978
Academic and Aptitude Information	ACE	Strassell, 1956
	Allied Health Profession Admissions Test (AHPAT)	Katzell, 1977 Leiken & Cunningham, 1980 Schimpfhauser & Broski, 1976
	American College Test (ACT)	Aldag & Kling, 1984 Heilman, 1988, 1991 Lundgren, 1968 Schimpfhauser & Broski, 1976
	Clinical grades	Holt, 1978
	English grade point average	Weed, 1996
	Flanagan Aptitude Classification Battery for a Biological Scientist	Strassell, 1956
	General Aptitude Test Battery	Williams, 1963
	Grade point average: Current	Laudicina, 1999a
	Grade point average: Pre-professional overall	Blagg, Gaspartich, & Guiles, 1986 Broski, Schimpfhauser, & Cook, 1977 Conrad, 1991 Elberfield & Love 1970 Heilman, 1988, 1991 Schimpfhauser & Broski, 1976 Thomas & Wilson, 1992 Wright, 1982
	Grade point average: Pre-professional science	Heilman, 1988 Lanier & Lambert, 1981

Table 1—*Continued.*

Type	Predictor	Study
Academic and Aptitude Information (Continued)	Guilford-Zimmerman Temperament Survey	Strassell, 1956
	High-school rank	Aldag & Kling, 1984 Holt, 1978 Lundgren, 1968
	Importance of earning a college degree	Laudicina, 1999a
	Nelson-Denny Reading Test	Heilman, 1988, 1991 Lanier & Lambert, 1981
	SAT/GRE math and verbal scores	Weed, 1996
	Select prerequisite science courses	Jeff & West, 1988
	Strong Vocational Interest Blank	McCune & Rausch, 1969

Table 2

Predictors of Program Success Not Found to Be Significant

Type	Predictor	Study
Demographic Information	Age	Conrad, 1991
	Enrollment status	Laudicina, 1999a
	Family obligations	Conrad, 1991
	Father's educational level	Laudicina, 1999a
	Gender	Laudicina, 1999a
	Marital status	Conrad, 1991
	Personality characteristics	Millstead, 1992
	Working full-time or part-time	Conrad, 1991
Academic and Aptitude Information	AHPAT	Broski, Schimpfhauser, & Cook, 1977
	Amount of education prior to enrollment	Laudicina, 1999a

Table 3

Predictors of Success on the Certification Examination Total Score or Subscores Found to Be Significant

Type	Predictor	Study
Demographic Information	Age	Handley, Hudson, Goodwin, & Lux, 1995 Holt, 1978
	Birth Order	Holt, 1978
	Gender	Handley, Hudson, Goodwin, & Lux, 1995
	Socio-economic level	Holt, 1978
	International student (have higher fail rate)	Conrad, 1991
	Personality characteristics: Cognitive style and leadership style	Blagg, Gaspartich, & Guiles, 1986
	Initiative/originality and comprehension	Millstead, 1992
Academic and Aptitude Information	ACT: Cumulative	Handley, Hudson, Goodwin, & Lux, 1995
	ACT: Mathematics, social science, natural science and composite	Heilman, 1988, 1991
	ACT: Natural science	Aldag & Kling, 1984
	AHPAT scores	Goodyear, 2004 Somma, 1988
	CLEP subject with correlating examination subscores	Ahlstrom, 1980
	Chemistry prerequisite coursework selected	Lin, Snyder, Agriesti-Johnson, & Powers, 1987
	College attended	Downing, Mann, & Tomlinson, 1982
	Curriculum prior to admission	Handley, Hudson, Goodwin,& Lux, 1995
	Departmental/program comprehensive examination: Subscore with correlating subject certification examination subscores	Crews, 1980
	Total score	Crews, 1980 Faubion, 1994 Handley Hudson, Goodwin, & Lux, 1995 Kiehn & Maehara, 1989 Sultan, 1992 Wiggers and Holton, 2001
	Didactic hours versus length of clinical contact hours —more didactic hours correlates with higher score	Stone, 1994

Table 3—*Continued.*

Type	Predictor	Study
Academic and Aptitude Information (Continued)	Grade point average: At admission	Blagg, Gaspartich, & Guiles, 1986 Conrad, 1991 Crews, 1980 Love, Holter, & Krall, 1982 Sultan,1992 Wright, 1982
	At entrance to curriculum	Crews, 1980
	Cumulative	Aldag & Kling, 1984 Goodyear, 2004 Handley, Hudson, Goodwin, & Lux, 1995 Holt, 1978 Love, Holter, & Krall, 1982 Somma, 1988 Sultan, 1992 Williams, Konecny, & Champion, 1967
	Practica courses	Sultan, 1992
	Pre-professional and professional	Sultan, 1992
	Professional year	Conrad, 1991 Faubion, 1993 Sultan, 1992
	Science at admissions	Crews, 1980 Goodyear, 2004 Lanier & Lambert, 1981 Somma, 1988
	Theory courses overall	Sultan, 1992
	Grades: Clinical grades	Holt, 1978
	Combined theory and practica grades, except Hematology, with subscores	Sultan, 1992
	Courses with correlating certification examination subscores	Ahlstrom, 1980 Crews, 1980 Sultan, 1992 Watkins, 1989
	Practica grades with correlating certification examination subscores	Sultan, 1992
	Nelson Denny Reading Test vocabulary and total	Heilman, 1988, 1991
	Otis Test	Lanier & Lambert, 1981
	Theory courses, except Hematology, with subscores	Sultan, 1992

Table 4

Predictors of Success on the Certification Examination Total Score or Subscores Not Found to Be Significant

Type	Predictor	Study
Demographic Information	Age	Conrad, 1991
	Family obligations	Conrad, 1991
	Gender	Conrad, 1991 Downing, Mann, & Tomlinson; 1982 Somma, 1988
	Marital status	Conrad, 1991
	Race	Somma, 1988
	Working full-time or part-time	Conrad, 1991
	Biology, microbiology, chemistry, and medical laboratory technician courses with total score	Watkins, 1989
Academic and Aptitude Information	Clinical contact hours for total score	Stone, 1994
	Comprehensive examination	Love, Holter, & Krall, 1982
	Grade point average:	
	Preprofessional overall	Heilman, 1988, 1991
	Preprofessional science	Heilman, 1988, 1991
	Intelligence quotient (IQ)	Millstead,1992
	Length of academic program	Downing, Mann, & Tomlinson, 1982
	Nelson Denny Reading Test	Heilman, 1988, 1991
	Previous laboratory training	Somma, 1988

examination success (Anderson, 1993; Daley, 2003; Foti & DeYoung, 1991; Horns , O'Sullivan, & Goodman, 1991; Morris, 1999; Ostrye, 2000; Roncoli, Lisanti, & Falcone, 2000; Schaal, 1990; Waterhouse, Carroll, & Beeman, 1993; Yang, Glick, & McClelland, 1987; Yin & Burger, 2003). Whitley and Chadwick (1986) determined that graduates who entered the nursing program in their study with low science and cumulative GPAs, low SAT scores, and whose cumulative GPAs during the course of nursing program lowered, were at a significantly high risk of failing the NCLEX-RN.

Science and overall GPA were found by Zaglaniczny (1991, 1992) to be predictive of the Registered Nurse Anesthesia Student (RNAS) national certification examination performance.

Demographic predictors also have been determined to have significance. Several researchers have found race (ethnicity) to be a significant predictor. Cloud-Hardaway (1988) found White graduates' mean NCLEX-RN score was greater than the average score for Black graduates. Horns et al. (1991) and Forsythe (1997) determined that there was a significant relationship between ethnicity and successful completion of the NCLEX-RN in that minorities were not as successful on the examination. Akers (1993) also reported that individuals from a minority group were less likely to complete a nursing program and pass the NCLEX-RN examination. Endres (1997) noted that foreign-born and ethnic minority graduates had greater difficulty completing the nursing curriculum and the licensing examination than did the other graduates. Nnedu (2000) showed that minority students have a lower pass rate than non-minority students and that older graduates have higher pass rates than do younger graduates, but that gender had no effect on NCLEX-RN performance. Beeson and Kissling (2001) also found nontraditional college-age students, those 23 or older, tended to have a higher passing rate than did traditional-age students.

Studies involving practical nursing programs also found that minority students did not perform as well as non-minority practical nursing students (Swift, 1989). H. P. Thompson (1989) determined that scholastic aptitude verbal test scores, career placement program reading test scores, race, and age were significant predictors of success on the licensing examination for practical nurses. Parrish (1994) determined that the youngest age group, those 17-24, and non-White students were found to have a lower-than-expected success rate in Licensed Practical Nurse programs. Lamm and McDaniel (2000) at Ivy Tech State College found that race was the only demographic variable that demonstrated a significant association with success on the NCLEX-Practical Nurse examination with more failures in the African-American group.

Auerhahn (1996) noted that the only personal characteristic found to be significantly associated with success in a master's-level Nurse Practitioner Program was ethnicity. Fullerton and Severino (1995) found that ethnicity was a factor on the national certification examination for nurse-midwifery in that White and Hispanic candidates received higher scores compared to the scores achieved by other groups.

The relationship between facility in language skills and examination success has also been pursued by researchers. Scholastic Aptitude Test verbal scores were determined to have a significant relationship with NCLEX-RN scores (Alexander, 1997; Foti & DeYoung, 1991; Schiffman, 1988; Woodham & Taube, 1986). Mathias (1983) found a low correlation with national origin but found a strong relationship between ACT English scores and grades in English for success on nursing's State Board Test Pool Examination. Carpio, O'Mara, and Hezekiah (1996) determined that Ontario Academic Credits (OAC) English was a better predictor of success in the Canadian Nurses Association Testing Service examination than that of the OAC Chemistry or the admission average obtained on other OAC subjects.

Mills, Becker, Sampel, and Pohlman (1992) noted that people with foreign education had lower probabilities of passing the NCLEX-RN. They identified two issues which they contend contribute to this. Struggles with the English language cause students for whom English is a second language to be more likely to have difficulty in course work. However, Mills et al. believe this is only part of the issue. They also contend that the objective testing methods (multiple-choice question format) used also cause challenges even for foreign-educated students from English-speaking countries where examinations are a series of essay questions.

Arathuzik and Aber (1998) wrote, "Students who did not speak English as their primary language at home did not do as well on the NCLEX-RN. These students may not have the linguistic skills needed to comprehend English thoroughly enough to pass the NCLEX-RN" (p. 124).

Manifold and Rambur (2001) in a study involving American Indian nursing students noted that for some American Indian students, even when English, not a traditional native language, is used in the home, the phrases and spoken words are not interpreted in the same way at home as in the collegiate setting. Because standard English format is used for examinations, Manifold and Rambur contend that the students may have difficulty in being able to analyze and comprehend what the examination questions are asking and what is meant.

Foti and DeYoung (1991) supported the value of schools designing programs to increase students' verbal abilities. Cunningham, Stacciarini, and Towle (2004) recognized that students who speak English as a second language have an additional challenge to overcome for success on the NCLEX-RN. The authors present strategies specifically designed for those students.

Other Health-Care Professions

As with the clinical laboratory science and nursing disciplines, eligibility for entrance into the health-care profession involves successful completion of some type of licensure or certification examination. Samples from the literature for other disciplines concerning predictors of examination success for the relevant discipline examinations follow.

Chiropractic

Zhang (1999) found that students' entry-level GPA had a low to moderate correlation with the students' National Board of Chiropractic Examiners (NBCE) scores and that entry-level GPA is a better predictor of class performance than examination scores.

Green, Johnson, and McCarthy (2003) determined there was no statistically significant difference in matriculating grade point average for students from English-speaking countries when compared to students from non-English-speaking countries. However, those born in English-speaking countries had a significantly higher cumulative first-year grade point average.

Dental Hygiene

Edenfield and Hansen (2000) found that the average of early course grades in the program and the mock board dental hygiene examination score correlate with passing the National Board Dental Hygiene Examination (NBDHE).

Shannon (1989) purported that the best predictors of pass/fail status on the NBDHE are dental hygiene GPA, ACT social studies scores, and grades in anatomy, general psychology, and sociology.

Physical Therapist

Dockter (2001) determined that core course GPA and the first-year GPA significantly correlate with the National Physical Therapy Licensing Examination (NPTE) success and found that the best predictor was the first-year physical therapy school GPA.

Physician Assistant

Oakes, MacLaren, Gorie, and Funstuen (1999) found that four demographic variables were significantly correlated with the Physician Assistant National Certifying Examination (PANCE) success. All academic performance variables were also significant. The clinical performance variable also emerged as moderately significant in predicting PANCE scores.

Physicians (Medical School)

Lipton, Huxham, and Hamilton (1975) established that general mental ability, reading comprehension, and verbal skills are significant predictors of achievement in medical school. They also noted that students of foreign origin who spoke English as a second language tended to perform better in essay-type rather than multiple-choice tests. They also noted that the students' "overall performance was lower than would have been expected from their other personality traits including their verbal skills" (p. 215).

Roth, Riley, Brandt, and Seibel (1996) determined that the verbal section of the SAT and the Skills Analysis: Reading Section of the Medical College Admissions Test were the single variables most highly predictive of United States Medical Licensing Examination Step 2 performance. They also noted that the SAT verbal score was strongly related to premedical GPA and suggested that high verbal aptitude is helpful to students when they are working with complex scientific concepts.

Ben-David et al. (1999) established an association between English language proficiency and a patient-based clinical skills examination that was being developed for potential use in the United States Medical Licensing Examination. They noted that an individual's English fluency may affect eventual examination success.

Radiologic Technologist

Barry (1983) determined that high-school GPA and the ACT composite, mathematics, natural science, English, and social science scores were all predictors for success on the American Registry of Radiologic Technologists (ARRT) examination.

Performance on a simulated registry and GPA proved to be statistically significant predictors of success on the ARRT as found by Macomber and Sanders (1984).

Respiratory Therapist

Thompkins and Harkins (1990) found that the Health Occupations Aptitude Examination vocational adjustment scores, high-school quartile, and the number of years since attending formal education were useful in predicting student success in a nontraditional respiratory therapy program. They also determined that the student's program average was helpful in predicting the student's success on the credentialing examination.

In Conclusion

The literature is replete with studies trying to find valid predictors of program and certification examination success. Yet it is evident that none of these are complete in and of themselves.

Several researchers have touched on the issue of the impact of verbal skills in addition to those of aptitude and academic predictors on certification examination success. Somma (1988) stated:

> The factor of race, although limited by the low sample population in some categories, should not be overlooked. The data suggested that further research into what may be an important variable is certainly warranted. The fact that the verbal ability subscore of the AHPAT proved to be not only the most important predictor of success on the ASCP exam for blacks, it also proved to be the only numerical predictor that entered. This could have far reaching consequences if this outcome is validated in a large study on minority populations. It could cause a re-evaluation of present numerical criteria and place more emphasis on the importance of communication skills in minorities and less

> reliance upon their mathematic and science backgrounds. It could help redirect efforts at remediation in those marginally qualified or those unqualified who would reapply at some future time. For the problem may be not in their science or mathematic backgrounds, but a deficiency in communication skills. (pp. 93-94)

Conrad (1991) noted the high failure rate that international students had in the national examination whereas Handley et al. (1995) determined a clear difference in the predictors for minority and nonminority students. Weed (1996) found that native language was the best predictor for successful completion of the program. Goodyear and Lampe (2004) identified the importance of the verbal subsection of the AHPAT to certification examination success.

Although the aptitude predictors such as ACT and AHPAT have been documented to have utility, in a student population that includes a number of nontraditional, post-baccalaureate students who come from other countries, these examinations results are often not available.

Despite an exhaustive review of the literature, which included the relevant dissertations and journal articles written since the inception of the medical technologist certification examination, to date there does not appear to be a study that has included all of the previous identified demographic and academic predictors for an ethnically and racially-diverse population, for minority and nonminority, for international and American-born, and for English as a first or second language. This study serves to address this deficiency.

Heilman (1988, 1991) stated it well when he recommended that the quality of the predictors used to assess applicants should be examined by each individual program for the needs of their own programs. Therefore, this study was undertaken.

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

This study utilized data retrieved from the permanent records of the graduates of the Andrews University Program for Clinical Laboratory Sciences (hereinafter referred to as the Program) maintained by the Department of Clinical and Laboratory Sciences, Andrews University, Berrien Springs, Michigan. The documentation from the files used included data from the student's application to the Program, admissions grade point average, admissions science grade point average, grades from the final transcript, and American Society for Clinical Pathology Board of Registry Medical Technologist Certification Examination (hereinafter referred to as the Certification Examination) Total Score, subscores, and pass or failure reported to the Program in their Board of Registry Program Performance Report Summary. Demographic information not included on some individuals' applications to the Program was retrieved from the University's permanent records of those persons.

Subjects

All graduates of the Program were included in the study from the first graduating class of 1989 to the present, including graduates of the class of 2004, $n = 254$. Of the graduates, 21 were eliminated from the study because they did not write, or have not yet written, the Certification Examination, or did take the examination but did not release their scores to the University. Statistical data were gathered for the graduates with reported scores, $n = 233$. Only the scores from the first time of writing the Certification Examination were used. No repeat examination scores for those failing on the first attempt were included in the analyses.

Measures

Grade point averages were reported on a 4.00 grade point scale using the following definitions: A=4.00, A-=3.67, B+=3.33, B=3.00, B-=2.67, C+=2.33, C=2.00, C-=1.67, D=1.00, and F=0.

Certification Examination Total Score and Subscores are reported as scaled score values, with the exception of the 1989-1993 Subscore results. During those years, the Subscore results were reported as percentages. These were converted to *z* scores and then to equivalent scaled scores for analysis. The relevant Board of Registry (BOR) examination periods were from August 1989 to January-June 2004. The national mean scores during that time frame ranged from 416.56- 475.41, with standard deviations from 86.79-109.11. The range of scores was from 36-949, with a passing score designated by the BOR as 400. The percentage of all individuals taking the examination who passed ranged from 54% to 81%, while the percentage of those taking the examination for the first time was from 70% to 87%. The reported examination statistics for each examination period are recorded in Table 65 in Appendix J.

Procedures

Data were transferred from the individual graduate's permanent record into Statistical Package for the Social Sciences (SPSS) version 12.0.1, an electronic software for statistical analysis. The graduate's name and University identification number were used to facilitate accuracy of data retrieval from the multiple documents required and for verification of the accuracy of data entry into SPSS. However, once the entry of data was complete, confidentiality was preserved by removing specific individual graduate identification.

Data analyzed for each graduate was in three areas: (a) demographic information, (b) academic measures, and (c) Board of Registry Program Performance Report. The variables considered were:

Demographic information:

1. Gender

2. Ethnicity as self-reported in definitions established by the National Center for Educational Statistics (White, Black, Asian, Hispanic, Pacific Islander or Native Hawaiian, American Indian or Native Alaskan)

3. English spoken as a first language or second language

4. Geographic region of birth country (Regions are identified as: United States of America, Bermuda and Canada, Caribbean and West Indies, Europe, Africa, Near and Middle East, Eurasia, Southern Asian, Southeast Asia and South Pacific Islands, and Northern Asia) (See Table 18 in Appendix B.)

5. First degree student or post-baccalaureate

Academic measures:

6. At time of admission to the Program, which is after the completion of the fall semester of the Junior Year for first-degree students

   a. Cumulative grade point average

   b. Cumulative science grade point average

7. Prerequisite sciences and math GPAs, which were calculated to include all relevant courses taken before the beginning of the clinical program

   a. Biology GPA, comprised of the biological science content course grades

   b. General Chemistry GPA, comprised of the academic year sequence grades

   c. Organic Chemistry GPA, comprised of the academic year sequence grades

d. Mathematics GPA, comprised of all mathematics or statistics course grades

8. Prerequisite clinical laboratory science fundamentals course grades and GPA:

    a. Fundamentals of Clinical Chemistry grade

    b. Fundamentals of Clinical Microbiology grade

    c. Fundamentals of Hematology grade

    d. Fundamentals of Immunohematology grade

    e. Principles of Immunology grade

    f. Preclinical courses GPA, of the courses listed above: 8a - 8e.

9. Clinical-year didactic GPAs, of both fall and winter/spring term didactic courses grades, and individual course grades (See Table 64 in Appendix I.)

    a. Immunohematology and Transfusion Medicine (blood banking) GPA

    b. Hematology and Hemostasis GPA

    c. Clinical Immunology grade

    d. Clinical Chemistry GPA

    e. Clinical Microbiology, Mycology, Parasitology, and Virology GPA

    f. Clinical Microscopy (Body Fluids) grade

    g. Laboratory Management grade

    h. Clinical-year didactic GPA, of the courses and GPAs listed above: 9a - 9g.

10. Clinical-year practica grades and GPA:

    a. Immunohematology Practicum grade

    b. Hematology and Hemostasis Practicum grade

    c. Clinical Immunology Practicum grade

    d. Clinical Chemistry Practicum grade

e. Clinical Microbiology, Mycology, Parasitology, and Virology Practicum grade

f. Clinical Microscopy Practicum grade

g. Independent Project grade

h. Clinical-year practica GPA, a calculation of the courses listed above: 10a-10g

11. Clinical-year cumulative GPA, includes all didactic and practica course grades

12. Cumulative graduating GPA for degree

Board of Registry Program Performance Report Medical Technologist Certification Examination scores:

13. Total scaled scores

14. Scaled subscores:

a. Blood Bank

b. Chemistry

c. Hematology

d. Immunology

e. Microbiology

f. Body fluids.

The Laboratory Operations Subscore was not included in this study because it was introduced in 2003 as a new edition to the Certification Examination. Insufficient numbers of the Program Graduates have taken this examination component to yield valid results.

Research Hypotheses and Methods of Analysis

This study was designed to answer the following questions for an ethnically and racially-diverse student population. These questions were first addressed for the graduates as a complete group. Then the questions were addressed separately by demographic characteristics of the graduates by gender, ethnicity, geographic region of birth country, English as a first or second language, and whether the student was completing a first degree or was attending as a post-baccalaureate student.

Question 1: Is there a relationship between student demographic characteristics and success on the Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject subscores?

This question was addressed using the following null hypothesis:

Hypothesis 1: There is no relationship between student demographic characteristics and success on the Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject subscores.

This hypothesis was tested by using chi square and ANOVA analyses.

Question 2: Is there a relationship between academic measures and success on the Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

This question was addressed by using the following null hypothesis:

Hypothesis 2: There is no correlation between academic measures and success on the Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores.

This hypothesis was tested by using ANOVA and Pearson product-moment correlations.

Question 3: Is there a combination of academic measures that may be a predictor of success on the Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

This question was addressed by using the following null hypothesis:

Hypothesis 3: There is no combination of academic measures which may be a predictor of success on the Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject subscores.

This hypothesis was tested by using multiple regression analysis.

All hypotheses were tested with $\alpha = .05$.

CHAPTER 4

RESULTS

Introduction

Chapter 4 presents the results of the study undertaken to address the utility of various demographic and academic measures as predictors of success for the American Society for Clinical Pathology Board of Registry Medical Technology Certification Examination (Certification Examination) and to assess those measures for relevance to an ethnically and racially-diverse student population.

Presentation of the Subjects

The subjects are the 233 graduates who completed the Certification Examination and released their scores. This includes 99 males and 134 females; 62 Whites and 171 minority (77 Blacks, 51 Asians, 20 Hispanics, and 23 Pacific Islanders); 98 born in the United States and 135 born in 53 different birth countries (see Table 17 in Appendix B); 152 who speak English as a first language and 81 who do not; and 196 who were completing their first degree while in the Program and 37 who were post-baccalaureate.

Since this study involved a large number of variables, the probability that many subjects would not have data for all variables was of concern. For chi square, analysis of variance, correlations, and regression analyses, it was decided not to delete a subject from all analyses due to some missing data or to compensate for missing data with a calculated average. Listwise elimination of missing data was used separately for each analysis. The "*n*"varied from 205 to

233. Care was taken to ensure that the varying numbers do not compromise the various analyses or their interpretations.

Organization of Chapter

This chapter is organized in the order of the research questions posed. Statistical significance is established at .05. In cases where significance is achieved at the .01 level, it will be noted in the text. Because the *p* value is not reported in the tables featuring correlation analyses, the significance level is denoted by asterisks: one for .05, and two for .01.

Question 1

Is there a relationship between student demographic characteristics and success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Chi square analysis was performed to assess relationship between the five demographic attributes of the graduates under consideration: gender, ethnicity, geographic region of birth, English spoken as a first or second language, and completion of first degree while in the Program or attending as a post-baccalaureate, with passing or failing the Certification Examination on the first attempt. Table 5 presents the chi square analysis results.

As shown, gender and ethnicity were not found to be significant. Whether the individuals were earning a first degree or second was very close to significance with a $p = .051$. Significance was found for geographic region of birth with pass percentages ranging from the lowest group, Inter America and South America at 14.3%, to Southern Asia at 85.7%. It should be noted that the *n*'s for these two groups and for Europe are small. However, because there are such marked differences in passing and failing both between these groups and when compared to other groups, these geographic regional groups were retained. Additionally, when these three groups were removed from the data and the chi square was rerun, significance was lost. Hence, the effect of the presence of these groups is important.

English as a first or second language demonstrated significance at the .01 level, with individuals speaking English as a first language passing the examination 22.2% higher than those who speak English as a second language.

Table 5

Chi Square Results of Demographic Characteristics by Pass/Fail

	Pass		Fail				
	n	%	*n*	%	Total	χ^2	*p*
Total	143	61.4	90	38.6	233		
Gender						0.043	.836
Male	60	60.6	39	39.4	99		
Female	83	61.9	51	38.1	134		
Ethnicity						8.845	.065
White	47	75.8	15	24.2	62		
Black	43	55.8	34	44.2	77		
Asian	30	58.8	21	41.2	51		
Hispanic	9	45.0	11	55.0	20		
Pacific Islander	14	60.9	9	39.1	23		
Geographic						15.837	.045
USA	64	65.3	34	34.7	98		
Canada & Bermuda	12	75.0	3	25.0	16		
Caribbean & West Indies	26	63.4	15	36.6	41		
Inter America & South America	1	14.3	6	85.7	7		
Europe	5	83.3	1	16.7	6		
Africa	6	40.0	9	60.0	15		
Southern Asia	6	85.7	1	14.3	7		
Southeast Asia & Pacific Islands	13	50.0	13	50.0	26		
Northern Asia	10	58.8	7	41.2	17		
English as a First Language						10.951	.001
English as a First Language	105	69.1	47	30.9	152		
English as a Second Language	38	46.9	43	53.1	81		
First Degree						3.795	.051
First degree	115	58.7	81	41.3	196		
Second degree	28	75.7	9	24.3	37		

Analysis of variance was performed to examine the relationship between the demographic attributes and the Certification Examination Total Score and six examination Subscores: Blood Bank, Chemistry, Hematology, Immunology, Microbiology, and Body Fluids (See Tables 6 - 10).

Gender showed significance only for the Immunology Subscore, in which the mean for females was 45 points higher than that achieved by the males (458.80 versus 413.60 respectively). (See Table 6.)

Table 6

ANOVA Analysis of Certification Examination Total Score and Subscores With Gender

Certification Examination	Gender	*n*	Mean	*SD*	*F*	*p*
Total Score	Total	233	431.91	93.88	0.001	.973
	Male	99	432.16	93.26		
	Female	134	431.73	94.68		
Blood Bank Subscore	Total	233	482.05	147.30	0.000	.986
	Male	99	482.55	156.98		
	Female	134	481.90	140.32		
Chemistry Subscore	Total	233	422.26	117.48	1.474	.226
	Male	99	433.12	112.01		
	Female	134	414.24	121.15		
Hematology Subscore	Total	233	413.84	139.27	0.654	.419
	Male	99	422.43	148.04		
	Female	134	407.50	132.63		
Immunology Subscore	Total	233	439.59	149.83	5.278	.022
	Male	99	413.60	144.21		
	Female	134	458.80	151.54		
Microbiology Subscore	Total	233	436.97	125.68	1.160	.283
	Male	99	426.66	119.05		
	Female	134	444.59	130.28		
Body Fluids Subscore	Total	233	404.74	162.90	0.001	.977
	Male	99	404.38	152.59		
	Female	134	405.01	170.67		

As shown in Table 7, there were significant differences for ethnicity with the Total Score and all Subscores. All were found to be significant at the .01 level with the exception of the Body Fluids Subscore, which was significant at the .05 level. In all cases, the means achieved by Whites were higher than those of the other ethnic groups.

The Student-Newman-Keuls (S-N-K) post hoc test was performed on all analyses that showed significance to provide a closer look at any contrasts among the ethnic groups. The significance differences found on the S-N-K test can be summarized as follows:

1. *Certification Examination Total Score*: The mean for Whites, 479.58, was higher than the other S-N-K grouping composed of the other four ethnic subgroups. The mean for Whites was 46.01 points higher than the next highest mean, that of the Pacific Islanders, 433.57.

2. *Blood Bank Subscore*: The ANOVA analysis found a significant difference between the groups. Although the power of the S-N-K post hoc test was not able to distinguish between the groups, there were two distinct groupings that were observed. The means achieved by Hispanics, Blacks, and Asians ranged from 446.09 to 459.06, whereas the means achieved by Pacific Islanders and Whites were 519.45 and 534.77, a difference of over 60 points.

3. *Immunology Subscore*: The same situation occurred for this Subscore with the ANOVA and S-N-K post hoc test as occurred with the Blood Bank analyses. Blacks', Pacific Islanders', Hispanics', and Asians' mean scores were 408.76, 409.65, 421.56, and 438.20, whereas the mean score achieved by Whites was 495.95, a difference of over 57 points from the next highest score.

4. *Chemistry Subscore*: Three groupings occurred. The mean score for Whites was 486.63, and 437.17 for Pacific Islanders. A second group was composed of Pacific Islanders, Blacks, 400.06, and Asians, 398.89. Blacks, Asians, and Hispanics, 350.62, comprised the third.

Table 7

ANOVA Analysis of Certification Examination Total Score and Subscores With Ethnicity

Certification Examination	Ethnicity	*n*	Mean	*SD*	*F*	*p*
Total Score	Total	233	431.91	93.88	6.979	.000
	White	62	479.58	101.06		
	Black	77	411.70	89.23		
	Asian	51	422.59	80.25		
	Hispanic	20	383.85	82.71		
	Pacific Islander	23	433.57	80.21		
Blood Bank Subscore	Total	233	482.05	147.30	3.900	.004
	White	62	534.77	148.86		
	Black	77	452.99	142.16		
	Asian	51	459.06	142.22		
	Hispanic	20	446.09	140.90		
	Pacific Islander	23	519.45	140.64		
Chemistry Subscore	Total	233	422.26	117.48	8.853	.000
	White	62	486.63	138.41		
	Black	77	400.06	87.84		
	Asian	51	398.89	93.48		
	Hispanic	20	350.62	126.79		
	Pacific Islander	23	437.17	111.60		
Hematology Subscore	Total	233	413.84	139.27	4.231	.003
	White	62	456.43	155.08		
	Black	77	392.72	134.07		
	Asian	51	421.99	125.80		
	Hispanic	20	325.57	113.39		
	Pacific Islander	23	428.45	120.64		
Immunology Subscore	Total	233	439.59	149.83	3.451	.009
	White	62	495.95	153.96		
	Black	77	408.76	142.55		
	Asian	51	438.20	163.10		
	Hispanic	20	421.56	135.18		
	Pacific Islander	23	409.65	105.22		
Microbiology Subscore	Total	233	436.97	125.68	3.744	.006
	White	62	477.94	135.44		
	Black	77	436.66	120.79		
	Asian	51	432.31	124.82		
	Hispanic	20	384.03	106.13		
	Pacific Islander	23	383.96	99.48		
Body Fluids Subscore	Total	233	404.74	162.90	2.631	.035
	White	62	448.64	175.69		
	Black	77	381.87	149.44		
	Asian	51	399.19	182.27		
	Hispanic	20	337.37	127.49		
	Pacific Islander	23	433.88	123.29		

Therefore, Whites were higher than Blacks, Asians, and Hispanics. Pacific Islanders were higher than Hispanics.

5. *Hematology Subscore*: The mean of Hispanics, 325.57, was significantly lower than the other group composed of Whites, with a mean of 456.43, Pacific Islanders, 428.45, Asians, 421.99, and Blacks, 392.72.

6. *Microbiology Subscore*: Two groupings occurred. The mean achieved by Hispanics, 384.03, and Pacific Islanders, 383.96, was much lower than that of Whites, 477.94. Asians, 432.31, and Blacks, 436.66, were part of both groupings.

7. *Body Fluids Subscore*: The means for Hispanics, 337.37, was 111.27 points lower than that achieved by Whites, 448.64. Blacks, 381.87, Asians, 399.19, and Pacific Islanders, 433.88, were present in both S-N-K groupings.

The ANOVA results of geographic region of birth with the Certification Examination scores are shown in Table 8. Only the differences between the geographic groups for the Total Score and the Blood Bank and Microbiology Subscores were significant at $p = .05$.

S-N-K was performed on the three analyses that showed significance. In all three cases, it was found that there was a higher mean score achieved by those from Southern Asia than those from Inter and South America. For Total Score, the mean for the Southern Asia subgroup, 488.57, was 143.57 points higher than that achieved by Inter and South America, 345.00. It should also be noted that the means for two of the groups, Inter and South America and Africa, were below the established pass score of 400.

For the Blood Bank Subscore, the Southern Asia mean, 583.57, was 207.34 points higher than that of the Inter and South America group, 376.23.

For the Microbiology Subscore, the Inter and South America mean, 319.25, was 237.67 points lower than the Southern Asia mean, 556.92.

Table 8

ANOVA Analysis of Certification Examination Total Score and Subscores With Geographic Region of Birth

Certification Examination	Geographic Region of Birth	*n*	Mean	*SD*	*F*	*p*
Total Score	Total	233	431.91	93.88	2.266	.024
	USA	98	447.59	102.12		
	Canada & Bermuda	16	440.69	75.32		
	Caribbean & West Indies	41	429.34	97.23		
	Inter America & South America	7	345.00	72.45		
	Europe	6	454.67	111.42		
	Africa	15	389.27	71.45		
	Southern Asia	7	488.57	61.17		
	Southeast Asia & Pacific Islands	26	403.54	79.74		
	Northern Asia	17	424.94	66.36		
Blood Bank Subscore	Total	233	482.05	147.30	1.998	.048
	USA	98	506.66	147.44		
	Canada & Bermuda	16	466.33	138.28		
	Caribbean & West Indies	41	487.61	163.75		
	Inter America & South America	7	376.23	153.68		
	Europe	6	492.90	81.03		
	Africa	15	413.55	121.10		
	Southern Asia	7	583.57	154.16		
	Southeast Asia & Pacific Islands	26	442.08	136.79		
	Northern Asia	17	481.08	122.53		
Chemistry Subscore	Total	233	422.26	117.48	1.519	.151
	USA	98	442.41	130.38'		
	Canada & Bermuda	16	446.11	124.03		
	Caribbean & West Indies	41	410.84	103.06		
	Inter America & South America	7	314.75	128.37		
	Europe	6	410.69	157.64		
	Africa	15	389.41	90.73		
	Southern Asia	7	428.90	109.70		
	Southeast Asia & Pacific Islands	26	400.62	95.65		
	Northern Asia	17	418.92	76.28		
Hematology Subscore	Total	233	413.84	139.27	1.569	.135
	USA	98	419.24	152.57		
	Canada & Bermuda	16	445.02	119.95		
	Caribbean & West Indies	41	403.30	142.13		
	Inter America & South America	7	283.32	116.79		
	Europe	6	500.09	105.61		
	Africa	15	383.52	120.11		
	Southern Asia	7	482.37	149.21		
	Southeast Asia & Pacific Islands	26	400.75	121.46		
	Northern Asia	17	420.64	92.68		

Table 8—*Continued.*

Certification Examination	Geographic Region of Birth	*n*	Mean	*SD*	*F*	*p*
Immunology Subscore	Total	233	439.59	149.33	1.143	.335
	USA	98	443.75	166.60		
	Canada & Bermuda	16	396.38	127.58		
	Caribbean & West Indies	41	451.22	139.30		
	Inter America & South America	7	363.53	140.17		
	Europe	6	516.52	174.39		
	Africa	15	416.90	149.36		
	Southern Asia	7	542.73	162.14		
	Southeast Asia & Pacific Islands	26	420.95	98.56		
	Northern Asia	17	438.48	138.87		
Microbiology Subscore	Total	233	436.97	125.68	2.162	.031
	USA	98	447.08	124.68		
	Canada & Bermuda	16	424.84	114.24		
	Caribbean & West Indies	41	448.41	129.24		
	Inter America & South America	7	319.25	111.10		
	Europe	6	461.73	160.25		
	Africa	15	425.71	91.58		
	Southern Asia	7	556.92	69.37		
	Southeast Asia & Pacific Islands	26	399.26	133.25		
	Northern Asia	17	420.48	121.81		
Body Fluids Subscore	Total	233	404.74	162.90	1.850	.069
	USA	98	419.97	153.98		
	Canada & Bermuda	16	430.01	165.48		
	Caribbean & West Indies	41	411.87	158.97		
	Inter America & South America	7	279.52	106.30		
	Europe	6	407.55	153.02		
	Africa	15	313.58	127.41		
	Southern Asia	7	403.99	143.72		
	Southeast Asia & Pacific Islands	26	364.51	157.76		
	Northern Asia	17	468.87	236.51		

Figure 1 depicts the box plots of the Certification Examination Total Score Medians, Quartiles, and Ranges of scores by geographic regions of birth of the examinees. The numbers above or below the box plots indicate the SPSS identification numbers of the individuals who are statistical outliers.

For the Southern Asian and Inter and South America subgroups, both the interquartile range and range of scores are much narrower than those of the other subgroups. These two regions also present the highest scores, Southern Asian, and the lowest, Inter and South America. The subgroups of Canada and Bermuda, Europe, and Northern Asia have very skewed distribution with a low median score within the 75 - 25 percentile range. The Caribbean and West Indies subgroup has the widest interquartile range with a range of score almost as wide as that of the USA subgroup.

Table 9 shows the results comparing students with English as a first or second language. Differences on the Total Score and four Subscores — Blood Bank, Chemistry, Microbiology, and Body Fluids — were significant at the .01 level with mean scores higher for English as a first language by 44 to 71 points. The Hematology Subscore was significant at the .05 level, while the Immunology Subscore result was not significant. It should also be noted that in the English as a second language group while the Total Score mean is just above the examination pass-fail cut-off level of 400 at 400.04, the mean scores for four of the Subscores were below 400. These were Chemistry (393.80), Hematology (383.76), Microbiology (397.67), and Body Fluids (364.95).

The results in Table 10 feature the comparison of exam results for individuals who had attended the program to complete their first degrees with those who had attended as a post-baccalaureate. It reveals that the difference in the Total Score means between the two groups was

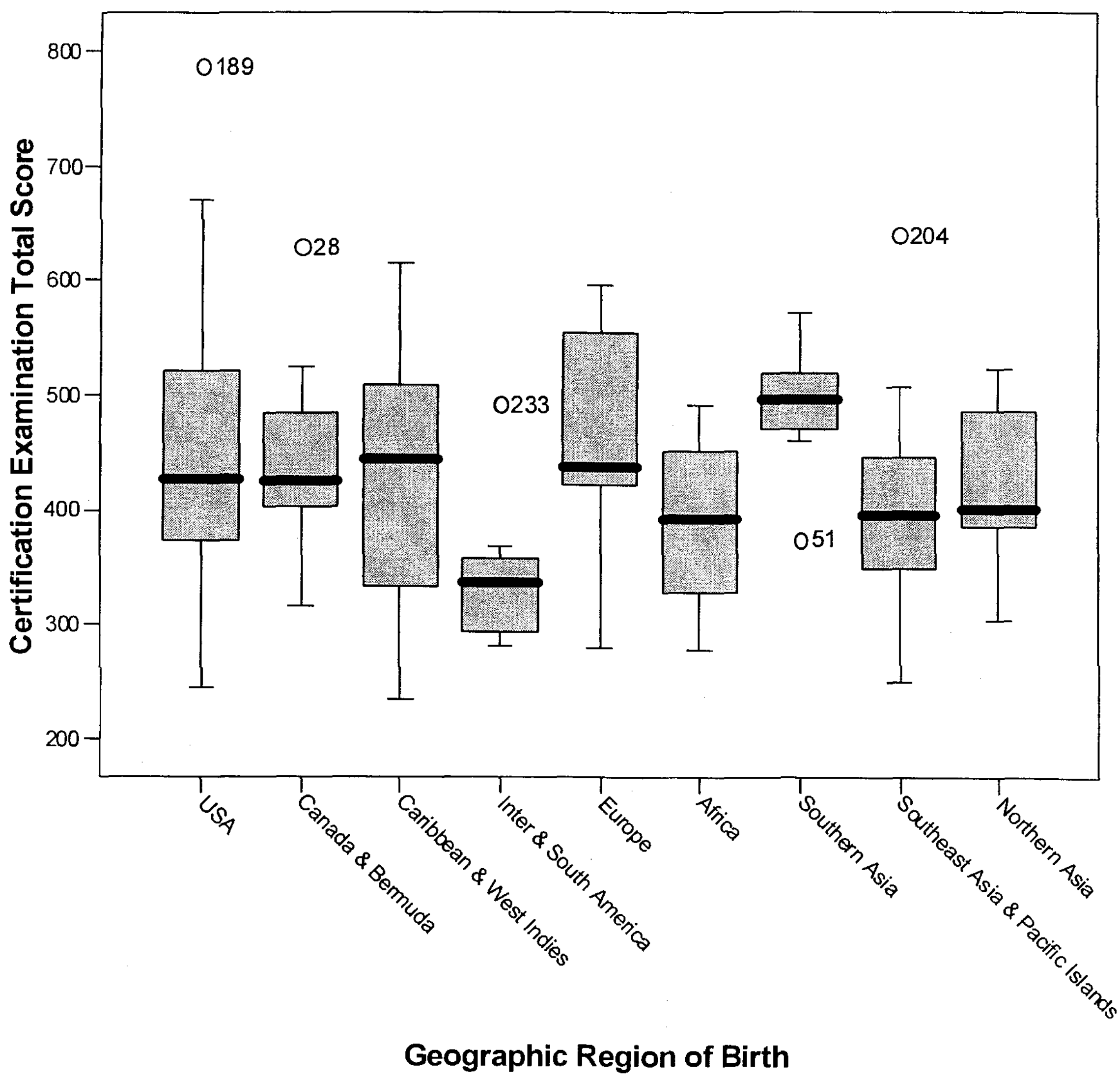

Figure 1. Certification Examination Total Score box plots by geographic region of birth.

Table 9

ANOVA Analysis of Certification Examination Total Score and Subscores With English as a First or Second Language

Certification Examination	English as a First or Second Language	*n*	Mean	*SD*	*F*	*p*
Total Score	Total	233	431.91	93.88	15.191	.000
	First Language	152	448.90	95.76		
	Second Language	81	400.04	81.70		
Blood Bank Subscore	Total	233	482.05	147.30	13.273	.000
	First Language	152	507.06	148.70		
	Second Language	81	435.12	133.30		
Chemistry Subscore	Total	233	422.26	117.48	7.490	.007
	First Language	152	437.42	122.73		
	Second Language	81	393.80	101.67		
Hematology Subscore	Total	233	413.84	139.27	5.914	.016
	First Language	152	429.87	143.76		
	Second Language	81	383.76	125.85		
Immunology Subscore	Total	233	439.59	149.83	.444	.506
	First Language	152	444.37	155.44		
	Second Language	81	430.62	139.19		
Microbiology Subscore	Total	233	436.97	125.68	12.759	.000
	First Language	152	457.92	123.75		
	Second Language	81	397.67	120.43		
Body Fluids Subscore	Total	233	404.74	162.90	7.619	.006
	First Language	152	425.95	152.46		
	Second Language	81	364.95	175.00		

Table 10

ANOVA Analysis of Certification Examination Total Score and Subscores With First Degree or Post-Baccalaureate Status

Certification Examination	First Degree or Post-Baccalaureate Status	*n*	Mean	*SD*	*F*	*p*
Total Score	Total	233	431.91	93.88	11.611	.001
	First Degree	196	423.01	89.51		
	Post Baccalaureate	37	479.08	103.38		
Blood Bank Subscore	Total	233	482.05	147.30	2.528	.113
	First Degree	196	475.40	146.85		
	Post Baccalaureate	37	517.25	146.65		
Chemistry Subscore	Total	233	422.26	117.48	9.346	.002
	First Degree	196	412.22	112.16		
	Post Baccalaureate	37	475.46	131.67		
Hematology Subscore	Total	233	413.84	139.27	2.897	.090
	First Degree	196	407.12	132.92		
	Post Baccalaureate	37	449.44	166.58		
Immunology Subscore	Total	233	439.59	149.83	6.398	.012
	First Degree	196	428.93	150.97		
	Post Baccalaureate	37	496.08	131.62		
Microbiology Subscore	Total	233	436.97	125.68	7.165	.008
	First Degree	196	427.52	124.98		
	Post Baccalaureate	37	487.04	118.86		
Body Fluids Subscore	Total	233	404.74	162.90	9.375	.002
	First Degree	196	390.80	148.11		
	Post Baccalaureate	37	478.63	213.33		

significant at the .01 level with post-baccalaureates scoring 56.07 higher than those completing a first degree. Chemistry, Immunology, Microbiology, and Body Fluids Subscores were significant at the .05 level with post-baccalaureate mean scores higher by 59 to 87 points. Differences on the Blood Bank and Hematology Subscores were not significant. In all analyses the post-baccalaureate mean scores were higher, but the difference was only significant in five of the eight analyses.

The box plots in Figure 2 summarize the Certification Examination Total Score Medians, Quartiles, and Range for the demographic subgroups. The numbers above or below the box plots indicate the SPSS identification numbers of the individuals who are statistical outliers. The geographic regions of birth have been grouped into those born in the United States of America and those born outside the United States.

The post-baccalaureate, White, English as a first language, and born in the United States subgroups have higher scores than other demographic subgroups.

Clearly there were marked differences between groups based on ethnicity, English as a first or second language, and first degree or post-baccalaureate status on the Certification Examination Total Score and Subscores and with passing or failing. Geographic regions of birth showed fewer differences of which none were significant at the .01 level. Gender was significant only for the Immunology Subscore. Table 11 summarizes the findings.

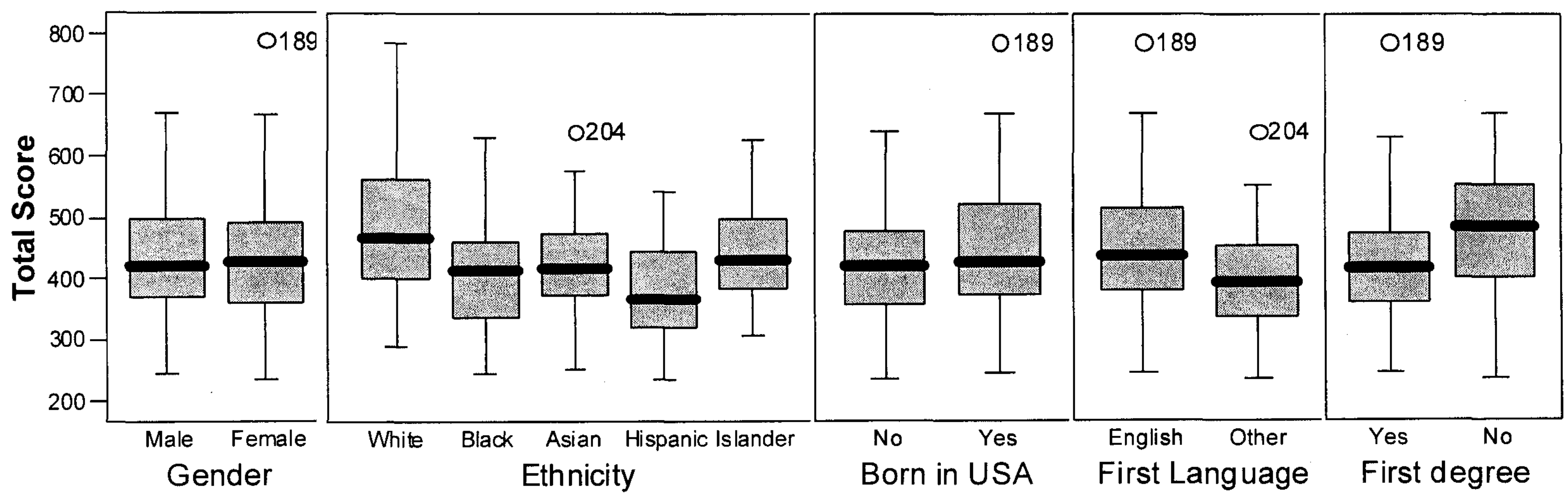

Figure 2. Certification Examination Total Score box plots by demographic characteristics.

Table 11

Significant Differences on Certification Examination Scores for Demographic Characteristics

	Demographic Characteristics				
Certification Examination	Gender	Ethnicity	Geographic Region of Birth	English as a First Language	First degree or Post-baccalaureate
Total Score		**	*	**	**
Pass/Fail			*	**	
Blood Bank Subscore		**	*	**	
Chemistry Subscore		**		**	**
Hematology Subscore		**		*	
Immunology Subscore	*	**			*
Microbiology Subscore		**	*	**	**
Body Fluids Subscore		*		**	**

*Significant at the .05 level. **Significant at the .01 level.

Question 2

Question 2: Is there a relationship between academic measures and success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Both analysis of variance and Pearson correlations were performed to address this question. Pearson correlations were performed between all academic measures variables and the Total Score. Table 12 presents those results.

Of the 31 academic measures variables analyzed, all were significantly related to the Total Score at the .01 level with the exception of the Independent Project, which was at the .05 level. All but 10 variables had correlations over .4. The highest relationships with Total Score with correlations over .6 in descending order were Immunohematology and Transfusion Medicine GPA (.696), clinical-year didactic GPA (.684), clinical-year GPA (.684), Clinical Chemistry GPA (.649), cumulative graduating GPA (.641), and Hematology and Hemostasis GPA (.623).

Table 12 also presents the results of the academic measures variables when correlated with the six examination Subscores. The relationships are not as consistently high as are those with the Total Score. Cumulative GPAs and content/subject-related GPAs and grades tend to demonstrate higher correlations, which is as expected. For example, for the Blood Bank Subscore, the highest correlation was with the Immunohematology and Transfusion Medicine GPA (.599). Some strong relationships did exist across content disciplines. For example, the Clinical Chemistry GPA's relationship to the Blood Bank Subscore was .537, whereas Immunohematology and Transfusion Medicine's GPA with the Chemistry Subscore was .528.

Table 12

Academic Measures Variables With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Admissions Cumulative GPA	0.21**	.428**	.337**	.304**	.386**	.227**	.332**	.215**
Admissions Science GPA	0.34**	.520**	.389**	.406**	.450**	.288**	.412**	.248**
Biology GPA	0.32**	.488**	.365**	.408**	.412**	.286**	.350**	.243**
General Chemistry GPA	0.34**	.410**	.323**	.323**	.307**	.287**	.330**	.206**
Organic Chemistry GPA	0.39**	.441**	.376**	.349**	.411**	.201**	.385**	.174**
Math GPA	0.17	.185**	.152*	.174*	.108	.164*	.148*	.105
Fundamentals of Immunohematology Grade	0.56**	.476**	.447**	.376**	.365**	.267**	.316**	.307**
Fundamentals of Clinical Chemistry Grade	0.49**	.436**	.371**	.397**	.353**	.311**	.289**	.209**
Fundamentals of Hematology Grade	0.41**	.399**	.267**	.276**	.366**	.300**	.270**	.198**
Principles of Immunology Grade	0.46**	.387**	.266**	.297**	.374**	.210**	.261**	.178**
Fundamentals of Clinical Microbiology Grade	0.49**	.434**	.326**	.320**	.438**	.184**	.306**	.253**
Preclinical Courses GPA	0.48**	.541**	.422**	.432**	.485**	.320**	.359**	.285**
Immunohematology & Transfusion Medicine GPA	0.71**	.696**	.599**	.532**	.576**	.420**	.473**	.390**
Clinical Chemistry GPA	0.59**	.649**	.537**	.528**	.583**	.430**	.455**	.340**
Hematology and Hemostasis GPA	0.58**	.623**	.483**	.470**	.553**	.386**	.465**	.337**
Clinical Immunology Grade	0.30**	.312**	.168*	.301**	.307**	.256**	.125	.183**

Table 12—*Continued.*

	PASS/ FAIL Difference in Means†	CORRELATIONS						
			SUBSCORE					
		TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Laboratory Management and LIS GPA	0.19**	.322**	.309**	.232**	.259**	.257**	.269**	.168*
Clinical Microbiology, Parasitology, Mycology, and Virology GPA	0.35**	.455**	.293**	.303**	.437**	.298**	.296**	.302**
Clinical Microscopy (Body Fluids) Grade	0.59**	.552**	.401**	.466**	.508**	.369**	.354**	.241**
Specimen Procurement and Processing Grade	0.20**	.365**	.273**	.255**	.292**	.286**	.280**	.195**
Immunohematology Practicum Grade	0.51**	.577**	.508**	.465**	.463**	.405**	.462**	.256**
Clinical Chemistry Practicum Grade	0.21**	.372**	.279**	.423**	.351**	.253**	.192**	.217**
Hematology and Hemostasis Practicum Grade	0.35**	.461**	.356**	.354**	.380**	.378**	.413**	.260**
Immunology Practicum Grade	0.25**	.291**	.229**	.252**	.249**	.233**	.184**	.110
Clinical Microbiology Practicum Grade	0.30**	.434**	.371**	.316**	.405**	.313**	.285**	.206**
Clinical Microscopy Practicum Grade	0.28**	.262**	.198**	.267**	.177**	.170**	.165*	.242**
Independent Project Grade	0.06	.140*	.065	.125	.104	.176**	.158*	.106
Clinical Didactic GPA	0.51**	.684**	.541**	.520**	.610**	.444**	.482**	.380**
Clinical Practica GPA	0.32**	.595**	.484**	.501**	.513**	.431**	.434**	.313**
Clinical-year GPA	0.41**	.684**	.546**	.540**	.602**	.463**	.489**	.372**
Cumulative Graduating GPA	0.31**	.641**	.491**	.499**	.560**	.376**	.454**	.353**

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

The Immunology and Body Fluids Subscore relationships were much weaker and very different from those seen in the other Subscores. One would expect that the Immunology Subscore and the content specific variables would have higher correlations than found: Principles of Immunology grade (.210), Clinical Immunology grade (.256), and Immunology Practicum (.233). The Body Fluids Subscore and its content-specific variables, Clinical Microscopy grade (.241) and Clinical Microscopy Practicum (.242), also did not demonstrate strong relationships.

To determine if the various demographic groups demonstrated correlation results differently from the aggregate, correlation analyses were performed for each demographic group with each academic measures variable. When analyzing the correlations for the geographic regions of birth, it was determined that the small "*n*" for several of the groups were causing results that were suspect. The subjects were re-divided into two groups, USA and non-USA, and all correlations were rerun. Differences were found but not such as to cause the overall correlation results to be disregarded. The correlation results for reconfigured subgroups are reported in the Appendices C, D, E, and F in Tables 19 - 49.

Appendix G includes Tables 50 - 57 in which the demographic groups have not been combined. The academic measures variables that show especially strong correlations were selected to showcase not only the effect of the small "n" but also to demonstrate the wide variability of the correlations between all the different demographic groups.

Table 13 summarizes the variability found between the correlation results for all subjects and the correlations results for each subgroup. Each column represents 217 correlation analyses (31 academic measures times the 7 examination Total Score and Subscores). If the Certification Total Score (designated TS) or Subscores (designated by the first letter/s of Subscore name/s) correlation results were $\leq .250$ or were not significant, the appropriate letter designation was

Table 13

Correlations With Values ≤.250 or Non-significant Results: Academic Measures With Certification Examination Total Score and Subscores

Academic Measures Variables	All Subjects	Male	Female	White	Black	Asian	Hispanic	PI	USA	Non USA	English 1st Lang	English 2nd Lang	Ist Deg	Post bac
Admissions Cumulative GPA	BF I	I*			BF* I* C	BB C	TS BB C M	BB C M	I*	BF* C		BF* C		I* TS BB C H M
Admissions Science GPA	BF		BF* I	BF*	C	BB I	TS BB C H I	BB I M	BF*		BF*		I	BF* BB C H
Biology GPA	BF		BF*	BF*	C I	BB I	TS BB C H I M	BB	BF*	I		BB C		TS BB C H
General Chemistry GPA	BF		H I	BF*	TS BB C H	TS BB I C H M	TS C H I M	BF* M	BF*	TS BB C H I M		TS BB C H M	I	BF* C H
Organic Chemistry GPA	BF I	I*		I*	C H M		TS BB C H M	BB C H	I*					TS BB C H
Math GPA	TS BB C BF H I M		TS* I* M*			C*	TS*		TS* BB* I* M*					I*
Fundamentals of Immunohematology					TS C H I M	BB BF C I M	BF C H I	BF C H I M		BF I M	I	BF H		BF H I M
Fundamentals of Clinical Chemistry	BF	BF*		BF* M	TS BB C H M	BB	TS BB C H I	BB H I M	BF*	C	M	BF*		I
Fundamentals of Hematology	BF	BF*	BB I M	BF* M	BB C	BB C I M	C H I	TS BB C H M	BF* M	BB C	BF* M	TS BB C H	BB C M	
Principles of Immunology	BF I	C	I* BB M	BF* I*	TS BB C H M	BB C M	TS C H M	I*	BF*	BB C M	BB	I*	BB	BF* I* H M

Table 13—*Continued.*

Academic Measures Variables	All Subjects	Male	Female	White	Black	Asian	Hispanic	Pacific Islander	USA	Non USA	English 1st Lang	English 2nd Lang	Ist Deg	Post bac
Fundamentals of Clinical Microbiology	I	I*	BF M	BF	BB BF C M	TS BB BF C	I* C	BF C		BB BF C		BF C	BF	H
Preclinical Courses GPA					BF C M I	BB BF C I	BF C	BF C H I		BF C		BF	BF	
Immunohematology & Transfusion Medicine						BF C	BF C I	BF H M						
Clinical Chemistry						BF	BF H	BF M						BF I
Hematology and Hemostasis						BF	BF	BB BF H I M						BF I
Clinical Immunology	BF BB M			BB*	C	TS C H I	TS C H I	TS C H I	BF* BB*	H I		BB* H I	TS C I	M* BB*
Laboratory Management	BF C	M	C* I	C* BB	C * H I	TS BB H M	TS BB H I M	BF* TS I BB H M	C* BB H	C* I	C* H	TS I M	M	H I M
Clinical Microbiology				BF I		TS BB BF C H I M	BB C M	TS BB C H M		BB C I		BB C I M	BB C	I
Clinical Microscopy	BF	BF*		I	M	C I	H M	TS BB I C H M	BF* BB C H M					I M
Specimen Procurement and Processing	BF	TS BBI C H M		C I	TS BB I C H M	TS BB C H I	H	BB C I M		BB C I	BB C H M	C	BB C M	H I
Immunohematology Practicum		BF				BF C	BF C H	BF BB C H I		BF		BF C H	BF	BF H

Table 13—*Continued.*

Academic Measures Variables	All Subjects	Male	Female	White	Black	Asian	Hispanic	Pacific Islander	USA	Non USA	English 1st Lang	English 2nd Lang	Ist Deg	Post bac
Clinical Chemistry Practicum	BF M			BF* I M*	TS BB H	TS BB C I	TS BB C H	BF* TS I BB C H	BF* M*	BB H I	I	BB H	BB	I
Hematology & Hemostasis Practicum			BF		BF H	BB BF C I M	TS BB I BF C H M	BF H I		BF		BF C	BF	
Immunology Practicum	BB BF H I M	H* I* TS C	BB* M*	H* C	I* C	BB* TS C	I* TS C	TS C	BF* H*	I* TS C	BB* H*	I* TS C	TS C	H*
Clinical Microbiology Practicum	BF	M		M	BF*	TS BB C I M	C H I M	BB H I M	BF*	C I		C H I M	M	BF*
Clinical Microscopy Practicum	BB BF I C H M		TS		TS	TS	TS			TS	TS		TS	
Independent Project	TS BB BF C H I M		M*			I* M*	H* M*							
Clinical Didactic GPA						BF C	BF	M						BF
Clinical Practica GPA						BB BF C	BF C H	BB BF H I M		BF		BF		
Clinical-year GPA						BF	BF	H M						
Cumulative Graduating GPA						BF	C I	BF M						

Note. TS = Certification Total Score; BB = Blood Bank Subscore; BF = Body Fluid Subscore; C = Chemistry Subscore; H = Hematology Subscore; I = Immunology Subscore; M = Microbiology Subscore. *Correlations for **all** subjects was $\leq .250$ or not significant; however, correlation for **specific score** was significant.

recorded in the table. The all-subjects column summarizes the correlation results of Table 12. Of the 217 correlation results for all subjects, 47 were ≤.250 or were not significant. The 13 demographic characteristic subgroup columns record the results that are different from the all-subjects column. If there is no asterisk, the correlation result for all subjects was significant but for that subgroup, the correlation was ≤.250 or not significant. If there is an asterisk, the correlation results for all subjects is ≤.250 or not significant, and the correlation result for the subgroup was significant.

As can be seen, while there are differences for each of the subgroups for the academic measures variables, there are proportionally many lower correlation results for Blacks, Asians, English as a second language, non-USA, and to a lesser extent for the Hispanic/Pacific Islander group.

The Body Fluids Subscore and Immunology Subscore were found to have correlations ≤.250 or not significant for all subjects for a number of the academic measures. However, in a number of the academic measures, particularly with the Body Fluids Subscore, significance was found for the Whites and for those born in the USA subgroups.

When compared to Whites, Hispanics and Pacific Islanders had almost 8 times as many low correlations, Blacks had over 4 times, while Asians had more than 7 times as many. The Non-USA had an astounding 14 times as many as the USA group. English as a second language had almost 4 times as many as the English as a first-language group.

In addition to exploring the relationships between the academic measures variables and the Total Score and Subscores, analysis of variance testing was performed to explore the relationship of the academic measures variables to passing or failing the Certification Examination. The differences in GPA means for individuals who passed from those who did not are reported in Table 12. All differences were found to be significant at the .01 level with the exceptions of the Math GPA and the Independent Project grade, which were not significant. A difference of greater than 0.33 represents a difference of one grade level increase (for example, from B+ to A- is a difference of 0.33). The highest difference was that of Immunohematology and Transfusion Medicine GPA at .71, the equivalent of over two grade levels. When comparing the means of those who passed with those who did not, of the 31 academic measures variables, 13 had differences of at least one grade level, 5 had differences between .30 and .32, which is almost a full grade level, and 8 had differences less than the equivalent of one grade level.

To determine if there were varying results for the various demographic subgroups, analysis of variance for each academic measure variable with passing or failing the Certification Examination was rerun for each subgroup. As with the previously discussed correlation results, there are differences that are evidenced by the different demographic subgroups. The ANOVA results tend to track consistently with those determined by the correlation results. Academic measure variables that had larger mean differences typically had higher correlations demonstrating congruence between the analyses. Those results are also reported in Appendices C, D, E, and F in Tables 19 - 49.

Question 3

Question 3: Is there a combination of academic measures that may be a predictor of success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Multiple regression analyses were performed for the Certification Examination Total Score, the six examination Subscores, and passing or failing the examination to facilitate selection of predictive models for performance success.

Sequential and sequential stepwise regression methodologies were the analyses chosen. This approach was deliberate. Although some statisticians purport that stepwise analysis is fraught with problems (B. Thompson, 1989, 1995), the procedures used were done with thought and care to negate the problematic issues posited.

To ameliorate the deficiencies that have been identified, several pro-active approaches were taken as recommended (Thayer, 2002). The first approach was the manner in which variables were included for regression analysis. Rather than utilizing a method in which variables are mass analyzed with the hope that something useful will emerge, the selection of variables for regression inclusion was purposeful. Two factors were paramount when identifying variables for the analyses: (a) how utilitarian the selected regression variables would eventually serve the Program as predictors; (b) whether the variables were individually highly correlated with the Total Score. When selecting variables for the regression analyses with Examination Subscores, the content-related subject GPAs and course grades were also included.

Second, to assist in the interpretation and selection process of good models, intercorrelation analysis was performed to determine the relationships of the academic measures variables with themselves. (See Appendix H , Tables 58 - 63.)

The third approach was to perform the analyses in a systematic manner by doing a sequential regression first and then a sequential stepwise regression.

When sequential regression was performed, the variables were placed in a logical sequence consistent with a student's sequenced matriculation prior to and then through the Program: admissions, pre-clinical, clinical-year didactic, clinical-year practica, and then the clinical-year and cumulative graduating GPAs. Variables were added to the model in sequence only if they added a significant amount to the R^2 of the model. As the variables were added, some of those initially introduced that were significant when added became not significant when later variables were introduced into the model.

After the sequential regression model was selected, a sequential stepwise regression was performed to see if a smaller model could be found that was satisfactory, using the same variables as in the sequential method. The model selected was the one with the highest R^2, in which each individual variable was significant at the .05 level.

When performing the sequential stepwise regression analyses, each analysis was first run with the *p* for entry set at the .10 level. This was done in an effort to allow more variables to be considered in the final model. If the model meeting the stated criteria of R^2 included any variables with significance over .05, that model's variables were rerun with the *p* for entry parameter set at .05, which in every case removed only that variable.

In two cases when performing regressions for the various Subscores, specifically relevant courses were removed from the procedure because their inclusion dropped the *n* to unacceptable levels due to listwise deletion. Fundamentals of Imunohematology was dropped from analysis for the Blood Bank Subscore, and Clinical Microscopy was dropped from regressions for the Body Fluids Subscore. In both cases, by doing so, the R^2 did not change markedly but there was a restoration of the *n* to levels consistent with that seen in the regression analyses for the other Subscores.

The last step was to determine if the forward stepwise sequential procedure might not detect a good model. Backward stepwise regression was performed for each of the eight regression analyses to evaluate the effect of combining the variables in a different sequence. It was found that in all cases there was either no difference or a very small amount from the R^2 when compared to the forward stepwise sequential model. In a couple of cases the variables selected did differ, but these were substitutions in which the variables involved were determined to be so highly intercorrelated that no substantive difference resulted.

The models in Table 14 represent the selected models for each of the eight dependent variables: Certification Examination Total Score, Pass/Fail, and the six Examination Subscores by both the sequential and sequential stepwise regression procedures. The table identifies the specific regression process, the R^2, Regression Coefficients for the Sequential Stepwise models, Part Correlation, Significance, and Zero-order Correlation for the variables that were retained in the model. The Part and Zero-order Correlations, when squared, indicate the percentage of variance of the dependent variables accounted for by the independent variable uniquely in the model and alone.

In six of the eight regression models, the R^2 value is slightly higher by a very small amount in the model established by the sequential regression process. However, because those models increase the number of retained variables to as many as six variables, the models will undoubtedly be unwieldy to actually use. Therefore, preference is given to the models established by the sequential stepwise method. There are fewer variables with minimally lower explained variance. These models will be more manageable and thus easier for educators to use.

The predictive model with the highest R^2 (.482) is for the Certification Examination Total Score and includes the variables: admission science GPA and clinical-year didactic GPA. The model for Pass/Fail explains 21% less of the variance with an R^2 of .267 for the one-variable model: clinical-year didactic GPA.

The models for the six Subscores have R^2 values which range in descending order from Hematology (.399), Blood Bank (.375), Chemistry (.321), Microbiology (.263), Immunology (.200), to Body Fluids (.152).

Table 14

Regression Comparisons

Dependent Variable	Regression Process	Model	R^2	*b*	Part Corr.	Sig.	Zero-order Corr.
Certification Examination Score	Sequential	Total	.511				
		Admission cumulative GPA			-.136	.006	.445
		Admission science GPA			.093	.061	.537
		Preclinical courses GPA			-.035	.482	.527
n = 208		Clinical-year didactic GPA			.222	.000	.679
		Cumulative graduating GPA			.153	.002	.646
	Sequential Stepwise	Total	.482				
		Admission science GPA		34.718	.147	.004	.537
		Clinical-year didactic GPA		109.626	.440	.000	.679
Pass Fail	Sequential	Total	.287				
		Admission cumulative GPA			-.098	.100	.266
n = 208		Admission science GPA			.063	.291	.342
		Preclinical courses GPA			.106	.076	.445
		Clinical-year didactic GPA			.278	.000	.516
	Sequential Stepwise	Total	.267				
		Clinical-year didactic GPA		.526	.516	.000	.516
Blood Bank Subscore	Sequential	Total	.362				
		Admission cumulative GPA			-.014	.802	.361
		Admission science GPA			.064	.255	.421
n = 208		Preclinical courses GPA			-.037	.515	.399
		Clinical-year didactic GPA			.033	.557	.524
		Immunohematology & Transfusion Medicine GPA			.267	.000	.594
	Sequential Stepwise	Total	.375				
		Immunohematology & Transfusion Medicine GPA		109.746	.357	.000	.594
		Immunohematology Practicum Grade		54.790	.146	.009	.497
Chemistry Subscore	Sequential	Total	.325				
		Admission cumulative GPA			-.167	.005	.316
		Admission science GPA			.099	.093	.416
n = 205		Preclinical courses GPA			-.018	.763	.420
		Clinical-year didactic GPA			.078	.186	.506
		Clinical-year practica GPA			.082	.162	.498
		Cumulative graduating GPA			.139	.018	.503
	Sequential Stepwise	Total	.321				
		Admission cumulative GPA		-84.135	-.157	.008	.316
		Clinical Chemistry GPA		49.723	.162	.006	.516
		Cumulative graduating GPA		178.547	.231	.000	.503

Table 14— *Continued.*

Dependent Variable	Regression Process	Model	R^2	*b*	Part Corr.	Sig.	Zero-order Corr.
Hematology Subscore	Sequential	Total	.402				
		Admission cumulative GPA			-.045	.405	.409
		Admission science GPA			.095	.084	.479
n = 206		Preclinical courses GPA			.035	.519	.514
		Clinical-year didactic GPA			.328	.000	.621
	Sequential Stepwise	Total	.399				
		Admission science GPA		42.653	.119	.029	.479
		Clinical-year didactic GPA		155.093	.412	.000	.621
Immunology Subscore	Sequential	Total	.204				
		Admission cumulative GPA			-.058	.359	.227
		Admission science GPA			.047	.461	.284
n = 205		Preclinical courses GPA			-.023	.721	.308
		Clinical-year didactic GPA			.156	.014	.428
		Clinical-year practica GPA			.127	.047	.416
	Sequential Stepwise	Total	.200				
		Clinical-year didactic GPA		82.968	.163	.010	.428
		Clinical-year practica GPA		91.115	.127	.046	.416
Microbiology Subscore	Sequential	Total	.283				
		Admission cumulative GPA			-.087	.149	.329
		Admission science GPA			.136	.024	.415
n = 205		Clinical-year didactic GPA			.298	.000	.481
		Microbiology, Mycology, Parasitology, & Virology GPA			-.151	.013	.286
	Sequential Stepwise	Total	.263				
		Clinical-year didactic GPA		192.230	.426	.000	.481
		Microbiology, Mycology, Parasitology, & Virology GPA		-69.074	-.180	.003	.286
Body Fluids Subscore	Sequential	Total	.145				
		Admission cumulative GPA			-.130	.044	.212
		Clinical-year didactic GPA			.074	.250	.357
n = 208		Cumulative graduating GPA			.174	.007	.354
	Sequential Stepwise	Total	.152				
		Cumulative graduating GPA		269.133	.327	.000	.354
		Admission cumulative GPA		-118.972	-.163	.012	.212

In addition to its presence in the models for Total Score and Pass/Fail, the clinical-year didactic GPA variable is included in three Subscore models: Hematology, Immunology, and Microbiology. The next most represented variable is admission science GPA, which is present in the Chemistry and Hematology Subscore models, as well as in the Total Score model. The Subscore models in four cases also include content-related variables.

When assessing the contribution of the variables in the Chemistry, Microbiology, and Body Fluids Subscore sequential stepwise models, there are Part values that are reported as negative. This is due to suppression, which arises from the high intercorrelation of the included variables. While it is difficult to tease apart the unique contribution of each variable in these models, each does contribute to the predictive value of the model.

Summary

Each of the three hypotheses was rejected.

Four of the five demographic characteristics — ethnicity, geographic region of birth, English as a first or second language, and completion of the first degree or as a post-baccalaureate while attending the Program — had significant relationships with Certification Examination success. Other than for the Immunology Subscore, gender was not found to be a significant demographic characteristic.

The correlation testing of the 31 academic measures variables found that all were significantly related to the Certification Examination and most had correlations >.4. Correlation testing of the academic measures variables for each demographic subgroup found differences from the aggregate particularly for Blacks, Asians, Hispanics, and Pacific Islanders, those born outside the United States, and those who speak English as a second language. Many more low correlations were found.

Using multiple regression analysis, many good models were found to predict the Certification Examination Total Score, passing and failing, and the six Subscores. The predictive model selected for the Certification Examination Total Score included admission science GPA and clinical-year didactic GPA.

CHAPTER 5

SUMMARY, CONCLUSIONS, PERSONAL OBSERVATIONS, AND RECOMMENDATIONS

Introduction

Academic and professional success is important to society and its educational systems, to the teachers who educate and foster students, and to the students themselves. Society needs graduates who enter the professional world well prepared, knowledgeable, and able to make a contribution in their chosen areas.

In disciplines that require certification/licensure examinations as a culmination to the educational process, additional pressure is placed on educators and on the students to be able to demonstrate optimal outcomes at the conclusion of the students' educational programs.

In health-care, patients' well-being and very lives depend on the knowledge and competence of the professionals caring for them. There is no margin of error for individuals unable to meet minimum entry-level competency expectations for newly minted graduates. Clinical laboratory scientists performing laboratory tests upon which physicians make the majority of medical decisions, must work accurately, be able to think independently, and make value judgments concerning the testing that they are performing.

This study examined student demographic characteristics and academic measures as predictors of success for the American Society for Clinical Pathology Board of Registry Medical

Technology Certification Examination (Certification Examination). These predictors were assessed for relevance to an ethnically and racially-diverse student population.

One of the compelling reasons for selecting this dissertation topic was to better serve the student populations that enter clinical laboratory science programs each year. This study is set within the context of leadership in clinical laboratory science programs, certification agencies, and accrediting bodies in their varying responsibilities to admit and educate students, assess professional entry-level competency, and evaluate programs. This study examines whether there is variability in student performance from different demographic groups.

Without knowing whether there truly were differences in the student demographic groups, the tendency might be to make assumptions based on observations of individual students and then easily miss or dismiss an issue that should be addressed. Practices and procedures might then tend to become more reactive than proactive. In addition, when better able to predict students who are more at risk of failing the Certification Examination, earlier intervention mechanisms can be put in place.

Overview of the Literature

The literature review covered the history of the formation, in 1922, of the American Society of Clinical Pathologists, the beginnings of the Board of Registry, and the subsequent development of the Certification Examination for Medical Technologists in 1933. A comprehensive search of the relevant research on predictors of success in medical technology programs and Certification Examination success covering all the years since the examination's inception was performed. Over the years a number of researchers have studied the value of demographic, academic, and aptitude characteristics as predictors.

Research on gender as a predictor of program success has produced conflicting results. Holt (1978) and Downing et al. (1982) found gender to be a predictor for success in medical technology programs, whereas Laudicina (1999a) did not. Gender was determined by Handley et al. (1995) to be a predictor of success on the Certification Examination, whereas three other studies by Conrad (1991), Downing et al. (1982), and Somma (1988) did not.

English as the native language was found by Weed (1996) to be the best predictor of program completion success. Conrad (1991) found international student status to affect success on the Certification Examination, noting the high failure rate of international students. Handley et al. (1995) determined a clear difference in the predictors for minority and nonminority students.

Many studies have focused on academic and aptitude predictors of program and certification examination success. Pre-professional grade point averages (GPAs) have been determined to be predictors of success by more than a dozen of the studies reviewed (see Tables 1 - 4). Curiously, only Heilman (1988, 1991) found neither preprofessional overall nor preprofessional science GPAs to be predictors of Certification Examination success.

Holt (1978) determined that clinical grades were predictors of examination success. Sultan (1992) found that theory course grades correlated with Certification Examination success and determined that both practica grades alone and a combination of theory and practica grades correlated with Certification Examination Subscore results, except for the Hematology Subscore. Other researchers (Ahlstrom, 1980; Crews, 1980; Sultan, 1992; Watkins, 1989) found that course grades correlated with the Certification Examination Subscores.

The professional (clinical) year GPA was determined to be a significant predictor by Conrad (1991), Faubion (1993), and Sultan (1992). Sultan also found that cumulative GPA was a significant predictor, as did Aldag and Kling (1984), Goodyear & Lampe (2004), Handley et al. (1995), Holt (1978), Love et al. (1982), Somma (1988), and Williams et al. (1967).

The literature is replete with studies researching predictors of success and registry or certification examination success for health-care profession programs such as nursing, physical therapy, respiratory therapy, and other disciplines. Results in these disciplines closely parallel those found for clinical laboratory science.

Subjects

This study utilized data retrieved from the permanent records of the graduates of the Andrews University Program for Clinical Laboratory Sciences (Program) maintained by the Department of Clinical and Laboratory Sciences, Andrews University, Berrien Springs, Michigan. The documentation from the files used included data from the students' applications to the Program, admissions GPA, admissions science GPA, grades from the final transcript, and American Society for Clinical Pathology Board of Registry Medical Technologist Certification Examination Total Score, Subscores, and pass or failure reported to the Program in their Board of Registry Program Performance Report Summary. Demographic information not included on some individuals' applications to the Program was retrieved from the University's permanent records for those persons.

All 254 graduates of the Program were included in the study from the first graduating class of 1989 to the graduates of the class of 2004. Of the graduates, 21 were eliminated from the study because they did not write, or have not yet written, the Certification Examination, or they did take the examination but did not release their scores to the University. Statistical data were gathered for the 233 graduates with reported scores. Only the scores from the first time of writing the Certification Examination were used. No repeat examination scores for those failing on the first attempt were included in the analyses.

Methodology

This study analyzed data for each graduate in three areas: (a) demographic information, (b) academic measures, and (c) Board of Registry Program Performance Report. The five demographic independent variables considered were: (a) gender, (b) ethnicity, (c) English spoken as a first language or second language, (d) geographic region of birth country, and (e) whether the student attended the Program to earn a first degree or was post-baccalaureate. The 31 academic measures independent variables considered were in five general categories: (a) admissions GPAs, (b) pre-clinical courses grades and GPA, (c) clinical-year didactic course grades and GPAs, (d) clinical-year practica course grades and GPAs, and (e) clinical-year and cumulative graduating GPAs.

The dependent variables were the Certification Examination Total Score, passing or failing, and six Certification Examination Subscores: Blood Bank, Chemistry, Hematology, Immunology, Microbiology, and Body Fluids.

Statistical methods used were chi square, analysis of variance (ANOVA), Pearson product-moment correlation, and multiple regression analysis. The Student-Neuman-Keuls Test, a post hoc multiple comparison procedure, was used to identify group mean differences when ANOVA testing resulted in a significant *p*.

Significance for all analyses was set at $\alpha = .05$.

Summarization and Discussion of the Results

Research Question 1: Is there a relationship between student demographic characteristics and success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Chi square and analysis of variance were used to analyze the relationships between the Certification Examination and the five demographic characteristics examined: gender, ethnicity, geographic region of birth, English as a first language, and whether the individuals were attending the Program while completing a first degree or were post-baccalaureate students.

Other than the Immunology Subscore in which females scored higher than males, gender did not prove to be a significant characteristic. That gender did not prove to be a significant characteristic parallels the results found by Conrad (1991), Downing et al. (1982), and Somma (1988) and disagrees with Handley et al. (1995) who found gender to be a significant predictor.

Ethnicity was found to have a significant relationship with the Total Score and all Subscores. The Total Score and six Subscore means achieved by Whites were higher than those achieved by the other four ethnic groups with pass rates ranging from 76% for Whites, to 45% for Hispanics. These results were unlike those of Somma (1988), who found race not to be significant. The results do reflect those found by the researchers in other health-care professions such as nursing, where ethnicity and minority status were found to be a significant demographic characteristic of either program or certification examination success (Cloud-Hardaway, 1988; Endres, 1997; Forsythe, 1997; Horns et al., 1991; Nnedu, 2000).

English as a first language was related to the examinee's success on the Certification Examination Total Score and most of the Subscores. The scores achieved by examinees who spoke English as a second language were lower on all tests, with their Total Score mean just above the Certification Examination pass/fail cut-off level of 400 and the mean scores for four of the Subscores below the 400 level: Chemistry, Hematology, Microbiology, and Body Fluids.

Examinees with English as a first language had a 69% pass rate, whereas the rate for those with English as a second language was 47%. Facility in English has a strong relationship with the graduates' examination success and may well prove for an individual examinee to be the major mitigating factor that determines whether that person passes or fails. The results of this study agree with those of previous studies finding that a student whose first language is English is more likely to pass a certification examination (Arathuzik & Aber, 1998, Manifold & Rambur, 2001).

Geographic region of birth is related to the Certification Examination Total Score and the Blood Bank and the Microbiology subscores. In each analysis, a significant difference was found between the higher mean score achieved by those from Southern Asia and lower for those from Inter America and South America.

Of the ethnic groups, Hispanics had the lowest pass rate. Of the geographic regions of birth, those from Inter America and South America had the lowest Total Score mean. The majority of Hispanics in the Program are from Inter America and South America, leading to the conclusion that there is a confounding of results. While it appears that geographic region of birth does lead to differences, a larger study with more individuals that would include more representation of minority groups born in the United States would be beneficial.

Previous academic accomplishment does serve the examinees well as evidenced by post-baccalaureate students passing the examination with a 76% rate as compared to 59% for those who were completing their first degrees. A higher level of academic attainment (one degree already completed) and the commitment necessary to return to school to complete another program generally meant the individuals were serious about the educational experience and strove to succeed with distinction. Indeed, four of these post-baccalaureate students were from other countries in which they had been previously trained as physicians (China, Union of Soviet Socialist Republics, and Bangladesh).

The four demographic characteristics that showed most significant relationships with Certification Examination success were those that reflect the impact of previous cultural and educational experiences: Ethnicity, Geographic region of birth, English as a first language, and first degree or post-baccalaureate status.

Research Question 2: Is there a relationship between academic measures and success on the American Society of Clinical Pathology Board of Registry Medical Technology Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Correlation coefficients were calculated between each of the seven dependent variables: Total Score and six examination Subscores: Blood Bank, Chemistry, Hematology, Immunology, Microbiology, and Body Fluids and the 31 academic measures in five general groupings: (a) admissions GPAs, (b) preclinical courses and GPA, (c) clinical-year didactic course grades and GPAs, (d) clinical-year practica grades and GPA, and (e) the cumulative clinical-year and graduating GPAs.

The correlations of the 31 academic measures with the Total Score were all significant. All but 10 variables had correlations over .40. The highest relationships with Total Score with correlations over .6, in descending order, were Immunohematology and Transfusion Medicine GPA, clinical-year didactic GPA, clinical-year GPA, Clinical Chemistry GPA, cumulative graduating GPA, and Hematology and Hemostasis GPA. These results were not found by Heilman (1988) but mirror those of a myriad of researchers (Ahlstrom, 1980; Conrad, 1991; Crews, 1980; Faubion, 1993; Goodyear & Lampe, 2004; Handley et al., 1995; Holt, 1978, Lanier & Lambert, 1981; Love et al., 1982; Somma, 1988; Sultan, 1992; Watkins, 1989).

The Certification Examination measures to a large degree the clinical laboratory science didactic information the individual has assimilated. It would stand to reason that the variables that represent a measurement of cumulative achievement would correlate highest with examination success. The better the student, the more he/she has learned, the higher the grades and GPA, the higher the likelihood that he/she would pass the Certification Examination.

The Immunology and Body Fluids Subscore relationships with academic measures were much weaker and very inconsistent from those seen with the other Subscores. The other four Subscores demonstrate moderate to strong correlations with the related didactic and practicum courses and GPAs. It is reasonable to expect that the relationships between the Immunology Subscore and the content-related variables would more closely parallel the relationships found between the other Subscores and their content-specific coursework. However, correlations between the Immunology Subscore were lower, ranging between .210 and .256. Likewise, the relationships between the Body Fluids Subscore and its content-related variables had correlations of .241 and .242.

The principles of Immunology, its techniques, and applications are part of the basic knowledge and processes used in the other content areas. It is the one content area that completely crosses and is embedded in all the other content disciplines. Hence, one would expect that not only would the correlations be strong between the specific Immunology course variables with the Immunology Subscore but that those variables would have strong correlations with the other Subscores as well. However, this is not the case.

The low Body Fluids Subscore correlations are also a bit of a conundrum. The Subscore content includes urinalysis and all other body fluids. The on-campus instructional didactic course materials and student laboratories cover all body fluids. Students participate in a Microscopy practicum during the Program Clinical Practica.

Graduates have reported that the Body Fluids portion of the Certification Examination sometimes has either heavy emphasis on urinalysis or on other body fluids. This variability in examination question content is due to the item selection process of computer-adaptive testing.

When the graduates report that their examination featured mostly urinalysis questions, they scored well. When the graduates reported that there were mostly other body fluid questions, the scores were lower. These results are to be expected because the vast majority of body fluids specimens, other than blood, that the students analyze during their clinical practica are urine specimens. The availability of equivalent number of other body fluids specimens, such as spinal fluid, in the clinical practica is not possible. This more restricted experience and the particular mix of Certification Examination questions, which varies from one examinee to the next in the computer-administered format, may both contribute to the low correlation results.

The Body Fluid Subscore correlations with the academic measures variables for all subjects were either $\leq .250$ or not significant in 15 of the 31 cases. Of the 15, in almost half of the cases, the Body Fluid relationships were $>.250$ and significant for Whites and those born in the USA. A cause of the overall weak relationships for all subjects may be the combination of very weak and not significant relationships for more subgroups that is not offset by the significant relationships of just a couple of subgroups.

Another factor to consider is the quality of instruction. All examinees in this study were taught by the same three instructors for four of the content areas, one for Immunohematology and Transfusion Medicine (Blood Banking), another for Clinical Chemistry and Body Fluids, and another for Hematology. Concerted effort has been made over the years by each of these instructors to teach students concept-driven learning. If students are going to succeed, they need to know how to apply knowledge, not memorize facts. Many students have struggled to reorient their approaches to learning, particularly if their previous educational successes have come because of their gifts for memorization.

By Program configuration and faculty workload assignments, the content areas of Microbiology and Immunology are taught by the same instructor. Over the time period of this study, there have been three different individuals teaching the courses for those two subjects. Because the Program orientation to teaching is for concept learning, each new instructor was coached in and followed that teaching style. However, because Microbiology does lend itself more to the memorization of a multitude of facts about the different organisms, clinical conditions, and therapies, the students who resonate with memorization would typically delight in Microbiology and would be particularly frustrated by Immunology, both taught by the same instructor.

The same instructor who teaches and is responsible for the content of the Program's Clinical Chemistry courses, which show high correlations with the Certification Examination Chemistry Subscore, also teaches the Microscopy course and oversees the Microscopy practicum experience. The instructor's professional experience, of over 30 years, and expertise are comparable in both content areas. Hence, if the content knowledge of the instructor, style, and quality of teaching are removed from consideration as contributing issues to the low correlations between the Microscopy courses and the Certification Examination Body Fluids Subscore, it may be that the computer-adapted test-generation process is a factor influencing the low correlations.

To determine whether the correlation results and ANOVA results may be different for the specific demographic subgroups from that found for all subjects, separate testing by individual subgroup was also performed. It was found that there are differences from the total, particularly for Blacks, Asians, Hispanics, Pacific Islanders, those born outside the United States, and those who speak English as a second language.

When compared to Whites, the other ethnic groups had 4 to 8 times as many correlations that were $\leq .250$ or were not significant, with Hispanics and Pacific Islanders having the highest numbers. The English spoken-as-a-second-language subgroup had 4 times as many correlations as the English as a first language group. Those born outside the United States had 11 times as many as did those born in the United States.

The disproportionate number of low correlations found for minority groups, English as a second language, and those born outside the United States underscores and supports the stance that factors other than just academic achievement do impact Certification Examination success.

Research Question 3: Is there a combination of academic measures that may be a predictor of success on the American Society of Clinical Pathology Board of Registry Medical Technologist Certification Examination as determined by the Total Score, by passing or failing, and by the examination subject Subscores?

Sequential and stepwise sequential regression methods were used to select models that were found to have good predictive capability and should be easy to use. The models will be most beneficial when they can help to identify at-risk students who would profit from additional monitoring and assistance, such as focused tutoring, to increase the probability that those students will be successful in writing the Certification Examination. The model identified for predicting Certification Examination Total Score had an R^2 of .482 and includes admission science GPA and clinical-year didactic GPA. Since the model is compromised of two variables for which the student data are available months before the student finishes the Program, there is time for remediation in an attempt to make a difference for the students for whom the predictions are not favorable.

Clinical-year didactic GPA proved to be a valuable variable in many of the regression models. In addition to inclusion in the model for Total Score, it is an included variable in models for predicting three of the six Subscores: Hematology, Immunology, and Microbiology. It is the one variable in the model predicting passing or failing. The presence of this specific variable in five of the eight models not only reflects the correlation of the clinical-year didactic GPAs of the students with the Certification Examination Score but also the correlation of the content of the courses for which the GPAs arise with the content of the Certification Examination itself.

The next most represented variable is admission science GPA, which is present in the Chemistry and Hematology Subscore models, as well as in the Total Score model. Inclusion of this variable in these models, particularly in the Total Score model, serves to reinforce the continuation of admission science GPA as a part of the admission criteria to the Program.

The model for passing and failing is not especially beneficial. It contains only one variable, clinical-year didactic GPA, and the strength of the prediction is almost 20% lower than the model for predicting Total Score. The student data to use either model, Total Score or passing/failing, would be available at the same time so there is virtually no additional benefit from this particular model.

The Subscore regression models do not explain as high a percentage of variance as the model for the Total Score. Models for predicting the six Subscores range from the highest percentage of variance explained at 39.9% for the Hematology Subscore, to the lowest of 15.2% for the Body Fluids Subscore. Although these predictive models for the Subscores do not reach the level of the Total Score, they can be valuable to the instructors not only for application to student predictions but for suggesting changes in teaching methodologies or a shift in the emphasis of course content.

Because there are lower correlations for some of the subgroups, caution must be exercised when using the regression models as tools to identify at-risk students. Over-enthusiastic utilization of one model that might not function equally for all the subgroups could be disadvantageous to those groups for whom the model is not as predictive. For example, the model for predicting the Chemistry Subscore for the total group includes admission cumulative GPA, Clinical Chemistry GPA, and cumulative graduating GPA. However, one of the variables included, admission cumulative GPA, has a correlation of $\leq .250$ or is not significant with the Chemistry Subscore for Blacks, Asians, Hispanics, Pacific Islanders, those born outside the United States, those who speak English as a Second Language, and post-baccalaureate students.

In addition to using models to predict Certification Examination scores, expectancy tables may also be used. Expectancy tables for select variables for Certification Examination passing and failing are included in Appendix I, Tables 64 - 66.

Conclusions

There are relationships between the demographic characteristics: ethnicity, geographic region of birth, English as a first or second language, and whether a student was achieving a first degree or attending as a post-baccalaureate and performance on the Certification Examination.

Greater than .60 correlations exist between admission, pre-clinical, clinical-year didactic, clinical-year practica, and cumulative clinical-year and graduating GPAs and the Certification Examination Total Score, pass and failing, and the six Certification Examination Subscores.

A two-variable regression model with 48% of the variance explained for the Certification Examination Total Score has been identified that can be used months before students graduate to allow for intervention strategies for those students determined to be at risk of failure.

Personal Observations

Language Facility

When the program faculty have interviewed graduates after they have written the Certification Examination, the responses are almost without exception that the examinees had seen the material before (there were no surprises). However, particularly the English-as-a-second-language students claim to know the information required to answer questions, but they could not figure out exactly what some of the questions were asking. A repeated refrain has been that the questions were confusing and not straightforward.

Many of these same students, during on-campus Program written examinations, would ask for question clarification when the questions where written in higher-level syntax or had a number of subordinate clauses or used words not routinely heard in everyday speech.

For example, one very academically gifted student, a physician educated in the People's Republic of China and former chief of the medical staff of a Beijing Hospital, did not understand the word "prior" believing it to mean "after." This was discovered by the faculty only 1 month before he wrote the Certification Examination. Since many case-study-style questions refer to past and current patient results, this one-word confusion could have caused a complete derailment in his ability to select the correct answer.

When the examinee is struggling to understand the question stem, it is difficult to engage in relevant item discrimination to select the correct response.

Memorization

Students who come from cultures with a tradition of maintaining oral histories or from education systems that are based on memorization are especially skilled in memorizing facts. They have notable talent in collecting a plethora of data seemingly without much effort. However, assimilation of the facts to a level that can allow for application or evaluation in situations different from the specific context from which the facts were acquired is sometimes very challenging for these students. Questions written beyond the recall level which require interpretation or problem solving skills (ASCP, 2001, p. 2) can be a problem for them.

"Group Think"

We have also noticed that there are some students whose entire orientation is to "group think." These students, either by personal proclivity or more often by cultural orientation, are excellent in partner or team-required activities such as is sometimes used in student laboratory procedures or problem-based learning scenarios. These individuals seem to be very reticent to make and defend decisions without corroboration from their peers. The process of individually achieving high levels of critical-thinking attainment required to pass the Certification Examination may take additional personal maturation and time beyond the time period of the Program. Indeed, most of the individuals who have not been successful on the first attempt at writing the Certification Examination are successful on the second.

Examination Characteristics

From the experience of the Program faculty, we have found that individuals educated under the British-style of educational system, which uses more essay-type examination questions, find the multiple-choice question format very frustrating. These students seem to have difficulty taking the information they have learned and demonstrating their knowledge attainment at the same academic performance level as they have previously shown.

The Certification Examination multiple-choice questions are carefully crafted to eliminate, as much as possible, the not-well-prepared student using a process of elimination to guess the answer. Question distracters are finely honed to discriminate between an answer option that might be considered correct but is not the best answer. Questions written at the Application and Synthesis levels prove challenging for the students who would prefer to write the answers to the exam in their own native language, have it based on memorization skills, or to have an essay question format.

In addition, now that the Certification Examination is exclusively computer administered, students who are also intimidated by the computer itself have an additional obstacle to overcome. Even how examinees manage time during test taking, particularly for a standardized time-limited examination, can affect whether there is a successful outcome. For all of these individuals, the Certification Examination is now measuring more than entry-level clinical laboratory science competence.

Recommendations

As the trend in academics continues to more diversity in student populations, leaders in three areas: education programs, certifying entities, and accrediting bodies must be prepared to recognize the effect of diversity on certification examination performance. Education must be designed to provide the knowledge base required and foster the skills necessary for clinical laboratory science health-care in all students, regardless of the students' ethnic, cultural, or educational background. Certification examinations must be designed to assess content knowledge without cultural or language bias. Accrediting agencies must recognize that demographic characteristics do impact student performance and will affect program assessment outcome measures. Leaders must embrace this responsibility with purpose and vigor recognizing that an academic equation for student success is:

Program Completion with passing the Certification Examination = Appropriate Admission + Good Retention + Solid Academics.

Recommendations for The Andrews University Program

The program should implement a mandatory screening of English language processing skills such as coding and encoding assessment for all Program students. Arrangements for students found to have difficulty with English should be made with the relevant University services for skill enhancement remediation.

To enhance test-taking skills and examinee confidence, increased utilization of available web-based practice examinations with high taxonomic level multiple-choice questions for all content areas should be implemented.

Recommendations for The Board of Registry

A test question language clarity audit using examinees who have just completed the Certification Examination should be initiated by the Board of Registry. A comparison of the feedback from individuals who speak English as a first language with those who speak English as a second language should be performed.

Recommendation for Health-care Program Accrediting Agencies

Accreditation standards that either stipulate or imply a particular certification/licensure examination pass rate for Programs to achieve or maintain accreditation should be revised to accommodate programs with highly diverse student populations.

For Future Research

A commitment to discover and address any impediments to student success is a compelling responsibility of all clinical laboratory science educators. Ongoing research must be a component part of the mission for quality education. A multi-year study for all certification examinees should be conducted that compares examination results with examinee ethnicity and whether English is spoken as a first or second language to determine if the results of this study are unique to this Program. Because of the larger number of examinees involved, a study with more individuals in the demographic groups that are particularly under represented in this research, such as Inter America and South America, Europe, and Southern Asia, could be included.

A follow up study to determine the interactions among ethnicity, geographic region of birth, and English as a second language as predictive of Certification Examination success should be initiated. Additionally, the issues of whether the learning environment impacts the various demographic groups differently should be researched.

A mixed quantitative/qualitative study should be conducted that would include language skills testing and pre- and post-examination interviews to continue an ongoing discovery of keys for student success.

APPENDIX A

INDEPENDENT AND DEPENDENT VARIABLES

Table 15

Academic Measures Independent and Certification Examination Dependent Variables

INDEPENDENT VARIABLES					DEPENDENT VARIABLES	
PREREQUISITES FOR ADMISSION			**CLINICAL YEAR**		**Medical Technologist Certification Examination**	
	Prerequisite Sciences and Math	**Prerequisite Clinical Sciences**	**Didactic**	**Practica**	**Subscores**	
Overall Academic Cumulative GPA	Biology GPA	Fundamentals of Clinical Chemistry Grade	Clinical Chemistry GPA	Clinical Chemistry Grade	Clinical Chemistry	**Total Score**
	General Chemistry GPA	Fundamentals of Hematology Grade	Hematology and Hemostasis GPA	Hematology Grade	Hematology	
	Organic Chemistry GPA	Fundamentals of Immunohematology Grade	Immunohematology & Transfusion Medicine GPA	Immunohematology Grade	Immunohematology	
	Math GPA	Principles of Immunology Grade	Immunology Grade	Immunology Grade	Immunology	
		Fundamentals of Microbiology Grade	Microbiology, Parasitology, Mycology, & Virology GPA	Clinical Microbiology Grade	Microbiology	
			Microscopy Grade	Clinical Microscopy Grade	Body Fluids	
			Laboratory Management & LIS GPA	Independent Project Grade		
				Specimen Procurement and Processing Grade		
	Cumulative Science GPA	**Preclinical GPA**	**Cumulative Didactic GPA**	**Cumulative Practica GPA**		
			Clinical Year Cumulative GPA			

Table 16

Demographic Characteristics Independent Variables

Demographic Characteristics
Gender Geographic region of birth country Ethnicity English spoken as second language First degree or post-baccalaureate student

APPENDIX B

DEMOGRAPHIC INFORMATION

Table 17

Birth Countries of Subjects

Country	*Number*	*Country*	*Number*
Bahamas	2	Kenya	2
Bangladesh	2	Korea	6
Barbados	2	Malawi	1
Bermudas	5	Malayasia	3
Botswana	1	Nigeria	1
British Virgin Islands	1	Peru	1
Canada	11	Philippines	12
Chile	1	Puerto Rico	6
China	2	Rwanda	1
Colombia	1	Singapore	1
Cuba	2	South Africa	1
Dominica	1	Spain	1
Dominican Republic	1	Sri Lanka	1
Ecuador	1	Taiwan	6
El Salvador	1	Thailand	1
England	1	Tobago	1
Ethiopia	2	Trinidad	2
France	1	U. S. Virgin Islands	4
Ghana	2	United States	98
Guam	3	U. S. S. R	1
Guyana	1	Venezuela	1
Haiti	2	Vietnam	1
Hong Kong	2	West Germany	1
India	4	Yugoslavia	1
Indonesia	5	Zambia	1
Jamaica	17	Zimbabwe	3
Japan	1		

Table 18

Geographic Regions of the World As Defined for the Study

1	2	3	4	5	6
		Caribbean & West Indies	Inter & South America	Europe	Africa
USA	Bermuda Canada	Antigua and Barbuda Anguilla Aruba Bahamas Barbados British Virgin Islands Cayman Islands Cuba Curacao Dominica Dominican Republic Grenada Guadeloupe Haiti Jamaica Puerto Rico St. Barts St. Kitts & Nevis St. Lucia St. Maarten St. Vincent & the Grenadines Trinidad & Tobago Turks & Caicos US Virgin Islands	Argentina Belize Bolivia Brazil Chile Colombia Costa Rica Ecuador El Salvador French Guyana Guatemala Honduras Mexico Nicaragua Panama Paraguay Peru Suriname Uruguay Venezuela	Albania Austria Belarus Belgium Bosnia & Herzegovina Britain Bulgaria Crete Croatia Cyprus Czech Republic Denmark Estonia Finland France Germany Greece Hungary Iceland Ireland Italy Latvia Lithuania Luxembourg Malta Monaco Netherlands Norway Poland Portugal Romania Slovakia Slovenia Spain Sweden Switzerland Russia Ukraine Yugoslavia	Angola Benin Botswana Burkina Faso Cameroon Cape Verde Central African Republic Chad Congo Equatorial Guinea Eritrea Ethiopia Gabon Gambia Ghana Guinea Bissau Guinea Ivory Coast Kenya Lesotho Liberia Madagascar Malawi Mali Mauritania Mozambique Nambia Niger Nigeria Senegal Sierra Leone Somalia South Africa Sudan Swaziland Tanzania Togo Uganda Zambia Zimbabwe

Table 18—*Continued.*

7	8	9	10	11
Near & Middle East	Eurasia	Southern Asia	Southeast Asia & South Pacific	Northern Asia
Algeria	Afghanistan	Bangladesh	Australia	China
Bahrain	Armenia	Bhutan	Brunei	Hong Kong
Egypt	Azerbaijan	India	Cambodia	Japan
Iran	Georgia	Maldives	Fiji	Korea
Iraq	Kazakhstan	Nepal	Guam	Mongolia
Israel	Kyrgyzstan	Pakistan	Indonesia	Taiwan
Jordan	Tajikistan	Sri Lanka	Laos	
Kuwait	Turkey		Malaysia	
Lebanon	Turkmenistan		Myanmar	
Libya	Uzbekistan		New Zealand	
Morocco			Other Pacific Islands	
Oman			Papua New Guinea	
Quatar			Philippines	
Saudi Arabia			Samoa	
Syria			Singapore	
Tunisia			Thailand	
United Arab Emirates			Vietnam	
Yemen				

APPENDIX C

TABLES: ADMISSIONS GPAS

Table 19

Admission Cumulative GPA With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS - FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects *n* = 229	0.21**	.428**	.337**	.304**	.386**	.227**	.332**	.215**
Male *n* = 97	0.24**	.501**	.378**	.348**	.435**	.337**	.357**	.217*
Female *n* = 132	0.18**	.370**	.299**	.279**	.344**	.133	.315**	.218*
White *n* = 60	0.19	.461**	.362**	.386**	.395**	.216	.373**	.097
Black *n* = 77	0.22**	.369**	.367**	.162	.282*	.277*	.359**	.291**
Asian *n* = 49	0.14	.372**	.165	.268	.419**	.087	.300*	.093
Hispanic *n* = 20	0.07	.148	.126	-.100	.277	-.025	.306	.227
Pacific Islander *n* = 23	0.24	.548**	.318	.402	.431*	.390	.347	.310
USA *n* = 97	0.21*	.476**	.400**	.400**	.447**	.269**	.369**	.134
Non-USA *n* = 132	0.20**	.371**	.274**	.189*	.321**	.180*	.297**	.274**
English as First Language *n* = 151	0.23**	.460**	.357**	.356**	.427**	.231**	.321**	.185*
English as Second Language *n* = 78	0.17*	.344**	.275*	.141	.264*	.208	.348**	.265*
First Degree *n* = 196	0.19**	.450**	.361**	.328**	.424**	.201**	.318**	.228**
Post Baccalaureate *n* = 33	0.23	.242	.100	.074	.142	.347*	.339	.080

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 20

Admission Science GPA With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 228$	0.34**	.520**	.389**	.406**	.450**	.288**	.412**	.248**
Male $n = 96$	0.39**	.574**	.433**	.438**	.492**	.401**	.425**	.236*
Female $n = 132$	0.30**	.479**	.349**	.388**	.414**	.209*	.408**	.260**
White $n = 60$	0.43**	.609**	.450**	.465**	.484**	.319*	.519**	.321*
Black $n = 77$	0.27**	.392**	.297**	.231*	.345**	.324**	.364**	.196
Asian $n = 48$	0.19	.454**	.277	.364*	.436**	.127	.358*	.035
Hispanic $n = 20$	0.28	.332	.348	.160	.297	.168	.488*	.260
Pacific Islander $n = 23$	0.40	.586**	.363	.478*	.466*	.333	.334	.258
USA $n = 97$	0.37**	.589**	.449**	.479**	.523**	.318**	.481**	.313**
Non-USA $n = 131$	0.30**	.433**	.318**	.308**	.377**	.253**	.348**	.188*
English as First Language $n = 151$	0.36**	.544**	.382**	.433**	.482**	.259**	.406**	.260**
English as Second Language $n = 77$	0.27**	.436**	.372**	.297**	.340**	.351**	.398**	.197
First Degree $n = 196$	0.30**	.515**	.410**	.425**	.477**	.239**	.368**	.206**
Post Baccalaureate $n = 32$	0.47**	.472**	.171	.181	.275	.559**	.619**	.356*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 21

Biology GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS							
				SUBSCORE						
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subject	n = 223	0.32**	.488**	.365**	.408**	.412**	.286**	.350**	.243**
Male	*n* = 96	0.31**	.552**	.468**	.394**	.489**	.359**	.385**	.222*
Female	*n* = 127	0.33**	.443**	.281**	.415**	.345**	.251**	.336**	.259**
White	n = 58	0.44**	.608**	.487**	.482**	.435**	.399**	.408**	.396**
Black	*n* = 77	0.28**	.351**	.282*	.244*	.323**	.244*	.350**	.113
Asian	*n* = 45	0.19	.528**	.263	.431**	.538**	.085	.382**	.057
Hispanic	*n* = 20	0.08	-.014	.065	-.128	.006	.090	.202	.246
Pacific Islander	*n* = 23	0.34	.565**	.336	.597**	.468*	.419*	.254	.163
USA	*n* = 95	0.34**	.580**	.482**	.496**	.486**	.346**	.408**	.324**
Non-USA	*n* = 128	0.29**	.384**	.254**	.301**	.347**	.225*	.296**	.174*
English as First Language	*n* = 149	0.36**	.520**	.395**	.461**	.447**	.266**	.317**	.235**
English as Second Language	*n* = 74	0.22*	.374**	.243*	.223	.288*	.318**	.387**	.222
First Degree	*n* = 193	0.33**	.489**	.379**	.418**	.446**	.253**	.316**	.233**
Post Baccalaureate	n = 30	0.10	.346	.279	.193	.198	.372*	.411*	.102

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 22

General Chemistry GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 218	0.34**	.410**	.323**	.323**	.307**	.287**	.330**	.206**
Male	*n* = 94	0.43**	.521**	.398**	.411**	.421**	.436**	.359**	.206*
Female	*n* = 124	0.27*	.327**	.259**	.251**	.204*	.201*	.322**	.210*
White	*n* = 56	0.54**	.609**	.529**	.478**	.457**	.332*	.456**	.391**
Black	*n* = 76	0.31*	.247*	.209	.123	.148	.365**	.393**	.013
Asian	*n* = 43	-0.04	.148	-.054	.100	.217	-.097	.123	.001
Hispanic	*n* = 20	0.15	.201	.444*	.181	-.088	.247	.125	.146
Pacific Islander	*n* = 23	0.67*	.656**	.441*	.468*	.476*	.558**	.338	.414*
USA	*n* = 95	0.53**	.599**	.538**	.482**	.484**	.339**	.478**	.322**
Non-USA	*n* = 123	0.19	.211*	.135	.140	.129	.229*	.195*	.112
English as First Language	*n* = 146	0.47**	.495**	.367**	.384**	.387**	.294**	.418**	.216**
English as Second Language	*n* = 72	0.15	.232*	.239*	.177	.122	.267*	.141	.192
First Degree	*n* = 190	0.28**	.387**	.299**	.316**	.319**	.240**	.305**	.119
Post Baccalaureate	*n* = 28	0.69*	.446*	.490**	.282	.205	.546**	.379*	.473*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 23

Organic Chemistry GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 221	0.39**	.441**	.376**	.349**	.411**	.201**	.385**	.174**
Male	*n* = 93	0.64**	.570**	.472**	.465**	.437**	.481**	.467**	.190
Female	*n* = 128	0.21	.360**	.314**	.265**	.391**	.050	.356**	.166
White	*n* = 58	0.29	.500**	.378**	.379**	.473**	.275*	.481**	.161
Black	*n* = 76	0.27	.271*	.287*	.164	.202	.119	.184	.208
Asian	*n* = 45	0.64**	.653**	.529**	.497**	.581**	.285	.515**	.150
Hispanic	*n* = 20	0.01	.066	.178	.102	.228	-.080	.443	-.324
Pacific Islander	*n* = 22	0.64*	.564**	.334	.422	.409	.245	.480*	.199
USA	*n* = 94	0.21	.448**	.343**	.374**	.479**	.256*	.401**	.161
Non-USA	*n* = 127	0.52**	.434**	.404**	.322**	.345**	.145	.372**	.182*
English as First Language	*n* = 147	0.33**	.461**	.378**	.361**	.449**	.220**	.378**	.178*
English as Second Language	*n* = 74	0.48**	.366**	.341**	.285*	.295*	.143	.373**	.132
First Degree	*n* = 191	0.41**	.458**	.414**	.366**	.430**	.187**	.370**	.155*
Post Baccalaureate	*n* = 30	0.16	.297	.069	.196	.287	.218	.421*	.195

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 24

Math GPA With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 206$	0.17	.185**	.152*	.174*	.108	.164*	.148*	.105
Male $n = 88$	0.09	.168	.147	.214*	.064	.144	.050	.139
Female $n = 118$	0.23	.196*	.156	.153	.140	.176	.209*	.082
White $n = 51$	0.23	.282*	.207	.253	.201	.303*	.356**	-.108
Black $n = 74$	0.02	-.055	.055	-.123	-.112	.063	-.002	.092
Asian $n = 40$	0.10	.154	.044	.396*	.124	.026	-.017	.076
Hispanic $n = 18$	0.79*	.470*	.418	.180	.143	.031	.584*	.262
Pacific Islander $n = 23$	-0.17	.202	.037	.133	.167	.235	-.043	.329
USA $n = 88$	0.25	.263*	.280**	.232*	.185	.270*	.259*	.045
Non-USA $n = 118$	0.11	.114	.060	.120	.040	.060	.063	.144
English as First Language $n = 138$	0.17	.216*	.162	.175*	.131	.204*	.189*	.101
English as Second Language $n = 68$	0.22	.159	.169	.196	.077	.073	.093	.132
First Degree $n = 184$	0.14	.182*	.146*	.197**	.133	.124	.132	.083
Post Baccalaureate $n = 22$	0.45	.267	.252	-.012	-.073	.758**	.407	.336

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

APPENDIX D

TABLES: PRECLINICAL GRADES AND GPAS

Table 25

Fundamentals of Immunohematology Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects *n* = 170	0.56**	.476**	.447**	.376**	.365**	.267**	.316**	.307**
Male *n* = 70	0.65**	.581**	.571**	.413**	.498**	.258*	.399**	.302*
Female *n* = 100	0.51**	.410**	.367**	.385**	.268**	.259**	.262**	.319**
White *n* = 39	0.68**	.665**	.616**	.595**	.479**	.443**	.369*	.489**
Black *n* = 62	0.41*	.247	.318*	.109	.139	.081	.164	.253*
Asian *n* = 35	0.25	.346*	.246	.113	.460**	.142	.279	-.018
Hispanic *n* = 12	0.88*	.708**	.678*	.495	.466	.344	.696*	.387
Pacific Islander *n* = 22	0.82**	.570**	.482*	.412	.341	.283	.415	.368
USA *n* = 75	0.79**	.567**	.572**	.432**	.469**	.317**	.390**	.408**
Non-USA *n* = 95	0.38**	.371**	.321**	.291**	.265**	.204*	.242*	.232*
English as First Language *n* = 116	0.63**	.505**	.495**	.398**	.387**	.249**	.302**	.386**
English as Second Language *n* = 54	0.40*	.353**	.284*	.270*	.258	.288*	.281*	.120
First Degree *n* = 146	0.56**	.476**	.428**	.362**	.381**	.254**	.321**	.317**
Post Baccalaureate *n* = 24	0.59	.503*	.558**	.466*	.299	.357	.312	.299

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 26

Fundamentals of Clinical Chemistry Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 223$	0.49**	.436**	.371**	.397**	.353**	.311**	.289**	.209**
Male $n = 97$	0.41**	.496**	.420**	.401**	.415**	.349**	.301**	.253*
Female $n = 126$	0.54**	.390**	.325**	.409**	.303**	.277**	.278**	.180*
White $n = 61$	0.70**	.511**	.496**	.543**	.426**	.264*	.183	.300*
Black $n = 74$	0.18	.163	.219	.142	.121	.268*	.129	-.023
Asian $n = 46$	0.51**	.560**	.248	.372*	.524**	.319*	.535**	.177
Hispanic $n = 19$	0.71*	.419	.388	.103	.264	.207	.542*	.452
Pacific Islander $n = 23$	0.33	.420*	.354	.492*	.192	.240	.216	.154
USA $n = 98$	0.53**	.519**	.466**	.528**	.449**	.313**	.256*	.305**
Non-USA $n = 125$	0.43**	.334**	.270**	.244**	.263**	.311**	.301**	.125
English as First Language $n = 150$	0.44**	.409**	.365**	.413**	.346**	.268**	.179*	.159
English as Second Language $n = 73$	0.54**	.461**	.336**	.318**	.329**	.402**	.475**	.253*
First Degree $n = 190$	0.45**	.410**	.335**	.366**	.351**	.296**	.266**	.178*
Post Baccalaureate $n = 33$	0.67**	.577**	.609**	.565**	.363*	.325	.396*	.307

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 27

Fundamentals of Hematology Grade With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	n = 224	0.41**	.399**	.267**	.276**	.366**	.300**	.270**	.198**
Male	n = 98	0.44**	.528**	.356**	.296**	.501**	.374**	.346**	.327**
Female	n = 126	0.38**	.302**	.191*	.272**	.256**	.241**	.213*	.109
White	n = 60	0.56**	.492**	.405**	.480**	.334**	.317*	.169	.355**
Black	n = 74	0.39*	.316**	.198	.153	.308**	.305**	.256*	.203
Asian	n = 47	0.25	.349*	.143	.110	.440**	.159	.265	.026
Hispanic	n = 20	0.62**	.506*	.487*	.222	.439	.298	.720**	.047
Pacific Islander	n = 23	0.10	.283	.056	.173	.289	.436*	.200	.044
USA	n = 97	0.50**	.472**	.383**	.382**	.415**	.300**	.246*	.297**
Non-USA	n = 127	0.33**	.323**	.164	.161	.321**	.302**	.280**	.121
English as First Language	n = 149	0.51**	.459**	.297**	.342**	.435**	.269**	.250**	.286**
English as Second Language	n = 75	0.21	.242*	.168	.088	.192	.363**	.278*	.018
First Degree	n = 191	0.35**	.368**	.231**	.245**	.363**	.275**	.229**	.183*
Post Baccalaureate	n = 33	0.69**	.492**	.436*	.356*	.354*	.369*	.447**	.169

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 28

Principles of Immunology Grade With Certification Examination Pass/Fail, Total, and SubScores

	PASS/ FAIL Difference in Means	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 219$	0.46**	.387**	.266**	.297**	.374**	.210**	.261**	.178**
Male $n = 96$	0.42**	.419**	.338**	.231*	.407**	.154	.310**	.151
Female $n = 123$	0.48**	.363**	.206*	.346**	.345**	.260**	.230**	.198*
White $n = 57$	0.86**	.581**	.351**	.539**	.479**	.309*	.379**	.305*
Black $n = 75$	0.19	.163	.139	.036	.237*	.064	.048	.126
Asian $n = 45$	0.31	.324*	.091	.033	.409**	.123	.264	.060
Hispanic $n = 19$	0.81*	.550*	.483*	.444	.485*	.545*	.594**	.147
Pacific Islander $n = 23$	0.45	.379	.483*	.283	.114	.130	.273	-.007
USA $n = 94$	0.49**	.445**	.343**	.394**	.398**	.161	.294**	.285**
Non-USA $n = 125$	0.40**	.318**	.192*	.194*	.358**	.247**	.221*	.094
English as First Language $n = 146$	0.38**	.342**	.174*	.277**	.323**	.122	.179*	.235**
English as Second Language $n = 73$	0.58**	.478**	.425**	.318**	.465**	.399**	.395**	.056
First Degree $n = 190$	0.42**	.359**	.231**	.269**	.379**	.171*	.254**	.125
Post Baccalaureate $n = 29$	0.72**	.566**	.573**	.461*	.352	.493**	.287	.428*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 29

Fundamentals of Clinical Microbiology Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL Difference in Means	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 223$	0.49**	.434**	.326**	.320**	.438**	.184**	.306**	.253**
Male $n = 96$	0.43**	.523**	.365**	.310**	.545**	.273**	.423**	.265**
Female $n = 127$	0.54**	.375**	.299**	.331**	.365**	.122	.230**	.247**
White $n = 59$	0.75**	.508**	.449**	.507**	.448**	.159	.269*	.246
Black $n = 75$	0.37**	.311**	.238*	.204	.416**	.110	.167	.179
Asian $n = 46$	0.27	.279	.124	.111	.347*	-.052	.359*	.177
Hispanic n = 20	0.73**	.617**	.546*	.410	.467*	.488*	.459*	.436
Pacific Islander $n = 23$	0.29	.401	.257	-.023	.413*	.333	.468*	.241
USA $n = 96$	0.69**	.571**	.493**	.492**	.557**	.237*	.341**	.358**
Non-USA $n = 127$	0.34**	.298**	.190*	.143	.335**	.129	.271**	.171
English as First Language $n = 149$	0.59**	.477**	.360**	.383**	.486**	.190*	.269**	.263**
English as Second Language $n = 74$	0.36*	.351**	.253*	.170	.334**	.164	.372**	.228
First Degree $n = 191$	0.48**	.424**	.322**	.285**	.463**	.177*	.294**	.236**
Post Baccalaureate $n = 32$	0.61**	.523**	.358*	.525**	.321	.223	.391*	.355*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 30

Preclinical Courses GPA With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 227$	0.48**	.541**	.422**	.432**	.485**	.320**	.359**	.285**
Male $n = 98$	0.45**	.647**	.505**	.426**	.604**	.367**	.447**	.327**
Female $n = 129$	0.50**	.463**	.354**	.447**	.394**	.282**	.296**	.258**
White $n = 61$	0.76**	.659**	.552**	.650**	.527**	.318*	.333**	.400**
Black $n = 76$	0.28**	.312**	.292**	.179	.336**	.231*	.164	.174
Asian $n = 47$	0.33*	.497**	.188	.202	.567**	.209	.483**	.132
Hispanic $n = 20$	0.74**	.618**	.564**	.363	.472*	.479*	.681**	.308
Pacific Islander $n = 23$	0.37*	.564**	.453*	.354	.374	.379	.433*	.214
USA $n = 98$	0.60**	.650**	.558**	.586**	.581**	.318**	.376**	.422**
Non-USA $n = 129$	0.38**	.416**	.287**	.250**	.400**	.324**	.337**	.171
English as First Language $n = 152$	0.51**	.545**	.417**	.463**	.496**	.264**	.272**	.324**
English as Second Language $n = 75$	0.45**	.514**	.401**	.323**	.436**	.447**	.510**	.183
First Degree $n = 191$	0.46**	.522**	.384**	.396**	.502**	.302**	.350**	.248**
Post Baccalaureate $n = 36$	0.64**	.618**	.606**	.569**	.397*	.383*	.357*	.397*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

APPENDIX E

TABLES: CLINICAL-YEAR GRADES AND GPAS

Table 31

Immunohematology and Transfusion Medicine GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 233	0.71**	.696**	.599**	.532**	.576**	.420**	.473**	.390**
Male	*n* = 99	0.65**	.692**	.580**	.504**	.621**	.342**	.422**	.383**
Female	*n* = 134	0.75**	.706**	.621**	.576**	.548**	.471**	.509**	.401**
White	*n* = 62	0.81**	.700**	.638**	.661**	.572**	.390**	.401**	.419**
Black	*n* = 77	0.65**	.654**	.587**	.367**	.585**	.391**	.454**	.531**
Asian	*n* = 51	0.34*	.560**	.365**	.202	.553**	.290*	.475**	.119
Hispanic	*n* = 20	0.83**	.671**	.588**	.328	.568**	.433	.761**	.290
Pacific Islander	*n* = 23	0.80**	.735**	.702**	.656**	.401	.474*	.401	.233
USA	*n* = 98	0.74**	.734**	.648**	.656**	.626**	.483**	.455**	.458**
Non-USA	*n* = 135	0.67**	.649**	.542**	.392**	.539**	.368**	.481**	.332**
English as First Language	*n* = 152	0.68**	.706**	.587**	.586**	.587**	.419**	.404**	.431**
English as Second Language	*n* = 81	0.69**	.621**	.560**	.347**	.506**	.423**	.532**	.257*
First Degree	*n* = 196	0.68**	.669**	.576**	.485**	.576**	.406**	.441**	.355**
Post Baccalaureate	*n* = 37	0.78**	.765**	.686**	.666**	.550**	.378*	.541**	.434**

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 32

Clinical Chemistry GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	$n = 233$	0.59**	.649**	.537**	.528**	.583**	.430**	.455**	.340**
Male	$n = 99$	0.59**	.728**	.624**	.544**	.672**	.492**	.490**	.461**
Female	$n = 134$	0.59**	.593**	.466**	.515**	.509**	.407**	.441**	.261**
White	$n = 62$	0.60**	.608**	.513**	.512**	.602**	.308*	.337**	.323**
Black	$n = 77$	0.63**	.605**	.494**	.423**	.553**	.491**	.545**	.420**
Asian	$n = 51$	0.34*	.628**	.438**	.427**	.615**	.291*	.410**	.116
Hispanic	$n = 20$	0.84**	.617**	.649**	.511*	.342	.496*	.743**	.197
Pacific Islander	$n = 23$	0.28	.657**	.518*	.643**	.442*	.636**	.184	.402
USA	$n = 98$	0.48**	.642**	.529**	.542**	.624**	.417**	.376**	.369**
Non-USA	$n = 135$	0.65**	.651**	.529**	.508**	.558**	.447**	.502**	.312**
English as First Language	$n = 152$	0.54**	.631**	.493**	.519**	.594**	.411**	.402**	.330**
English as Second Language	$n = 81$	0.64**	.663**	.585**	.513**	.533**	.467**	.505**	.310**
First Degree	$n = 196$	0.56**	.634**	.517**	.500**	.581**	.424**	.446**	.363**
Post Baccalaureate	$n = 37$	0.62**	.646**	.603**	.563**	.579**	.321	.373*	.132

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 33

Hematology and Hemostasis GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	$n = 233$	0.58**	.623**	.483**	.470**	.553**	.386**	.465**	.337**
Male	$n = 99$	0.49**	.661**	.487**	.467**	.635**	.321**	.421**	.414**
Female	$n = 134$	0.65**	.595**	.482**	.478**	.490**	.437**	.496**	.288**
White	$n = 62$	0.84**	.668**	.589**	.591**	.604**	.311*	.378**	.387**
Black	$n = 77$	0.46**	.531**	.399**	.268*	.498**	.388**	.478**	.392**
Asian	$n = 51$	0.37*	.579**	.373**	.328*	.527**	.331*	.426**	.145
Hispanic	$n = 20$	0.82**	.692**	.555*	.469*	.635**	.492*	.717**	.368
Pacific Islander	$n = 23$	0.32	.537**	.389	.498*	.289	.291	.412	.130
USA	$n = 98$	0.58**	.638**	.498**	.584**	.641**	.409**	.440**	.348**
Non-USA	$n = 135$	0.57**	.606**	.460**	.365**	.487**	.372**	.476**	.321**
English as First Language	$n = 152$	0.55**	.605**	.431**	.468**	.586**	.374**	.409**	.328**
English as Second Language	$n = 81$	0.61**	.645**	.556**	.447**	.461**	.407**	.535**	.316**
First Degree	$n = 196$	0.53**	.600**	.474**	.438**	.535**	.376**	.428**	.321**
Post Baccalaureate	$n = 37$	0.76**	.654**	.482**	.522**	.604**	.316	.390*	.304

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 34

Clinical Immunology Grade With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 233	0.30**	.312**	.168**	.301**	.307**	.256**	.125	.183**
Male	*n* = 99	0.23*	.363**	.222*	.295**	.361**	.296**	.139	.176
Female	*n* = 134	0.35**	.284**	.136	.300**	.274**	.254**	.124	.188*
White	*n* = 62	0.56**	.419**	.303*	.428**	.402**	.263*	.173	.172
Black	*n* = 77	0.37**	.271*	.048	.221	.273*	.301**	.223	.218
Asian	*n* = 51	0.02	.054	.008	.094	.160	.053	-.081	.038
Hispanic	*n* = 20	0.06	.328	.130	.282	.295	.182	.088	.137
Pacific Islander	*n* = 23	0.14	.327	.348	.352	.196	.374	-.179	.369
USA	*n* = 98	0.37**	.387**	.301**	.353**	.389**	.285**	.120	.306**
Non-USA	*n* = 135	0.25*	.253**	.070	.260**	.237**	.232**	.128	.101
English as First Language	*n* = 152	0.36**	.356**	.183*	.332**	.368**	.281**	.167*	.211**
English as Second Language	*n* = 81	0.30**	.351**	.253*	.319**	.238*	.219*	.134	.213
First Degree	*n* = 196	0.24**	.239**	.106	.227**	.273**	.214**	.064	.130
Post Baccalaureate	*n* = 37	0.54**	.602**	.502**	.606**	.450**	.415*	.362*	.312

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 35

Laboratory Management and LIS GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL Difference in Means†	CORRELATIONS						
			TOTAL SCORE	SUBSCORE					
				Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	n = 233	0.19**	.322**	.309**	.232**	.259**	.257**	.269**	.168**
Male	n = 99	0.19*	.316**	.335**	.153	.258**	.386**	.238*	.199*
Female	n = 134	0.19 *	.326**	.290**	.291**	.265**	.165	.289**	.148
White	n = 62	0.23*	.335**	.250*	.286*	.257*	.279*	.314*	.135
Black	n = 77	0.20	.282*	.442**	.166	.160	.142	.283*	.243*
Asian	n = 51	0.06	.166	.068	-.019	.271	.297*	.101	-.153
Hispanic	n = 20	0.19	.353	.307	.189	.356	.285	.430	.404
Pacific Islander	n = 23	0.08	.370	.244	.352	.170	.320	.121	.448*
USA	n = 98	0.20**	.299**	.245*	.302**	.250*	.360**	.279**	.067
Non-USA	n = 135	0.17 *	.325**	.327**	.167	.272**	.198*	.257**	.205*
English as First Language	n = 152	0.16 *	.321**	.287**	.268**	.215**	.360**	.294**	.126
English as Second Language	n = 81	0.14	.226*	.253*	.088	.272*	.081	.134	.143
First Degree	n = 196	0.18 **	.300**	.284**	.212**	.252**	.279**	.249**	.153*
Post Baccalaureate	n = 37	0.16	.332*	.395*	.227	.243	-.008	.281	.137

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 36

Clinical Microbiology GPA With Certification Examination Pass/Fail, Total Score, and SubScores

	PASS/ FAIL Difference in Means†	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 233$	0.35**	.455**	.293**	.303**	.437**	.298**	.296**	.302**
Male $n = 99$	0.30**	.524**	.319**	.334**	.556**	.344**	.293**	.307**
Female $n = 134$	0.39**	.409**	.274**	.286**	.351**	.269**	.297**	.299**
White $n = 62$	0.52**	.499**	.357**	.409**	.513**	.199	.310*	.200
Black $n = 77$	0.40**	.460**	.266*	.281*	.407**	.431**	.388**	.401**
Asian $n = 51$	0.10	.199	.092	-.008	.272	.056	.125	.148
Hispanic $n = 20$	0.44	.554*	.379	.351	.445*	.287	.285	.318
Pacific Islander $n = 23$	0.03	.392	.203	.088	.370	.419*	.147	.539**
USA $n = 98$	0.46**	.568**	.414**	.449**	.562**	.357**	.304**	.352**
Non-USA $n = 135$	0.28**	.362**	.203*	.171*	.327**	.245**	.290**	.269**
English as First Language $n = 152$	0.46**	.527**	.333**	.398**	.500**	.370**	.353**	.314**
English as Second Language $n = 81$	0.23*	.341**	.235*	.088	.311**	.133	.207	.303**
First Degree $n = 196$	0.29**	.399**	.240**	.232**	.408**	.285**	.255**	.255**
Post Baccalaureate $n = 37$	0.67**	.645**	.527**	.535**	.531**	.257	.418**	.410*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 37

Clinical Microscopy Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS							
			SUBSCORE						
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects *n* = 187	0.59**	.552**	.401**	.466**	.508**	.369**	.354**	.241**
Male *n* = 87	0.50**	.558**	.381**	.442**	.514**	.409**	.329**	.297**
Female *n* = 100	0.68**	.548**	.423**	.492**	.508**	.333**	.371**	.199*
White *n* = 55	0.64**	.511**	.333*	.437**	.528**	.260	.335*	.203
Black *n* = 54	0.69**	.505**	.380**	.453**	.434**	.360**	.225	.210
Asian *n* = 41	0.20	.460**	.312*	.230	.571**	.237	.385*	-.022
Hispanic *n* = 18	0.58	.461	.409	.465	.368	.386	.411	.151
Pacific Islander *n* = 19	0.24	.484*	.315	.406	.155	.489*	.125	.555*
USA *n* = 76	0.50**	.542**	.358**	.498**	.488**	.430**	.359**	.257*
Non-USA *n* = 111	0.62**	.545**	.388**	.422**	.517**	.339**	.336**	.195*
English as First Language *n* = 114	0.63**	.593**	.410**	.558**	.495**	.409**	.371**	.311**
English as Second Language *n* = 73	0.49**	.458**	.337**	.285*	.500**	.314**	.273*	.117
First Degree *n* = 158	0.57**	.533**	.366**	.431**	.492**	.394**	.355**	.255**
Post Baccalaureate *n* = 29	0.62*	.570**	.517**	.549**	.550**	.096	.226	.114

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 38

Specimen Procurement and Processing Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL Difference in Means†	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects *n* = 226	0.20**	.365**	.273**	.255**	.292**	.286**	.280**	.195**
Male *n* = 98	0.07	.227*	.132	.148	.214*	.129	.100	.071
Female *n* = 128	0.30**	.467**	.395**	.333**	.358**	.396**	.402**	.278**
White *n* = 60	0.02	.310*	.273*	.224	.293*	.054	.282*	.203
Black *n* = 73	0.15	.214	.124	.145	.199	.165	.174	.105
Asian *n* = 50	0.22*	.260	.161	.014	.200	.244	.290*	.066
Hispanic *n* = 20	0.35*	.628**	.484*	.596**	.425	.729**	.507*	.360
Pacific Islander *n* = 23	0.24	.533**	.394	.271	.494*	.297	.162	.365
USA *n* = 95	0.13**	.400**	.342**	.275**	.378**	.398**	.286**	.237*
Non-USA *n* = 131	0.23**	.336**	.211*	.226**	.254**	.234**	.266**	.159
English as First Language *n* = 146	0.12**	.335**	.211*	.240**	.244**	.276**	.247**	.173*
English as Second Language *n* = 80	0.28**	.362**	.293**	.238*	.329**	.314**	.254*	.163
First Degree *n* = 192	0.19**	.331**	.250**	.197**	.284**	.303**	.235**	.179*
Post Baccalaureate *n* = 34	0.30*	.537**	.396*	.495**	.325	.215	.544 **	.254

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 39

Immunohematology Practicum Grade With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 233	0.51**	.577**	.508**	.465**	.463**	.405**	.462**	.256**
Male	*n* = 99	0.39**	.525**	.391**	.393**	.500**	.382**	.473**	.137
Female	*n* = 134	0.59**	.620**	.611**	.530**	.439**	.419**	.453**	.341**
White	*n* = 62	0.61**	.651**	.607**	.595**	.579**	.299*	.489**	.316*
Black	*n* = 77	0.51**	.549**	.470**	.425**	.392**	.448**	.429**	.395**
Asian	*n* = 51	0.33*	.436**	.374**	.245	.401**	.326*	.428**	-.075
Hispanic	*n* = 20	0.52*	.486*	.520*	.320	.385	.552*	.526*	.066
Pacific Islander	*n* = 23	0.29	.491*	.280	.313	.274	.251	.574**	.247
USA	*n* = 98	0.61**	.715**	.612**	.624**	.648**	.480**	.489**	.452**
Non-USA	*n* = 135	0.43**	.465**	.428**	.327**	.314**	.345**	.439**	.125
English as First Language	*n* = 152	0.58**	.670**	.567**	.571**	.590**	.449**	.440**	.362**
English as Second Language	*n* = 81	0.37**	.374**	.365**	.224*	.193	.322**	.462**	.055
First Degree	*n* = 196	0.51**	.580**	.496**	.435**	.499**	.396**	.457**	.233**
Post Baccalaureate	*n* = 37	0.45*	.553**	.547**	.583**	.284	.402*	.438**	.303

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 40

Clinical Chemistry Practicum Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL Difference in Means†	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 233$	0.21**	.372**	.279**	.423**	.351**	.253**	.192**	.217**
Male $n = 99$	0.20*	.407**	.285**	.503**	.366**	.263**	.159	.243*
Female $n = 134$	0.22**	.345**	.273**	.365**	.336**	.259**	.221**	.200*
White $n = 62$	0.40**	.512**	.457**	.479**	.508**	.224	.315*	.318*
Black $n = 77$	0.19	.223	.193	.377**	.178	.261*	.151	.121
Asian $n = 51$	-0.04	.180	-.017	.270	.328*	.064	.026	.030
Hispanic $n = 20$	0.26	.320	.355	.290	.143	.444*	.398	-.012
Pacific Islander $n = 23$	0.02	.219	.105	.342	.088	.084	-.217	.489*
USA $n = 98$	0.27*	.498**	.417**	.490**	.537**	.281**	.263**	.370**
Non-USA $n = 135$	0.17*	.231**	.145	.341**	.160	.221**	.124	.091
English as First Language $n = 152$	0.25**	.401**	.295**	.466**	.403**	.244**	.209**	.241**
English as Second Language $n = 81$	0.20	.300**	.225*	.315**	.223*	.266*	.131	.158
First Degree $n = 196$	0.18**	.325**	.218**	.396**	.303**	.257**	.155*	.188**
Post Baccalaureate $n = 37$	0.46*	.552**	.541**	.525**	.515**	.216	.341*	.289

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 41

Hematology and Hemostasis Practicum Grade With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	PEARSON CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	$n = 233$	0.35**	.461**	.356**	.354**	.380**	.378**	.413**	.260**
Male	$n = 99$	0.47**	.483**	.369**	.291**	.442**	.373**	.397**	.306**
Female	$n = 134$	0.25**	.446**	.343**	.412**	.321**	.395**	.435**	.228**
White	$n = 62$	0.54**	.542**	.365**	.404**	.477**	.386**	.472**	.373**
Black	$n = 77$	0.25*	.302**	.276*	.255*	.154	.444**	.405**	.194
Asian	$n = 51$	0.19	.403**	.256	.162	.448**	.241	.275	.079
Hispanic	$n = 20$	0.18	.305	.348	.135	.367	.304	.283	.286
Pacific Islander	$n = 23$	0.47**	.597**	.496*	.538**	.260	.237	.525**	.121
USA	$n = 98$	0.49**	.573**	.472**	.443**	.518**	.444**	.443**	.358**
Non-USA	$n = 135$	0.25**	.369**	.268**	.277**	.263**	.321**	.390**	.193*
English as First Language	$n = 152$	0.39**	.473**	.334**	.395**	.394**	.400**	.422**	.268**
English as Second Language	$n = 81$	0.23*	.375**	.328**	.207	.305**	.328**	.334**	.190
First Degree	$n = 196$	0.32**	.436**	.348**	.333**	.384**	.354**	.398**	.211**
Post Baccalaureate	$n = 37$	0.49**	.519**	.343*	.377*	.328*	.443**	.419**	.388*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 42

Immunology Practicum Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS / FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects *n* = 233	0.25**	.291**	.229**	.252**	.249**	.233**	.184**	.110
Male *n* = 99	0.13	.226*	.170	.177	.283**	.253*	.064	.004
Female *n* = 134	0.34**	.338**	.279**	.305**	.222**	.223**	.266**	.181*
White *n* = 62	0.45**	.312*	.227	.246	.346**	.138	.143	.173
Black *n* = 77	0.26*	.268*	.218	.193	.231*	.322**	.219	.125
Asian *n* = 51	0.04	.259	.303*	.172	.211	.064	.161	-.135
Hispanic *n* = 20	0.26	.135	.074	.248	.044	.338	.173	.063
Pacific Islander *n* = 23	-0.04	.008	-.016	.261	-.187	-.019	-.224	.250
USA *n* = 98	0.35**	.369**	.242*	.332**	.386**	.212*	.143	.266**
Non-USA *n* = 135	0.19*	.233**	.231**	.189*	.124	.256**	.221**	.005
English as First Language *n* = 152	0.33**	.361**	.258**	.321**	.339**	.224**	.213**	.148
English as Second Language *n* = 81	0.19	.204	.229*	.129	.078	.264*	.179	.078
First Degree *n* = 196	0.21**	.240**	.211**	.209**	.207**	.227**	.141*	.047
Post Baccalaureate *n* = 37	0.33*	.430**	.257	.342*	.421**	.054	.289	.250

* Significant at the 0.05 level (2-tailed). **Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 43

Clinical Microbiology Practicum Grade With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 233	0.30**	.434**	.371**	.316**	.405**	.313**	.285**	.206**
Male	*n* = 99	0.19	.414**	.344**	.359**	.391**	.333**	.187	.237*
Female	*n* = 134	0.39**	.450**	.396**	.299**	.426**	.289**	.347**	.187*
White	*n* = 62	0.46**	.452**	.408**	.332**	.504**	.282*	.250*	.212
Black	*n* = 77	0.34**	.480**	.340**	.365**	.399**	.426**	.425**	.301**
Asian	*n* = 51	-0.05	.224	.157	.096	.302*	.147	.132	-.036
Hispanic	*n* = 20	0.61*	.459*	.704**	.299	.073	.336	.327	.117
Pacific Islander	*n* = 23	0.19	.534**	.382	.486*	.336	.201	.211	.369
USA	*n* = 98	0.37**	.506**	.432**	.413**	.510**	.387**	.287**	.293**
Non-USA	*n* = 135	0.27**	.387**	.341**	.241**	.309**	.243**	.290**	.152
English as First Language	*n* = 152	0.39**	.508**	.389**	.370**	.501**	.377**	.350**	.247**
English as Second Language	*n* = 81	0.21	.319**	.369**	.215	.216	.179	.182	.150
First Degree	*n* = 196	0.28**	.393**	.323**	.289**	.382**	.296**	.242**	.144*
Post Baccalaureate	*n* = 37	0.63**	.560**	.581**	.370*	.470**	.334*	.440**	.367*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 44

Clinical Microscopy Practicum Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subject $n = 233$	0.28**	.262**	.198**	.267**	.177**	.170**	.165*	.242**
Male $n = 99$	0.26*	.281**	.225*	.285**	.246*	.082	.095	.260**
Female $n = 134$	0.29**	.249**	.178*	.252**	.122	.243**	.215*	.232**
White $n = 62$	0.41**	.382**	.384**	.297*	.349**	.151	.244	.241
Black $n = 77$	0.21	.090	.063	.176	.024	.094	.119	.089
Asian $n = 51$	0.26	.197	.081	.142	.139	.111	.119	.374**
Hispanic $n = 20$	0.33	.595**	.364	.465*	.453*	.233	.356	.304
Pacific Islander $n = 23$	-0.06	-.047	-.053	.213	-.254	.086	-.218	.164
USA $n = 98$	0.33**	.349**	.364**	.278**	.347**	.209*	.166	.293**
Non-USA $n = 135$	0.23*	.184*	.073	.247**	.047	.141	.157	.204*
English as First Language $n = 152$	0.29**	.243**	.179*	.275**	.192*	.175*	.168*	.192*
English as Second Language $n = 81$	0.28*	.321**	.243*	.265*	.154	.163	.165	.319**
First Degree $n = 196$	0.20**	.185**	.114	.241**	.125	.157*	.121	.155*
Post Baccalaureate $n = 37$	0.78**	.529**	.565**	.222	.346*	.181	.323	.495**

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 45

Independent Project Grade With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subject $n = 233$	0.06	.140*	.065	.125	.104	.176**	.158*	.106
Male $n = 99$	0.00	.046	-.027	.051	-.002	.169	.014	.103
Female $n = 134$	0.11**	.238**	.171*	.214*	.234**	.168	.286**	.114
White $n = 62$	††	††	††	††	††	††	††	††
Black $n = 77$	0.07	.047	.060	.024	-.007	.114	.078	.053
Asian $n = 51$	0.07	.269	.083	.178	.029	.300*	.309*	.179
Hispanic $n = 20$	0.18	.290	.008	.378	.528*	.444	.452*	.110
Pacific Islander $n = 23$	-0.08	-.004	-.117	-.125	.166	-.169	-.006	.188
USA $n = 98$	-0.02	.084	-.033	.181	.096	.190	.037	.057
Non-USA $n = 135$	0.11*	.156	.080	.092	.114	.192*	.200*	.115
English as First Language $n = 152$	0.01	.109	.047	.148	.111	.139	.080	-.023
English as Second Language $n = 81$	0.10	.107	-.002	.068	.061	.241*	.168	.143
First Degree $n = 196$	0.07	.138	.064	.120	.110	.178*	.151*	.109
Post Baccalaureate $n = 37$	-0.02	.034	-.026	.064	-.028	-.015	.158	-.011

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed).
† Tested by ANOVA. †† No statistics reported due to no variability on Independent Project grades for Whites.

APPENDIX F

TABLES: CUMULATIVE GPAS

Table 46

Clinical-year Didactic GPA With Certification Examination Pass/Fail, Total Score, and Subscores

	PASS/ FAIL	**CORRELATIONS**						
			SUBSCORE					
	Difference in Means†	**TOTAL SCORE**	**Blood Bank**	**Chemistry**	**Hematology**	**Immunology**	**Microbiology**	**Body Fluids**
All Subject *n* = 233	0.51**	.684**	.541**	.520**	.610**	.444**	.482**	.380**
Male *n* = 99	0.46**	.741**	.575**	.521**	.703**	.455**	.475**	.449**
Female *n* = 134	0.55**	.643**	.515**	.524**	.539**	.442**	.489**	.336**
White *n* = 62	0.64**	.677**	.565**	.593**	.636**	.336**	.394**	.350**
Black *n* = 77	0.51**	.635**	.503**	.395**	.567**	.493**	.541**	.490**
Asian *n* = 51	0.25*	.567**	.355*	.263	.593**	.300*	.423**	.116
Hispanic *n* = 20	0.63**	.718**	.609**	.485*	.562**	.490*	.702**	.325
Pacific Islander *n* = 23	0.32	.746**	.612**	.598**	.445*	.606**	.382	.447*
USA *n* = 98	0.52**	.729**	.597**	.630**	.695**	.484**	.440**	.430**
Non-USA *n* = 135	0.49**	.641**	.486**	.410**	.545**	.414**	.506**	.338**
English as First Language *n* = 152	0.52**	.689**	.516**	.553**	.632**	.459**	.445**	.389**
English as Second Language *n* = 81	0.48**	.652**	.556**	.401**	.531**	.406**	.513**	.326**
First Degree *n* = 196	0.48**	.653**	.513**	.469**	.600**	.438**	.460**	.370**
Post Baccalaureate *n* = 37	0.61**	.759**	.649**	.655**	.638**	.345*	.487**	.316

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 47

Clinical-year Practica GPA With Certification Examination Pass/Fail, Total Score, And Subscores

	PASS/FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects $n = 233$	0.32**	.595**	.484**	.501**	.513**	.431**	.434**	.313**
Male $n = 99$	0.27**	.581**	.435**	.492**	.542**	.424**	.371**	.302**
Female $n = 134$	0.35**	.606**	.527**	.516**	.491**	.440**	.481**	.323**
White $n = 62$	0.45**	.613**	.529**	.502**	.595**	.328**	.437**	.355**
Black $n = 77$	0.30**	.543**	.444**	.493**	.397**	.527**	.484**	.364**
Asian $n = 51$	0.10	.442**	.262	.272	.510**	.284*	.317*	.022
Hispanic $n = 20$	0.39**	.607**	.712**	.433	.357	.621**	.576**	.189
Pacific Islander $n = 23$	0.20	.575**	.387	.539**	.290	.246	.314	.408
USA $n = 98$	0.39**	.684**	.576**	.583**	.668**	.477**	.444**	.448**
Non-USA $n = 135$	0.26**	.502**	.401**	.411**	.357**	.384**	.425**	.208*
English as First Language $n = 152$	0.35**	.629**	.480**	.549**	.576**	.448**	.440**	.348**
English as Second Language $n = 81$	0.25**	.491**	.454**	.352**	.336**	.388**	.382**	.217
First Degree $n = 196$	0.29**	.569**	.449**	.475**	.511**	.430**	.409**	.265**
Post Baccalaureate $n = 37$	0.48**	.657**	.613**	.553**	.489**	.382*	.498**	.409*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 48

Clinical-year GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	$n = 233$	0.41**	.684**	.546**	.540**	.602**	.463**	.489**	.372**
Male	$n = 99$	0.37**	.714**	.546**	.539**	.673**	.467**	.456**	.409**
Female	$n = 134$	0.45**	.662**	.547**	.548**	.548**	.465**	.512**	.349**
White	$n = 62$	0.55**	.675**	.571**	.574**	.643**	.345**	.430**	.365**
Black	$n = 77$	0.41**	.643**	.514**	.467**	.538**	.544**	.555**	.472**
Asian	$n = 51$	0.18	.563**	.347*	.291*	.610**	.318*	.413**	.088
Hispanic	$n = 20$	0.51**	.721**	.695**	.498*	.516*	.580**	.698**	.284
Pacific Islander	$n = 23$	0.26	.713**	.550**	.603**	.402	.487*	.376	.455*
USA	$n = 98$	0.46**	.740**	.613**	.635**	.713**	.501**	.461**	.457**
Non-USA	$n = 135$	0.38**	.625**	.481**	.438**	.501**	.429**	.505**	.305**
English as First Language	$n = 152$	0.44**	.697**	.525**	.577**	.640**	.477**	.465**	.391**
English as Second Language	$n = 81$	0.36**	.630**	.552**	.411**	.484**	.428**	.494**	.301**
First Degree	$n = 196$	0.38**	.655**	.515**	.498**	.596**	.460**	.464**	.345**
Post Baccalaureate	$n = 37$	0.55**	.750**	.664**	.639**	.602**	.380*	.518**	.378*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 49

Cumulative Graduating GPA With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/FAIL Difference in Means†	CORRELATIONS						
			TOTAL SCORE	SUBSCORE					
				Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	$n = 217$	0.31**	.641**	.491**	.499**	.560**	.376**	.454**	.353**
Male	$n = 96$	0.32**	.684**	.506**	.509**	.610**	.440**	.415**	.366**
Female	$n = 121$	0.31**	.609**	.478**	.499**	.510**	.337**	.498**	.345**
White	$n = 52$	0.34**	.683**	.588**	.620**	.602**	.311*	.471**	.301*
Black	$n = 74$	0.31**	.569**	.449**	.365**	.473**	.425**	.469**	.454**
Asian	$n = 49$	0.18*	.569**	.313*	.331*	.573**	.284*	.445**	.127
Hispanic	$n = 19$	0.36*	.626**	.538*	.312	.464*	.333	.574**	.526*
Pacific Islander	$n = 23$	0.25	.652**	.440*	.512*	.452*	.434*	.408	.356
USA	$n = 86$	0.32**	.686**	.562**	.607**	.674**	.413**	.463**	.341**
Non-USA	$n = 131$	0.31**	.594**	.432**	.389**	.460**	.347**	.445**	.363**
English as First Language	$n = 139$	0.32**	.651**	.468**	.538**	.615**	.360**	.423**	.349**
English as Second Language	$n = 78$	0.29**	.583**	.498**	.360**	.394**	.413**	.476**	.336**
First Degree	$n = 187$	0.29**	.603**	.472**	.468**	.542**	.346**	.418**	.328**
Post Baccalaureate	$n = 30$	0.42**	.787**	.703**	.610**	.616**	.470**	.568**	.379*

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). † Tested by ANOVA.

APPENDIX G

TABLES: SELECT ACADEMIC MEASURES VARIABLES WITH GEOGRAPHIC REGION SUBGROUPS NOT COLLAPSED

Table 50

Admission Cumulative GPA for All Subgroups With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS - FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 229	0.21**	.428**	.337**	.304**	.386**	.227**	.332**	.215**
Male	*n* = 97	0.24**	.501**	.378**	.348**	.435**	.337**	.357**	.217*
Female	*n* = 132	0.18**	.370**	.299**	.279**	.344**	.133	.315**	.218*
White	*n* = 60	0.19	.461**	.362**	.386**	.395**	.216	.373**	.097
Black	*n* = 77	0.22**	.369**	.367**	.162	.282*	.277*	.359**	.291**
Asian	*n* = 49	0.14	.372**	.165	.268	.419**	.087	.300*	.093
Hispanic	n = 20	0.07	.148	.126	-.100	.277	-.025	.306	.227
Pacific Islander	*n* = 23	0.24	.548**	.318	.402	.431*	.390	.347	.310
USA	*n* = 97	0.21*	.476**	.400**	.400**	.447**	.269**	.369**	.134
Bermuda & Canada	*n* = 16	-0.04	.376	.203	.405	.316	-.081	-.021	.296
Caribbean & West Indies	*n* = 41	0.33**	.459**	.385*	.063	.388*	.311*	.455**	.370*
Inter & South America	*n* = 7	0.42	.683	.324	.668	.775*	.576	.555	.120
Europe	*n* = 5	0.48	.954*	.706	.912*	.759	.755	.695	.921*
Africa	*n* = 15	0.16	.210	.348	-.004	.029	.221	.427	.301
Southern Asia	*n* = 7	0.27	.161	-.306	.325	.323	.155	.209	.009

Table 50—*Continued.*

	PASS - FAIL Difference in Means†	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Southeast Asia & South Pacific *n* = 26	0.16	.286	.264	.159	.084	-.104	.179	.310
Northern Asia *n* = 15	0.00	.231	.115	-.083	.317	-.012	.176	.268
English as First Language *n* = 151	0.23**	.460**	.357**	.356**	.427**	.231**	.321**	.185*
English as Second Language *n* = 78	0.17*	.344**	.275*	.141	.264*	.208	.348**	.265*
First Degree *n* = 196	0.19**	.450**	.361**	.328**	.424**	.201**	.318**	.228**
Post Baccalaureate *n* = 33	0.23	.242	.100	.074	.142	.347*	.339	.080

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 51

Admission Science GPA for All Subgroups With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS							
				SUBSCORE						
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	n = 228	0.34**	.520**	.389**	.406**	.450**	.288**	.412**	.248**
Male	n = 96	0.39**	.574**	.433**	.438**	.492**	.401**	.425**	.236*
Female	n = 132	0.30**	.479**	.349**	.388**	.414**	.209*	.408**	.260**
White	n = 60	0.43**	.609**	.450**	.465**	.484**	.319*	.519**	.321*
Black	n = 77	0.27**	.392**	.297**	.231*	.345**	.324**	.364**	.196
Asian	n = 48	0.19	.454**	.277	.364*	.436**	.127	.358*	.035
Hispanic	n = 20	0.28	.332	.348	.160	.297	.168	.488*	.260
Pacific Islander	n = 23	0.40	.586**	.363	.478*	.466*	.333	.334	.258
USA	n = 97	0.37**	.589**	.449**	.479**	.523**	.318**	.481**	.313**
Bermuda & Canada	n = 16	0.13	.405	.113	.416	.415	-.178	.087	.173
Caribbean & West Indies	n = 41	0.45**	.538**	.384*	.263	.472**	.379*	.530**	.298
Inter & South America	n = 7	0.62	.708	.665	.897**	.627	.756*	.612	-.335
Europe	n = 5	0.50	.919*	.617	.957*	.748	.688	.501	.846
Africa	n = 15	0.20	.192	.239	-.045	.160	.332	.341	.238
Southern Asia	n = 6	0.04	.054	-.080	.464	.157	.491	-.342	-.559

Table 51—*Continued.*

	PASS/ FAIL Difference in Means†	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Southeast Asia & South Pacific *n* = 26	0.26	.379	.402*	.360	.100	-.129	.128	.309
Northern Asia *n* = 15	0.24	.679**	.523*	.021	.632*	.196	.725**	.353
English as First Language *n* = 151	0.36**	.544**	.382**	.433**	.482**	.259**	.406**	.260**
English as Second Language *n* = 77	0.27**	.436**	.372**	.297**	.340**	.351**	.398**	.197
First Degree *n* = 196	0.30**	.515**	.410**	.425**	.477**	.239**	.368**	.206**
Post Baccalaureate *n* = 32	0.47**	.472**	.171	.181	.275	.559**	.619**	.356*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 52

Preclinical GPA for All Subgroups With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	**CORRELATIONS**						
				SUBSCORE					
		Difference in Means†	**TOTAL SCORE**	**Blood Bank**	**Chemistry**	**Hematology**	**Immunology**	**Microbiology**	**Body Fluids**
All Subjects	*n* = 227	0.48**	.541**	.422**	.432**	.485**	.320**	.359**	.285**
Male	*n* = 98	0.45**	.647**	.505**	.426**	.604**	.367**	.447**	.327**
Female	*n* = 129	0.50**	.463**	.354**	.447**	.394**	.282**	.296**	.258**
White	*n* = 61	0.76**	.659**	.552**	.650**	.527**	.318*	.333**	.400**
Black	*n* = 76	0.28**	.312**	.292**	.179	.336**	.231*	.164	.174
Asian	*n* = 47	0.33*	.497**	.188	.202	.567**	.209	.483**	.132
Hispanic	*n* = 20	0.74**	.618**	.564**	.363	.472*	.479*	.681**	.308
Pacific Islander	*n* = 23	0.37*	.564**	.453*	.354	.374	.379	.433*	.214
USA	*n* = 98	0.60**	.650**	.558**	.586**	.581**	.318**	.376**	.422**
Bermuda & Canada	*n* = 16	0.31	.192	-.025	.418	.173	.193	-.142	-.166
Caribbean & West Indies	*n* = 41	0.44**	.484**	.434**	.290	.431**	.391*	.230	.307
Inter & South America	*n* = 7	1.00*	.729	.378	.638	.648	.140	.744	-.128
Europe	*n* = 5	-0.01	-.188	.227	.018	-.822	.094	-.020	-.387
Africa	*n* = 14	0.29	.369	.283	.253	.394	.292	.446	.218
Southern Asia	*n* = 7	0.36	-.128	-.497	-.243	.099	.290	.203	.342

Table 52—*Continued.*

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Southeast Asia & South Pacific $n = 26$	0.40*	.454*	.250	.062	.283	.309	.516**	.182
Northern Asia $n = 13$	0.06	.469	.132	.063	.631*	.117	.448	.184
English as First Language $n = 152$	0.51**	.545**	.417**	.463**	.496**	.264**	.272**	.324**
English as Second Language $n = 75$	0.45**	.514**	.401**	.323**	.436**	.447**	.510**	.183
First Degree $n = 191$	0.46**	.522**	.384**	.396**	.502**	.302**	.350**	.248**
Post Baccalaureate $n = 36$	0.64**	.618**	.606**	.569**	.397*	.383*	.357*	.397*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 53

Immunohematology and Transfusion Medicine GPA for All Subgroups With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	$n = 233$	0.71**	.696**	.599**	.532**	.576**	.420**	.473**	.390**
Male	$n = 99$	0.65**	.692**	.580**	.504**	.621**	.342**	.422**	.383**
Female	$n = 134$	0.75**	.706**	.621**	.576**	.548**	.471**	.509**	.401**
White	$n = 62$	0.81**	.700**	.638**	.661**	.572**	.390**	.401**	.419**
Black	$n = 77$	0.65**	.654**	.587**	.367**	.585**	.391**	.454**	.531**
Asian	$n = 51$	0.34*	.560**	.365**	.202	.553**	.290*	.475**	.119
Hispanic	$n = 20$	0.83**	.671**	.588**	.328	.568**	.433	.761**	.290
Pacific Islander	$n = 23$	0.80**	.735**	.702**	.656**	.401	.474*	.401	.233
USA	$n = 98$	0.74**	.734**	.648**	.656**	.626**	.483**	.455**	.458**
Bermuda & Canada	$n = 16$	0.31	.391	.226	.495	.439	-.286	-.077	-.014
Caribbean & West Indies	$n = 41$	0.71**	.778**	.677**	.352*	.686**	.505**	.533**	.712**
Inter & South America	$n = 7$	1.16**	.790*	.635	.498	.613	.034	.867*	-.564
Europe	$n = 6$	0.53	.619	.674	.402	.518	.312	.387	.688
Africa	$n = 15$	0.56	.287	.372	.130	.298	.428	.348	.099
Southern Asia	$n = 7$	0.86	.617	.446	.349	.698	.942**	.236	-.478

Table 53—*Continued.*

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Southeast Asia & South Pacific *n* = 26	0.81**	.674**	.586**	.506**	.222	.503**	.567**	.189
Northern Asia *n* = 17	0.23	.575*	.372	.069	.603**	.106	.576*	.346
English as First Language *n* = 152	0.68**	.706**	.587**	.586**	.587**	.419**	.404**	.431**
English as Second Language *n* = 81	0.69**	.621**	.560**	.347**	.506**	.423**	.532**	.257*
First Degree *n* = 196	0.68**	.669**	.576**	.485**	.576**	.406**	.441**	.355**
Post Baccalaureate *n* = 37	0.78**	.765**	.686**	.666**	.550**	.378*	.541**	.434**

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 54

Clinical-year Didactic GPA for All Subgroups With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 233	0.51**	.684**	.541**	.520**	.610**	.444**	.482**	.380**
Male	*n* = 99	0.46**	.741**	.575**	.521**	.703**	.455**	.475**	.449**
Female	*n* = 134	0.55**	.643**	.515**	.524**	.539**	.442**	.489**	.336**
White	*n* = 62	0.64**	.677**	.565**	.593**	.636**	.336**	.394**	.350**
Black	*n* = 77	0.51**	.635**	.503**	.395**	.567**	.493**	.541**	.490**
Asian	*n* = 51	0.25*	.567**	.355*	.263	.593**	.300*	.423**	.116
Hispanic	*n* = 20	0.63**	.718**	.609**	.485*	.562**	.490*	.702**	.325
Pacific Islander	*n* = 23	0.32	.746**	.612**	.598**	.445*	.606**	.382	.447*
USA	*n* = 98	0.52**	.729**	.597**	.630**	.695**	.484**	.440**	.430**
Bermuda & Canada	*n* = 16	0.10	.251	-.033	.494	.163	.030	.026	-.090
Caribbean & West Indies	*n* = 41	0.65**	.778**	.608**	.450**	.689**	.638**	.602**	.609**
Inter & South America	*n* = 7	0.87**	.870*	.656	.537	.557	-.096	.870*	-.566
Europe	*n* = 6	0.61	.754	.797	.459	.645	.358	.745	.854*
Africa	*n* = 15	0.40	.329	.400	.147	.327	.295	.445	.238
Southern Asia	*n* = 7	0.45	.647	.381	.467	.635	.887**	.456	-.506

Table 54—*Continued.*

	PASS/ FAIL Difference in Means†	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Southeast Asia & South Pacific *n* = 26	0.49**	.657**	.535**	.375	.251	.517**	.520**	.355
Northern Asia *n* = 17	0.02	.535*	.336	.171	.791**	-.021	.331	.220
English as First Language *n* = 152	0.52**	.689**	.516**	.553**	.632**	.459**	.445**	.389**
English as Second Language *n* = 81	0.48**	.652**	.556**	.401**	.531**	.406**	.513**	.326**
First Degree *n* = 196	0.48**	.653**	.513**	.469**	.600**	.438**	.460**	.370**
Post Baccalaureate *n* = 37	0.61**	.759**	.649**	.655**	.638**	.345*	.487**	.316

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 55

Clinical-year Practica GPA For All Subgroups With Certification Examination Pass/Fail, Total Score, And Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	*n* = 233	0.32**	.595**	.448**	.501**	.513**	.431**	.434**	.313**
Male	*n* = 99	0.27**	.581**	.435**	.492**	.542**	.424**	.371**	.302**
Female	*n* = 134	0.35**	.606**	.527**	.516**	.491**	.440**	.481**	.323**
White	*n* = 62	0.45**	.613**	.529**	.502**	.595**	.328**	.437**	.355**
Black	*n* = 77	0.30**	.543**	.444**	.493**	.397**	.527**	.484**	.364**
Asian	*n* = 51	0.10	.442**	.262	.272	.510**	.284*	.317*	.022
Hispanic	*n* = 20	0.39**	.607**	.712**	.433	.357	.621**	.576**	.189
Pacific Islander	*n* = 23	0.20	.575**	.387	.539**	.290	.246	.314	.408
USA	*n* = 98	0.39**	.684**	.576**	.583**	.668**	.477**	.444**	.448**
Bermuda & Canada	*n* = 16	0.04	.192	-.112	.391	.106	-.034	.033	-.155
Caribbean & West Indies	*n* = 41	0.42**	.653**	.581**	.557**	.449**	.649**	.581**	.374*
Inter & South America	*n* = 7	0.42	.214	.411	.499	.144	.251	.437	-.570
Europe	*n* = 6	0.61	.836*	.853*	.564	.639	.476	.867*	.907*
Africa	*n* = 15	0.22	.206	.257	.115	.259	.157	.407	.107
Southern Asia	*n* = 7	-0.06	.093	-.010	.683	.112	-.029	-.413	-.554

Table 55—*Continued.*

	PASS/ FAIL	CORRELATIONS						
			SUBSCORE					
	Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Southeast Asia & South Pacific *n* = 26	0.18	.456*	.288	.314	.054	.436*	.472*	.200
Northern Asia *n* = 17	0.00	.482*	.445	.253	.589*	.216	.131	.113
English as First Language *n* = 152	0.35**	.629**	.480**	.549**	.576**	.448**	.440**	.348**
English as Second Language *n* = 81	0.25**	.491**	.454**	.352**	.336**	.388**	.382**	.217
First Degree *n* = 196	0.29**	.569**	.449**	.475**	.511**	.430**	.409**	.265**
Post Baccalaureate *n* = 37	0.48**	.657**	.613**	.553**	.489**	.382*	.498**	.409*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 56

Clinical-year GPA for All Subgroups With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL	CORRELATIONS						
				SUBSCORE					
		Difference in Means†	TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	n = 233	0.41**	.684**	.546**	.540**	.602**	.463**	.489**	.372**
Male	n = 99	0.37**	.714**	.546**	.539**	.673**	.467**	.456**	.409**
Female	n = 134	0.45**	.662**	.547**	.548**	.548**	.465**	.512**	.349**
White	n = 62	0.55**	.675**	.571**	.574**	.643**	.345**	.430**	.365**
Black	n = 77	0.41**	.643**	.514**	.467**	.538**	.544**	.555**	.472**
Asian	n = 51	0.18	.563**	.347*	.291*	.610**	.318*	.413**	.088
Hispanic	n = 20	0.51**	.721**	.695**	.498*	.516*	.580**	.698**	.284
Pacific Islander	n = 23	0.26	.713**	.550**	.603**	.402	.487*	.376	.455*
USA	n = 98	0.46**	.740**	.613**	.635**	.713**	.501**	.461**	.457**
Bermuda & Canada	n = 16	0.07	.236	-.064	.466	.149	.009	.028	-.118
Caribbean & West Indies	n = 41	0.53**	.782**	.640**	.529**	.640**	.689**	.636**	.551**
Inter & South America	n = 7	0.65**	.720	.678	.643	.466	.068	.844*	-.707
Europe	n = 6	0.61	.797	.825*	.509	.654	.413	.797	.887*
Africa	n = 15	0.32	.288	.350	.144	.308	.245	.452	.187
Southern Asia	n = 7	0.20	.572	.312	.658	.569	.721	.206	-.641

Table 56—*Continued.*

	PASS/ FAIL Difference in Means†	CORRELATIONS						
		TOTAL SCORE	SUBSCORE					
			Blood Bank	**Chemistry**	**Hematology**	**Immunology**	**Microbiology**	**Body Fluids**
Southeast Asia & South Pacific *n* = 26	0.34**	.623**	.472*	.379	.188	.526**	.542**	.317
Northern Asia *n* = 17	0.01	.566*	.413	.222	.784**	.071	.282	.203
English as First Language *n* = 152	0.44**	.697**	.525**	.577**	.640**	.477**	.465**	.391**
English as Second Language *n* = 81	0.36**	.630**	.552**	.411**	.484**	.428**	.494**	.301**
First Degree *n* = 196	0.38**	.655**	.515**	.498**	.596**	.460**	.464**	.345**
Post Baccalaureate *n* = 37	0.55**	.750**	.664**	.639**	.602**	.380*	.518**	.378*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

Table 57

Cumulative Graduating GPA for All Subgroups With Certification Examination Pass/Fail, Total Score, and Subscores

		PASS/ FAIL Difference in Means†	CORRELATIONS						
			TOTAL SCORE	SUBSCORE					
				Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
All Subjects	n = 217	0.31**	.641**	.491**	.499**	.560**	.376**	.454**	.353**
Male	n = 96	0.32**	.684**	.506**	.509**	.610**	.440**	.415**	.366**
Female	n = 121	0.31**	.609**	.478**	.499**	.510**	.337**	.498**	.345**
White	n = 52	0.34**	.683**	.588**	.620**	.602**	.311*	.471**	.301*
Black	n = 74	0.31**	.569**	.449**	.365**	.473**	.425**	.469**	.454**
Asian	n = 49	0.18*	.569**	.313*	.331*	.573**	.284*	.445**	.127
Hispanic	n = 19	0.36*	.626**	.538*	.312	.464*	.333	.574**	.526*
Pacific Islander	n = 23	0.25	.652**	.440*	.512*	.452*	.434*	.408	.356
USA	n = 86	0.32**	.686**	.562**	.607**	.674**	.413**	.463**	.341**
Bermuda & Canada	n = 16	0.03	.392	.142	.491	.284	-.060	.074	.216
Caribbean & West Indies	n = 40	0.49**	.744**	.539**	.398*	.595**	.530**	.574**	.606**
Inter & South America	n = 7	0.56**	.876**	.559	.706	.807*	.257	.934**	-.428
Europe	n = 6	0.23	.561	.675	.684	.033	.411	.381	.381
Africa	n = 14	0.31	.294	.359	.094	.160	.349	.482	.368
Southern Asia	n = 6	0.29	.207	-.296	-.103	.177	.559	.544	.105

Table 57—*Continued.*

	PASS/ FAIL Difference in Means†	CORRELATIONS						
			SUBSCORE					
		TOTAL SCORE	Blood Bank	Chemistry	Hematology	Immunology	Microbiology	Body Fluids
Southeast Asia & South Pacific n = 25	0.27*	.582**	.445*	.217	.274	.172	.454*	.439*
Northern Asia n = 17	-0.01	.498*	.368	.165	.577*	.194	.193	.281
English as First Language n = 139	0.32**	.651**	.468**	.538**	.615**	.360**	.423**	.349**
English as Second Language n = 78	0.29**	.583**	.498**	.360**	.394**	.413**	.476**	.336**
First Degree n = 187	0.29**	.603**	.472**	.468**	.542**	.346**	.418**	.328**
Post Baccalaureate n = 30	0.42**	.787**	.703**	.610**	.616**	.470**	.568**	.379*

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). † Tested by ANOVA.

APPENDIX H

TABLES: INTERCORRELATIONS OF ACADEMIC MEASURES

Tables 58 - 63 in the Appendix present the intercorrelations of all the independent variables and are grouped into three main categories: (1) admission, prerequisite science GPAs, and preclinical courses grades and GPA; (2) clinical-year courses grades and GPAs; and (3) cumulative clinical-year and graduating GPAs.

The relationships between admissions GPAs, cognate science GPAs and preclinical courses and GPAs with themselves is presented in Table 58 (Category 1 with itself), with the clinical-year courses grades and GPAs in Table 59 (Category 1 with Category 2), and with the clinical-year and graduating cumulative GPAs in Table 60 (Category 1 with Category 3). The intercorrelations of the clinical-year courses grades and GPAs with themselves is show in Table 61 (Category 2 with itself). Table 62 presents the clinical-year courses grades and GPAs intercorrelations with the cumulative clinical-year and graduating GPAs (Category 2 with Category 3). Table 63 depicts the cumulative clinical-year and graduating GPAs with themselves (Category 3 with itself).

Table 58

Intercorrelations of Academic Measures Variables: Admissions GPAs and Preclinical Courses Grades and GPAs

		Admissions GPAs						Preclinical Courses Grades and GPAs					
		AdmCm GPA	AdmSci GPA	Biology GPA	GenChm GPA	O. Chem GPA	Math GPA	FdBlood Bank	Fd Chem	Fd Hemat	Prin Immuno	Fd Micro	Preclin GPA
Admission GPAs	AdmCumGPA	1	.854**	.710**	.684**	.650**	.485**	.568**	.556**	.561**	.425**	.378**	.598**
	AdmSciGPA	.854**	1	.796**	.782**	.686**	.417**	.593**	.582**	.572**	.457**	.430**	.640**
	BiologyGPA	.710**	.796**	1	.587**	.503**	.301**	.473**	.529**	.519**	.391**	.365**	.567**
	GenChemGPA	.684**	.782**	.587**	1	.512**	.389**	.532**	.487**	.445**	.327**	.330**	.498**
	OChemGPA	.650**	.686**	.503**	.512**	1	.382**	.332**	.375**	.327**	.308**	.242**	.395*
	MathGPA	.485**	.417**	.301**	.389**	.382**	1	.386**	.288**	.236**	.269**	.143*	.301**
Preclinical Courses	FdBloodBank	.568**	.593**	.473**	.532**	.332**	.386**	1	.575**	.520**	.424**	..383**	.676**
	FdChemistry	.556**	.582**	.529**	.487**	.375**	.288**	.575**	1	.554**	.460**	.484**	.804**
	FdHematology	.561**	.572**	.519**	.445**	.327**	.236**	.520**	.554**	1	.503**	.474**	.759**
	PrinImmunology	.425**	.457**	.391**	.327**	.308**	.269**	.424**	.460**	.503**	1	.464**	.769**
	FdMicrobiology	.378**	.430**	.365**	.330**	.242**	.143*	.383**	.484**	.474**	.464**	1	.770**
	Preclin GPA	.598**	.640**	.567**	.498**	.395**	.301**	.676**	.804**	.759**	.769**	.770**	1

* Corrrelation is significant at the 0.05 level (2-tailed). **Corrrelation is significant at the 0.01 level (2-tailed).

Table 59

Intercorrelations of Academic Measures Variables: Admissions GPAs and Preclinical Courses Grades and GPAS with Clinical-year Course Grades

		Clinical-year Grades														
		Blood Bank	Chem	Hema	Immun	Lab Manag	Microb	Microsc	Phlebo	BB Pract	Chem Pract	Hem Pract	Immun Pract	Micro Pract	BdFlds Pract	Ind Project
Admission GPAs	AdmCumGPA	.491**	.509**	.525**	.238**	.363**	.367**	.371**	.258**	.447**	.351**	.429**	.176**	.394**	.153*	.202**
	AdmSciGPA	.580**	.588**	.589**	.287**	.338**	.379**	.403**	.301**	.492**	.399**	.489**	.216**	.442**	.169*	.220**
	BiologyGPA	.541**	.602**	.516**	.329**	.300**	.379**	.415**	.246**	.468**	.379**	.428**	.296**	.376**	.177**	.144*
	GenChemGPA	.483**	.482**	.487**	.286**	.257**	.356**	.332**	.284**	.431**	.398**	.479**	.200**	.454**	.247**	.145*
	OChemGPA	.363**	.352**	.411**	.118	.282**	.171*	.241**	.221**	.353**	.206**	.386**	.054	.306**	.047	.203**
	MathGPA	.332**	.283**	.246**	.045	.195**	.108	.086	.198**	.278**	.208**	.311**	.076	.211**	.166*	.169*
Preclinical Courses	FdBloodBank	.643**	.514**	.484**	.184*	.394**	.322**	.450**	.369**	.512**	.372**	.502**	.252**	.409**	.298**	.158*
	FdChemistry	.588**	.598**	.563**	.254**	.350**	.377**	.482**	.322**	.483**	.436**	.370**	.313**	.462**	.284**	.158*
	FdHematology	.497**	.562**	.554**	.376**	.217**	.486**	.470**	.189**	.379**	.372**	.418**	.251**	.415**	.258**	.049
	PrinImmunology	.473**	.464**	.500**	.320**	.143*	.322**	.394**	.167*	.344**	.285**	.391**	.224**	.334**	.112	.061
	FdMicrobiology	.446**	.460**	.500**	.450**	.140*	.566**	.461**	.256**	.368**	.361**	.273**	.306**	.391**	.188**	.131
	Preclin GPA	.654**	.650**	.659**	.420**	.301**	.535**	.581**	.308**	.519**	.471**	.464**	.363**	.518**	.270**	.140*

* Corrrelation is significant at the 0.05 level (2-tailed). **Corrrelation is significant at the 0.01 level (2-tailed).

Table 60

Intercorrelations of Academic Measures Variables: Admissions GPAs and Preclinical Courses Grades and GPAS with Cumulative GPAs

		Cumulative GPAs			
		Clinical-year Didactic GPA	Clinical-year Practica GPA	Clinical-year Cumulative GPA	Graduation Cumulative GPA
Admissions GPAs	Admission Cumulative GPA	.536**	.508**	.552**	.832**
	Admission Science GPA	.599**	.576**	.621**	.855**
	Biology GPA	.583**	.526**	.590**	.754**
	General Chemistry GPA	.505**	.563**	.559**	.699**
	Organic Chemistry GPA	.366**	.394**	.398**	.650**
	Math GPA	.262**	.336**	.310**	.483**
Preclinical Courses and GPA	Fund of Blood Bank	.567**	.581**	.603**	.653**
	Fund of Clinical Chemistry	.606**	.563**	.620**	.658**
	Fund of Hematology	.603**	.500**	.591**	.630**
	Principles of Immunology	.498**	.425**	.492**	.537**
	Fund of Clinical Microbiology	.566**	.458**	.551**	.526**
	Preclinical Courses GPA	.715**	.632**	.718**	.752**

* Corrrelation is significant at the 0.05 level (2-tailed). **Corrrelation is significant at the 0.01 level (2-tailed).

Table 61

Intercorrelations of Academic Measures Variables: Clinical-year Courses

Clinical-year Courses	Clinical-year Courses														
	Blood Bank	Chem	Hema	Immun	Lab Manag	Microb	Microsc	Phlebo	BB Pract	Chem Pract	Hem Pract	Immun Pract	Micro Pract	BdFlds Pract	Ind Project
BloodBank	1	.743**	.735**	.416**	.442**	.527**	.565**	.445**	.648**	.480**	.509**	.364**	.460**	.277**	.191**
Chemistry	.743**	1	.772**	.523**	.440**	.655**	.669**	.385**	.575**	.574**	.557**	.482**	.587**	.368**	.126
Hematology	.735**	.772**	1	.486**	.396**	.599**	.585**	.387**	.535**	.436**	.557**	.365**	.542**	.293**	.170**
Immunology	.416**	.523**	.486**	1	.096	.749**	.516**	.152*	.330**	.511**	.273**	.444**	.474**	.278**	.013
LabManagement	.442**	.440**	.396**	.096	1	.226**	.329**	.216**	.341**	.206**	.374**	.202**	.298**	.063	.135*
Microbiology	.527**	.655**	.599**	.749**	.226**	1	.673**	.250**	.418**	.540**	.385**	.501**	.604**	.349**	.045
Microscopy	.565**	.669**	.585**	.516**	.329**	.673**	1	.340**	.441**	.484**	.429**	.407**	.525**	.364**	.197**
Phlebotomy	.445**	.385**	.387**	.152*	.216**	.250**	.340**	1	.407**	.281**	.256**	.286**	.299**	.243**	.250**
BloodBank Pract	.648**	.575**	.535**	.330**	.341**	.418**	.441**	.407**	1	.455**	.509**	.446**	.462**	.355**	.169*
Chemistry Pract	.480**	.574**	.436**	.511**	.206**	.540**	.484**	.281**	.455**	1	.420**	.463**	.512**	.521**	.235**
Hemato Pract	.509**	.557**	.557**	.273**	.374**	.385**	.429**	.256**	.509**	.420**	1	.326**	.466**	.367**	.270**
Immuno Pract	.364**	.482**	.365**	.444**	.202**	.501**	.407**	.286**	.446**	.463**	.326**	1	.517**	.367**	.164*
Microbio Pract	.460**	.587**	.542**	.474**	.298**	.604**	.525**	.299**	.462**	.512**	.466**	.517**	1	.286**	.160*
BodyFluids Pract	.277**	.368**	.293**	.278**	.063	.349**	.364**	.243**	.355**	.521**	.367**	.367**	.286**	1	.037
Indep Project	.191**	.126	.170**	.013	.135*	.045	.197**	.250**	.169**	.235**	.270**	.164*	.160*	.037	1

* Corrrelation is significant at the 0.05 level (2-tailed). **Corrrelation is significant at the 0.01 level (2-tailed).

Table 62

Intercorrelations of Academic Measures Variables: Clinical-year Course Grades and GPAS with Clinical-year Cumulative GPAs

Clinical-year Courses	Cumulative GPAs			
	Clinical-year Didactic GPA	Clinical-year Practica GPA	Clinical-year Cum GPA	Graduation Cumulative GPA
Blood Bank	.848**	.678**	.821**	.722**
Chemistry	.914**	.739**	.889**	.748**
Hematology	.874**	.664**	.831**	.748**
Immunology	.655**	.507**	.629**	.435**
Lab Management	.475**	.396**	.465**	.449**
Microbiology	.813**	.626**	.778**	.549**
Microscopy	.743**	.611**	.728**	.580**
Phlebotomy	.409**	.462**	.455**	.396**
Blood Bank Practicum	.625**	.769**	.724**	.629**
Chemistry Practicum	.594**	.792**	.715**	.535**
Hematology Practicum	.579**	.741**	.681**	.602**
Immunology Practicum	.506**	.598**	.575**	.365**
Microbiology Practicum	.644**	.781**	.739**	.604**
Body Fluids (Microscopy) Practicum	.369**	.535**	.464**	.276**
Independent Project	.149*	.299**	.222**	.258**

* Corrrelation is significant at the 0.05 level (2-tailed). **Corrrelation is significant at the 0.01 level (2-tailed).

Table 63

Intercorrelations of Academic Measures Variables: Clinical-year Cumulative GPAs

Clinical-year GPAs	Clinical-year GPAs			
	Clinical-year Didactic GPA	Clinical-year Practica GPA	Clinical-year Cumulative GPA	Graduation Cumulative GPA
Clinical-year Didactic GPA	1	.786**	.963**	.792**
Clinical-year Practica GPA	.786**	1	.924**	.761**
Clinical-year Cumulative GPA	.963**	.924**	1	.824**
Graduation Cumulative GPA	.792**	.761**	.824**	1

* Corrrelation is significant at the 0.05 level (2-tailed). **Corrrelation is significant at the 0.01 level (2-tailed).

APPENDIX I

TABLES: EXPECTANCY

Table 64

Admission and Preclinical Grade Point Averages Expectancy Tables

		CERTIFICATION EXAMINATION		
		PASS	FAIL	TOTAL
ADMISSION CUMULATIVE GPA	2.00 - 2.25	--	--	--
	2.26 - 2.50	7 (70.0%)	3 (30.0%)	10 (100%)
	2.51 - 2.75	16 (43.2%)	21 (56.8%)	37 (100%)
	2.76 - 3.00	18 (48.6%)	19 (51.4%)	37 (100%)
	3.01 - 3.25	30 (54.5%)	25 (45.5%)	55 (100%)
	3.26 - 3.50	24 (64.9%)	13 (35.1%)	37 (100%)
	3.51 - 3.75	29 (80.6%)	7 (19.4%)	36 (100%)
	3.76 - 4.00	16 (94.1%)	1 (5.9%)	17 (100%)
	Total	140 (61.1%)	89 (38.9%)	229 (100%)
ADMISSION SCIENCE GPA	2.00 - 2.25	4 (33.3%)	8 (66.7%)	12 (100%)
	2.26 - 2.50	21 (55.3%)	17 (44.7%)	38 (100%)
	2.51 - 2.75	20 (43.5%)	26 (56.5%)	46 (100%)
	2.76 - 3.00	20 (52.6%)	18 (47.4%)	38 (100%)
	3.01 - 3.25	19 (63.3%)	11 (36.7%)	30 (100%)
	3.26 - 3.50	22 (78.6%)	6 (21.4%)	28 (100%)
	3.51 - 3.75	17 (89.5%)	2 (10.5%)	19 (100%)
	3.76 - 4.00	16 (94.1%)	1 (5.9%)	17 (100%)
	Total	139 (61.0%)	89 (39.0%)	228 (100%)
PRECLINICAL COURSES GPA	2.00 - 2.25	0 (0%)	4 (100%)	4 (100%)
	2.26 - 2.50	2 (25.0%)	6 (75.0%)	8 (100%)
	2.51 - 2.75	9 (37.5%)	15 (62.5%)	24 (100%)
	2.76 - 3.00	10 (35.7%)	18 (64.3%)	28 (100%)
	3.01 - 3.25	19 (50.0%)	19 (50.0%)	38 (100%)
	3.26 - 3.50	23 (67.6%)	11 (32.4%)	34 (100%)
	3.51 - 3.75	20 (69.0%)	9 (31.0%)	29 (100%)
	3.76 - 4.00	56 (90.3%)	6 (9.7%)	62 (100%)
	Total	139 (61.2%)	88 (38.8%)	227 (100%)

Table 65

Clinical-Year Grade Point Averages Expectancy Tables

		CERTIFICATION EXAMINATION		
		PASS	FAIL	TOTAL
CLINICAL-YEAR DIDACTIC GPA	2.00 - 2.25	0 (0%)	2 (100%)	2 (100%)
	2.26 - 2.50	3 (27.3%)	8 (72.7%)	11 (100%)
	2.51 - 2.75	9 (32.1%)	19 (67.9%)	28 (100%)
	2.76 - 3.00	10 (33.3%)	20 (66.7%)	30 (100%)
	3.01 - 3.25	2 (51.2%)	20 (48.8%)	41 (100%)
	3.26 - 3.50	22 (62.9%)	13 (37.1%)	35 (100%)
	3.51 - 3.75	26 (76.5%)	8 (23.5%)	34 (100%)
	3.76 - 4.00	52 (100%)	0 (0%)	52 (100%)
	Total	143 (61.4%)	90 (38.6%)	233 (100%)
CLINICAL-YEAR PRACTICUM GPA	2.00 - 2.25	--	--	--
	2.26 - 2.50	0 (0%)	1 (100%)	1 (100%)
	2.51 - 2.75	2 (33.3%)	4 (66.7%)	6 (100%)
	2.76 - 3.00	6 (25.0%)	18 (75.0%)	24 (100%)
	3.01 - 3.25	20 (46.5%)	23 (53.5%)	43 (100%)
	3.26 - 3.50	29 (53.7%)	25 (46.3%)	54 (100%)
	3.51 - 3.75	48 (75.0%)	16 (25.0%)	64 (100%)
	3.76 - 4.00	38 (92.7%)	3 (7.3%)	41 (100%)
	Total	143 (61.4%)	90 (38.6%)	233 (100%)
CLINICAL-YEAR CUMULATIVE GPA	2.00 - 2.25	--	--	--
	2.26 - 2.50	0 (0%)	3 (100%)	3 (100%)
	2.51 - 2.75	6 (33.3%)	12 (66.7%)	18 (100%)
	2.76 - 3.00	10 (31.3%)	22 68.8%)	32 (100%)
	3.01 - 3.25	21 (50.0%)	21 (50.0%)	42 (100%)
	3.26 - 3.50	27 (50.9%)	26 (49.1%)	53 (100%)
	3.51 - 3.75	39 (90.7%)	4 (9.3%)	43 (100%)
	3.76 - 4.00	40 (95.2%)	2 (4.8%)	42 (100%)
	Total	143 (61.4%)	90 (38.6%)	233 (100%)

Table 66

Graduation Cumulative Grade Point Average Expectancy Table

		CERTIFICATION EXAMINATION		
		PASS	FAIL	TOTAL
GRADUATION CUMULATIVE GPA	2.00 - 2.25	--	--	--
	2.26 - 2.50	0 (0%)	1 (100%)	1 (100%)
	2.51 - 2.75	8 (36.4%)	14 (63.6%)	22 (100%)
	2.76 - 3.00	20 (43.5%)	26 (56.5%)	46 (100%)
	3.01 - 3.25	28 (50.0%)	28 (50.0%)	56 (100%)
	3.26 - 3.50	22 (62.9%)	13 (37.1%)	35 (100%)
	3.51 - 3.75	36 (90.0%)	4 (10.0%)	40 (100%)
	3.76 - 4.00	17 (100%)	0 (0%)	17 (100%)
	Total	131 (60.4%)	86 (39.6%)	217 (100%)

APPENDIX J

ANDREWS UNIVERSITY CLS (MT) PROGRAM CURRICULUM

Table 67

Andrews University for Clinical Laboratory Sciences Curriculum Subject Areas with Specific Courses Identified as Offered Through the Years

	SUBJECT	COURSE	CREDITS
Prerequisites	Fundamentals of Hematology	MTCH115 Blood Cell Biology	1
		MTCH116 Blood Cell Biology Laboratory	2
		MTCH115 Introduction to Hematology	1
		MTCH116 Introduction to Hematology Laboratory	2
		MTCH215 Fundamentals of Hematology	3
		MTCH215 Fundamentals of Hematology and Hemostasis	3
	Human Blood Biology	CLSC260 Fundamentals of Human Blood Biology (merged MTCH215 & MTCH245)	3
	Urinalysis and Coagulation	MTCH205 Fundamentals of Urinalysis and Coagulation	1
	Fundamentals of Microbiology	MTCH335 Clinical Microbiology	2
		MTCH335 Clinical Microbiology Laboratory	2
		MTCH235 Fundamentals of Clinical Microbiology	4
		CLSC230 Fundamentals of Clinical Microbiology	3
	Immunohematology	MTCH245 Fundamentals of Immunohematology	2
	Principles of Immunology	MTCH200 Fundamentals of Serology	1
		MTCH345 Clinical Immunology	3
		MTCH346 Clinical Immunology Laboratory	1
		MTCH345 Principles of Immunology	3
		MTCH345 Principles of Immunology	4
		CLSC320 Principles of Immunology	3
	Fundamentals of Clinical Chemistry	MTCH355 Clinical Biochemistry I	3
		MTCH356 Clinical Biochemistry Laboratory	2
		MTCH355 Clinical Chemistry I	3
		MTCH356 Clinical Chemistry I Laboratory	2
		MTCH255 Fundamentals of Clinical Chemistry and Instrumentation	4
		MTCH255 Fundamentals of Clinical Chemistry and Urinalysis	4
		CLSC250 Fundamentals of Clinical Chemistry	3

Table 67—*Continued.*

	SUBJECT	COURSE	CREDITS
Clinical-Year Didactic	Seminar	MTCH401, 402 Clinical Year Seminar I, II	0, 0
		CLSC401, 402 Clinical Year Seminar I, II	0, 0
	Hematology	MTCH411 Hematology and Hemostasis I	3
		MTCH412 Hematology and Hemostasis II	3
		CLSC411 Hematology	3
		CLSC412 Hemostasis	1
	Immunology	MTCH421 Immunology	2
		CLSC421 Clinical Immunology	2
	Microbiology	MTCH431, 432 Clinical Bacteriology I, II	3, 3
		MTCH431, 432 Clinical Microbiology II, III	3, 3
		MTCH431, 432 Clinical Microbiology I, II	4, 4
		CLSC431 Clinical Microbiology	4
		CLSC432 Special Microbiology	2
		MTCH471 Medical Parasitology	1
		MTCH481 Medical Mycology	2
		MTCH481 Medical Mycology	1
	Immunohematology	MTCH441, 442 Immunohematology I, II	2, 2
		MTCH441, 442 Immunohematology I, II	3, 3
		CLSC441 Immunohematology	3
	Chemistry	MTCH453 Clinical Chemistry III	3
		MTCH452 Clinical Chemistry II	3
		CLSC452 Clinical Chemistry and Body Fluids	2
	Microscopy	MTCH461 Clinical Microscopy	1
	Management and LIS	MTCH410 Laboratory Information Systems	1
		MTCH490 Laboratory Management and Education	1
		MTCH490 Laboratory Management and Education	2
		CLSC460 Clinical Laboratory Systems	2

Table 67—*Continued.*

	SUBJECT	COURSE	CREDITS
Clinical-Year Practicum	Phlebotomy	MTCH400 Medical Orientation and Phlebotomy	2
		CLSC400 Specimen Procurement and Processing	2
	Hematology Practicum	MTCH413 Hematology Practicum	6
		CLSC413 Clinical Hematology and Hemostasis Practicum	4
	Immunology Practicum	MTCH422 Immunology Practicum	1
		CLSC423 Clinical Immunology Practicum	1
	Microbiology Practicum	MTCH433 Clinical Bacteriology Practicum	6
		MTCH433 Clinical Bacteriology Practicum	8
		MTCH433 Clinical Microbiology Practicum	7
		CLSC433 Clinical Microbiology Practicum	5
		MTCH472 Medical Parasitology Practicum	2
		MTCH482 Medical Mycology Practicum	1
	Immunohematology Practicum	MTCH443 Immunohematology Practicum	6
		CLSC443 Clinical Immunohematology Practicum	4
	Clinical Chemistry Practicum	MTCH454 Clinical Chemistry Practicum	6
		MTCH454 Clinical Chemistry Practicum	8
	Microscopy Practicum	MTCH462 Clinical Microscopy Practicum	1
		CLSC463 Clinical Microscopy Practicum	1
	Independent Project	MTCH495 Independent Project	1
		CLSC495 Independent Project	1

APPENDIX K

ASCP MEDICAL TECHNOLOGIST CERTIFICATION EXAMINATION STATISTICS

Table 68

Board of Registry Medical Technologist Examination Statistics

DATE OF EXAMINATION	MEAN	SD	RANGE OF SCORES	TOTAL TAKING	TOTAL PASS	TOTAL FAIL	1st TIME TOTAL PASS
August 1989	468.52	96.47	142-878	3370	2536 (75%)	834 (25%)	2147 (83%)
February 1990	416.56	90.25	185-800	1266	680 (54%)	586 (46%)	362 (76%)
August 1990	453.23	96.51	186-841	3099	2169 (70%)	930 (30%)	1942 (80%)
February 1991	425	88	91-809	1277	732 (57%)	545 (43%)	471 (75%)
August 1991	462	95	189-949	2909	2149 (74%)	760 (26%)	1995 (81%)
February 1992	418.23	86.79	36-689	1287	713 (55%)	574 (45%)	440 (79%)
August 1992	475.41	87.69	191-880	3005	2426 (81%)	579 (19%)	2111 (87%)
February 1993	421.00	89.58	204-799	1052	581 (55%)	471 (45%)	414 (76%)
August 1993	465.34	89.27	147-835	1669	1292 (77%)	377 (23%)	1171 (84%)
January - June 1994	431.86	108.70	149-890	1613	959 (59%)	654 (41%)	671 (79%)
July - December 1994	466.87	109.11	127-860	3216	2345 (73%)	871 (27%)	2070 (80%)
January - June 1995	447.98	107.01	113-802	1425	944 (66%)	481 (34%)	737 (81%)
July - December 1995	473.51	107.45	179-883	3058	2269 (74%)	789 (26%)	2023 (82%)
January - June 1996	453.16	107.10	168-887	1444	975 (68%)	469 (32%)	714 (85%)
July - December 1996	470.62	104.86	213-872	2826	2076 (73%)	750 (27%)	1818 (81%)
January - June 1997	448	100	223-767	1400	920 (66%)	480 (34%)	673 (82%)
July - December 1997	465	102	182-787	2555	1839 (72%)	716 (28%)	1583 (80%)

Table 68—*Continued.*

DATE OF EXAMINATION	MEAN	SD	RANGE OF SCORES	TOTAL TAKING	TOTAL PASS	TOTAL FAIL	1st TIME TOTAL PASS
January - June 1998	443	104	141-806	1294	819 (63%)	475 (37%)	599 (81%)
July - December 1998	464	99	172-800	2261	1656 (73%)	605 (27%)	1422 (82%)
January- June 1999	440	95	214-756	1172	761 (65%)	411 (35%)	555(82%)
July - December 1999	455	100	193-943	2042	1455 (71%)	587 (29%)	1258 (70%)
January - June 2000	435	90	220-717	1142	725 (63%)	417 (37%)	545 (79%)
July - December 2000	448	98	173-775	1859	1265 (68%)	594 (32%)	1100 (78%)
January - June 2001	446	101	200-800	1089	697 (64%)	392 (36%)	536 (83%)
July - December 2001	454	97	196-883	1667	1163 (70%)	504 (30%)	977 (80%)
January - June 2002	445	98	189-811	1021	651 (64%)	370 (36%)	500 (81%)
July - December 2002	468	107	100-788	1642	1216 (74%)	426 (26%)	1003 (84%)
January - June 2003	455	105	112-744	1016	693 (68%)	323 (32%)	532 (86%)
July - December 2003	464	105	100-815	1539	1109 (72%)	430 (28%)	957 (83%)
January - June 2004	464	107	139-849	1007	696 (69%)	311 (31%)	535 (85%)

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REFERENCE LIST

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