Environmental factors affecting retention and graduation in Mlt /Clt programs

Patricia R Castro

University of Nevada, Las Vegas

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ENVIRONMENTAL FACTORS AFFECTING RETENTION AND GRADUATION IN MLT/CLT PROGRAMS

by

Patricia R. Castro

Bachelor of Science
Long Island University
1980

Master of Science
University of Nevada Las Vegas
1997

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College of Education

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Doctor of Education in Educational Leadership

By the undersigned:

Paul Meacham, Examination Committee Chair

Gerald Kops, Examination Committee Member

Robert Ackerman, Examination Committee Member

Penny Amy, Graduate Faculty Representative

Dean of the Graduate College
ABSTRACT

Environmental Factors Affecting Retention and Graduation in MLT/CLT Programs

by

Patricia R. Castro

Dr. Paul Meacham, Examination Committee Chair
Professor of Education Administration
University of Nevada, Las Vegas

The quality of education delivered to medical laboratory technician/clinical laboratory technician (MLT/CLT) students has been an evolving concern for the clinical laboratory sciences profession. This situation prompted consideration of various factors in MLT/CLT education to determine if student/program characteristics affected student performance.

Principles extracted from Alexander Astin’s Input-Environment-Output (I-E-O) model were used as a foundation for considering the factors that affect MLT/CLT program student outcomes. Input, environmental, and outcome variables related to MLT/CLT programs were identified for study.

A literature review was conducted to gather information relevant to the development of clinical laboratory science practice and education, curriculum development and evaluation, MLT/CLT student and program characteristics, program accreditation and graduate certification.
The primary data source was a survey instrument sent to program directors of the sample MLT/CLT programs, as identified by the Health Professions Career and Education Directory 2002-2003 (American Medical Association, 2002). A fifty-five question survey was developed and distributed to the sample MLT/CLT programs. All survey requests originated from the Cannon Center for Survey Research at the University of Nevada, Las Vegas. All survey responses went directly to the data center, where they were organized and tabulated. Data were received, analyzed, and used as the basis for discussion.

Factors influencing student success included program size, English-speaking ability, enrollment status, course sequence, faculty-student ratio, clinical preceptor quality, and portfolio submission. Students in smaller programs were more likely to stay enrolled, pass the certification examination, and gain employment. Non-native English-speaking students were more likely to voluntarily withdraw from the professional program than their English-speaking counterparts. Full-time students enrolled in a structured sequence of professional courses were more likely to complete the program and pass the national certification examination. Students were also more likely to remain enrolled when full-time faculty-student ratios were low. Clinical preceptor academic level also contributed to retention. Attrition increased when portfolio submission was required as a component of performance assessment.
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me to achieve a significant personal and professional goal. The true reward of this project has been my ability to demonstrate to my daughter the value of lifelong learning and the importance of remaining committed to a goal, no matter how long it takes to reach it.
CHAPTER 1

INTRODUCTION

Background of the Study

Since the early 1980's, there has been increasing interest in the quality of education delivered to undergraduate students in colleges and universities across the United States (NCES report, 1997). As these institutions compete for funding with health, welfare, public schools, prisons, and other state priorities, government agencies and other constituencies are pressuring them for evidence that funds allocated for higher education are producing the desired results. Legislators, governing boards, accrediting bodies, business and industry, students, and their families, are all vested parties with different expectations of higher education. While these constituencies may not agree on how higher education should improve quality and efficiency, they do agree that it must improve quality and efficiency to justify public funding. Therefore, a variety of performance measures have been developed and utilized by institutions of higher education to demonstrate accountability and improvement (NCES report, 1997).

Monitoring accountability from the outside has primarily been delegated to regional and professional accrediting bodies, which traditionally focus on the
quality of the institutional or program resources and processes (Dill, 1998).
Public institutions are also mandated to conduct periodic internal program review
audits (Dill, 1998). To truly measure program effectiveness, graduate
competence and capability in the workplace, a systematic analysis of data must
be conducted at various levels within the institution. This will allow stakeholders
to make informed decisions about the quality and effectiveness of learning at the
institution, program, and course levels.

One area under particular scrutiny at colleges and universities is allied
health profession education (Castillo, 2000). Traditionally, most allied health
programs limit class size, have low student-to-faculty ratios, and are expensive to
run because of recurring costs associated with laboratory course work (Castillo,
2000). Significant costs are also associated with maintaining the mandatory
specialized accreditation required by most programs. In addition, many allied
health disciplines require students to complete lengthy clinical training offsite at
affiliate institutions, such as hospitals or other healthcare providers. In many
cases, this training is limited to sites that can provide evidence of compliance
with certain performance standards.

Changes in the financing and delivery of healthcare, first implemented in
the 1980's, including the prospective payment system and managed care, have
had a significant impact on the reimbursement and hiring practices by hospitals
and other healthcare facilities (Castillo, 2000). These effects can be observed in
many allied health professions, including the clinical laboratory sciences. The
biennial Wage and Vacancy Study conducted by the American Society of Clinical
Pathology Board of Registry reports that significant vacancy rates exist for several staff categories, including medical technologist, cytotechnologist, histotechnician, histotechnologist, medical laboratory technician, and phlebotomist (Steward, Ward-Cook, and Tannar, 2005). The study also reports that wages are increasing at rates very close to the national averages for inflation. Despite the availability of positions in almost all staff categories, along with modest increases in entry-level salaries, program directors are reporting only modestly increased enrollments in some medical science programs (Ward-Cook, Chapman, and Lindler, 2003). Other significant findings of the ASCP BOR annual Survey of Medical Laboratory Science Programs include program director concerns about recruitment of qualified applicants, maintaining adequate clinical training sites, and increasing public awareness of clinical laboratory sciences careers.

Continuous monitoring and evaluation of medical laboratory science programs by a variety of stakeholders is necessary to strengthen and support existing programs and justify the establishment of new ones in order to maintain a qualified, competent workforce of laboratory professionals.

Statement of the Problem

Because class size is limited in most allied health professions training programs, it is critical to attract and retain the most qualified students in order to provide a workforce capable of meeting future healthcare demands. This study sought to identify student and institutional factors associated with in-program and
post-program performance in MLT/CLT programs.

Purpose of the Study

The current study focused on accredited, associate degree-granting programs preparing MLT/CLT students. The purpose of the study was to examine and compare selected characteristics associated with MLT/CLT programs nationwide and determine their effect on program outcomes. These characteristics include faculty and student quality, program structure, clinical training, and performance assessment. Outcomes included attrition, certification examination passage, and post-graduate employment.

Data analysis identified selected trends in characteristics among programs and compared the characteristics of successful programs. Success was measured by passing performance on a national certification examination and employment in an occupation supported by their clinical laboratory science training. These data may be used to help program directors and other stakeholders make informed decisions regarding possible revisions that may enhance program effectiveness.

Conceptual Framework

Astin's doctoral training in psychology and his early employment as a clinical and counseling psychologist in a variety of medical settings provided him with a structure from which to observe human behavior. It became apparent that the success of the treatment obtained by patients could not be judged only in
terms of the outcome. Rather, effectiveness of treatment must be judged in terms of the degree of improvement that occurs (Astin, 1991). His first educational research project investigated doctoral student production among various institutions. This and subsequent studies convinced Astin that 1) the output of an institution or program must always be evaluated in terms of input; 2) an output measure is not determined only by a single input measure; and 3) input and output data are of limited usefulness unless considered together with information on the college environment (Astin, 1991). Educational assessments are not conclusive without considering information relating to students inputs, the institutional environment, and student outcomes (Astin, 1991).

Astin provides a framework for assessing a multitude of college student outcomes. The input-environment-output (I-E-O) model proposes that student outcomes are affected by both inputs and college environments. Although this model has undergone several revisions over the years (Astin 1977, 1991), the basic premise remains the same.

"Inputs" refer to the characteristics of the student at the time of initial entry into the institution; "environment" refers to the various programs, policies, faculty, peers, and educational experiences to which the student is exposed; and "outcomes" refers to the student's characteristics after exposure to the environment (Astin, 1993).

The inputs component of the I-E-O model includes an assortment of "personal, family, and educational background characteristics that students bring with them to their post-secondary experience" (NCES report, 1997). Examples
of inputs include student background characteristics, such as entrance examination scores, prior course work, parental income and occupation, student's age, gender, marital status, and ethnicity (Astin, 1993). Inputs also refer to other obligations a student may have, such as those to family and/or work (NCES report, 1997).

The environment of the I-E-O model includes all those characteristics that might influence what and how much students learn and change (NCES report, 1997). Four major institutional-level sources of influence on student outcomes are recognized: 1) curricular influences; 2) formal instructional experiences; 3) out-of-class experiences; and 4) institutional characteristics (NCES report, 1997). Examples of environmental characteristics include courses taken, major field, type and quality of instruction, interaction with faculty, peer relations, place of residence, and institutional mission, size, physical and financial characteristics (NCES report, 1997).

Outcomes represent the effects of a student's post-secondary education. Astin (1991) refers to outcomes as the talents we are trying to develop in our educational programs. A wide range of potential outcomes is possible. Some can be measured during the college experience, such as grade point average, examination scores, course performance, retention, and degree completion. Other outcomes may be measured after the student has left the educational environment, such as job attainment, career satisfaction, income, and scores on post-graduate examinations (Astin, 1991). Astin stresses the importance of learning as much as possible about how to structure educational environments in
order to maximize talent development (Astin, 1991).

This research effort focused on the input and environmental factors relative to the education and clinical training of MLT/CLT students. Input data included minimum GPA for both prerequisite and professional coursework, student age and marital status, minority and non-native English-speaking status, as well as student educational background prior to program entry. Environmental factors, such as curricular structure, instructional and assessment methods, faculty characteristics, and clinical training will were also studied. Outcome measures included attrition rates, passing performance on a national certification examination, and employment in an occupation supported by their clinical laboratory science training.

Directing the attention of program assessment on outcome measures alone does not adequately address program impact or effectiveness. The results of this study may be used by MLT/CLT program directors, administrators, and other stakeholders to assess the effectiveness of current program characteristics. Further, the results may encourage educational practitioners to consider the potential impacts of alternative environmental variables in the revision of MLT/CLT curricula.

A theoretical framework based on selected components of Astin's I-E-O theory has been presented, suggesting that input, environment, and outcome variables influence student academic performance. It is hypothesized that Astin's theory is consistent with MLT/CLT program variables, as reported by the program director.
Research Questions

The following research questions were formulated to obtain data to support the hypothesis that various factors in MLT/CLT education, such as student/program characteristics, affected student performance.

R.Q. 1  Is there a relationship between selected student characteristics and MLT/CLT student attrition? (Input: student variables)

R.Q. 2  Is there a relationship between prior education level and post-graduate performance? (Input: student variables)

R.Q. 3  Is there a relationship between selected curriculum characteristics, teaching methods and learning methods, and MLT/CLT student attrition and post-graduate performance? (Environment: institutional variables)

R.Q. 4  Is there a relationship between selected faculty characteristics and MLT/CLT student attrition and post-graduate performance? (Environment: institutional variables)

R.Q. 5  Is there a relationship between selected MLT/CLT in-program assessment methods, and student attrition and post-graduate performance? (Outcome: certification examination passage and post-graduate employment)

Research Design and Methodology

A descriptive study design was employed to examine and compare
selected variables associated with MLT/CLT programs. The survey was
constructed, approved by the committee, and approved by UNLV's Office for the
Protection of Human Research Subjects. It was then validated by a pilot study.
Potential respondents came from the 2002-2003 Health Professions Career and
Education Directory (American Medical Association), which listed national
MLT/CLT programs. This group was delimited by requiring NAACLS
accreditation and associate degree award, yielding the national population of
NAACLS-accredited associate level MLT/CLT programs.

Data were analyzed using descriptive statistics and Pearson product-
moment correlation coefficient.

Significance of the Study

Clinical laboratory sciences training may be obtained in a variety of
settings, including colleges and universities; community and junior colleges;
vocational and technical schools; and hospitals and medical centers.
Assessment is needed to determine the effectiveness of these training programs
and maximize the number of graduates.

The results of this research may be helpful to administrators, MLT
program personnel, students, and other stakeholders involved in program
evaluation. Although this research effort is directed at MLT/CLT educational
programs, similar studies might be useful at all levels of CLS education.
Delimitations and Limitations

The study was delimited by the following:

1. Inclusion of only Medical Laboratory Technician Associate Degree (MLT-AD) programs. Those programs granting certificates of completion were not studied.

2. Inclusion of only those programs accredited by the National Accrediting Agency Clinical Laboratory Sciences (NAACLS).

3. Inclusion of only fall admissions data for academic year 2002.

The study was limited by the following:

1. Results could not be generalized beyond this specific population.

2. Because a survey was used to collect data, the study was dependent upon the respondents to fully and accurately report on the data requested. Threats to external validity, such as the Hawthorne effect, were beyond the control of the researcher.

3. Data acquisition was dependent on unbiased reporting by program directors.

4. The return of all surveys could not be guaranteed.

Definition of Terms

1. Accreditation - the process of external review in which an agency grants public recognition to a program of study or an institution that meets established qualifications and educational standards (Newell, 1993).
2. American Society of Clinical Pathology (ASCP) - A non-profit medical society dedicated to providing excellence in education, certification, and advocacy on behalf of patients, pathologists, and laboratory professionals; formerly known as the American Society of Clinical Pathologists (www.ascp.org).

3. Attrition – failure of students to re-enroll (Berger & Lyon, 2005).

4. Board of Registry (BOR) - separate certifying body within the organizational structure of the American Society for Clinical Pathology (www.ascp.org/bor).

5. College of American Pathologists (CAP) - medical society composed of pathologists dedicated to providing laboratory quality improvement programs; sponsors accreditation of those laboratories meeting compliance with standards developed to ensure that appropriate quality control and quality assurance procedures are used to benefit the patients they serve (www.cap.org).

6. Certification - the process by which a non-governmental agency or association grants recognition of competence to an individual who has met certain predetermined qualifications, as specified by the agency or association (Waller, 2003).

7. Certification examination - testing mechanism used to measure eligible individual’s competence to practice in a clinical laboratory sciences discipline (www.ascp.org/bor).
8. Certification examination performance - result of examinee’s achievement on a certification examination; a minimum passing overall score must be achieved to attain certification status (www.ascp.org/bor).

9. Clinical affiliate - clinical training site associated with an MLT/CLT training program where students perform diagnostic testing under the supervision of licensed laboratory personnel; may be a hospital, private laboratory, clinic, physician’s office, etc (NAACLS Guide to Accreditation, 2005).

10. Medical laboratory technician/clinical laboratory technician - laboratory professional able to perform routine testing in hematology, clinical chemistry, immunohematology, microbiology, serology/immunology, and coagulation; make specimen-oriented decisions using pre-determined criteria; apply quality control procedures; and recognize critical values (NAACLS Guide to Accreditation, 2005).

11. Medical laboratory technician/clinical laboratory technician education program - structured curriculum composed of general education, basic sciences, mathematics, and professional courses, including clinical education; the curriculum must cover methodologies for all major areas currently practiced by a modern clinical laboratory; collection, processing, and analyzing biological specimens and other substances; use of laboratory results in
diagnosis and treatment; communications sufficient to serve the needs of the patient and public; technical training equal to entry-level standards; quality assessment in laboratory practice; laboratory safety and regulatory compliance; information processing; ethical and professional conduct; and significance of continued professional development (NAACLS Guide to Accreditation, 2005).

12. National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) - a non-profit organization that independently accredits clinical laboratory scientist/medical technologist, clinical laboratory technician/medical laboratory technician, histotechnologist, histologic technician, pathologists' assistant, diagnostic molecular science, and cytogenetic technology educational programs; also independently approves phlebotomist and clinical assistant educational programs (NAACLS Guide to Accreditation, 2005).


14. Pilot study - a small-scale, preliminary investigation that is conducted to develop and test the measures or procedures that will be used in a research study (Gall, Borg, and Gall, 1996).

15. Preceptor - an expert or specialist, such as a physician, who gives practical experience and training to a student, especially of

Organization of the Dissertation

Chapter One defined the problem and discussed the purpose of the study. The conceptual framework for the research study was also presented, along with a set of research questions and associated hypotheses. Chapter Two consists of a review of the literature related to the development of clinical laboratory science practice and education requirements, curriculum development and evaluation, MLT/CLT program characteristics, accreditation and certification. Chapter Three will more fully discuss the methods employed in constructing and distributing the surveys that will be used to assess the program characteristics and related factors of the target population of MLT/CLT-AD programs. Chapter Four presents the results of data collection and the statistical techniques used to interpret the data. Chapter Five consists of an interpretation of the major findings of the study and possible recommendations for MLT/CLT program revision. The appendices contain the survey instrument, cover letter, informed consent, human subject research approval, and bibliography. A compact disk containing Statistical Package for the Social Sciences (SPSS) data is attached.
Summary

The clinical laboratory science professions and related academic programs experienced steady growth throughout the 1960's and 1970's as diagnostic testing played an increasingly important role in patient diagnosis and treatment. However, since the 1980's, academic programs in many clinical laboratory science disciplines have reported declining enrollments and program closures (Castillo, 2000). Cross-training, increased workloads, use of less-qualified personnel, increasing automation, and adoption of the "core lab" concept are some of the strategies that laboratories have utilized to overcome the personnel shortage. However, highly skilled and educated clinical laboratory professionals are still necessary to ensure the quality of future diagnostic services, as both the workforce and the patient population ages. An examination of current educational programs may provide information that will be useful in preparing a sufficient number of qualified graduates to meet these needs.

A conceptual framework based on Astin’s I-E-O model was proposed as a foundation for considering the factors that affect MLT/CLT program student outcomes. Input, environmental, and outcome variables related to MLT/CLT programs were identified for study.

A fifty-five question survey was developed and distributed to the sample MLT/CLT programs. Data were received, analyzed, and used as the basis for discussion.
CHAPTER 2

REVIEW OF RELATED LITERATURE

The History of the Clinical Laboratory Sciences Profession and Education

"There is no future without the past. In order to discuss the problems of the future intelligently, the accomplishments of the past may well be considered first. Therefore, to appreciate what may be in store for the future of medical technology, it seems logical to dwell briefly upon the record of what has been attempted and accomplished during the earlier years" (Ikeda, 1946, p. 146).

Prior to the turn of the century, the clinical usefulness of laboratory determinations was not widely recognized (Kotlarz, 1998a). Therefore, laboratory testing was not routinely utilized in patient diagnosis and treatment. Basic testing was performed by a physician in a corner of his home, office, or a hospital ward (Kotlarz, 1998a). Advances in microbiology, microscopy, and the development of additional methods for analyzing blood and urine soon established the role of laboratory testing in the diagnosis of disease (Kotlarz, 1998a).

The first clinical laboratories were established in teaching hospitals and public health departments in response to epidemic outbreaks of infectious diseases (Kotlarz, 1998a). More sophisticated testing methods and the
availability of laboratory equipment contributed to an increase in routine laboratory testing (Kotlarz, 1998a). As the workload increased, it became necessary to delegate some of the testing responsibilities (Kotlarz, 1998a). Initially, testing was assigned to interns or other members of the house staff (Kotlarz, 1998a). Few men were attracted to work in the laboratory due to the low wages and lack of opportunities for advancement (Kotlarz, 1998b). Women were considered ideal employees since they were willing to work for lower salaries than equally qualified men, obtain formal training, were sufficiently competent to work independently, and did not challenge the authority of the pathologist (Kotlarz, 1998b).

The establishment of many civilian and military laboratories during and after World War I increased the need for trained laboratory personnel (Kotlarz, 1998b). The typical laboratory worker received apprentice-ship training designed to meet the particular needs of the hospital at which they were employed (Kotlarz, 1998b). Due to the lack of established training standards and educational pre-requisites, few formal programs were available for laboratory technician instruction (Kotlarz, 1998b). Commercial schools capitalized on the labor shortage by promoting short-term programs for laboratory technicians; however, the performance of graduates was considered to be sub-standard (Ikeda, 1940).

In 1919, the American College of Surgeons (ACS) implemented a process for assuring minimum standards of hospital care (Kotlarz, 1998a). In order to control the quality of clinical and anatomic pathology services, the ACS also
introduced requirements designed to ensure that laboratories were developed in hospitals and under the direction of a physician, preferably a pathologist (Kotlarz, 1998a). Accreditation of a hospital by the ACS was linked to the establishment of a hospital-based laboratory (Kotlarz, 1998a).

During this time, another factor contributed to the need for technicians. Legislation enacted in Pennsylvania required the State Board of Medical Licensure to ensure "that all hospitals and institutions, particularly those receiving state aid, install and equip an adequate laboratory and employ a laboratory technician on a full-time basis" (Montgomery, 1970, p. 434).

Clinical institutions developed intensive and systematic training programs targeting techniques and practical instruction (Kotlarz, 1998b). Eventually, colleges and universities began providing training programs for laboratory technicians. Coursework in applied sciences, public health, and basic laboratory techniques were required at Simmons College in 1919, one of the first institutions to develop a specific program, including practical training, for laboratory technicians (Kotlarz, 1998). In 1922, the University of Minnesota was the first institution to grant a baccalaureate degree in medical technology (Hovde, 1957). Requirements for admission to the Medical Technology program were the same as those for the College of Science, Literature, and the Arts, recognizing the value of a combined liberal arts and professional education (Hovde, 1957).

Dr. Kano Ikeda was one of the first physicians to recognize the contribution of trained assistants to the emerging practice of clinical pathology.
(Ikeda, 1940). When the American Society of Clinical Pathologists (ASCP) was established in 1922, many members expressed concerns about the lack of qualified training programs and laboratory professionals (Ikeda, 1940). The "Committee on the Registration of Laboratory Technicians" was convened in 1926 to "define a technician; possibly different classes of technicians, as Class A, Class B, and Class C and then proceed to make it known that we have such a bureau which will undoubtedly bring forth many applications for registration" (Ikeda, 1940, p. 223).

Dr. Ikeda and his colleagues reported their findings in 1928 and recommended that a permanent Board of Registry (BOR) be created to register laboratory technicians who met the designated standards and qualifications (Kotlarz, 1998c). Other functions of the BOR included investigating and registering schools offering an acceptable course of laboratory training, conducting a placement bureau, and promoting ethical standards among registrants (Ikeda, 1940; Montgomery, 1970).

Technical workers were classified according to their education, training, and experience (Ikeda, 1940; Montgomery, 1970; Kotlarz, 1998c). Those applicants possessing a university degree with at least one year in basic sciences, including laboratory coursework, and one year of practical experience in a recognized laboratory were registered as medical technologists (Montgomery, 1970; Kotlarz, 1998c). Minimum requirements for registration as a laboratory technician were high school graduation, one year of didactic coursework in basic sciences, and six months of practical experience.
(Montgomery, 1970; Kotlarz, 1998c). In 1930, certificates were issued for the first time to 400 medical technologists and laboratory technicians (Kotlarz, 1998c). Registrants were also required to work under the direct supervision of a qualified physician or clinical pathologist (Kotlarz, 1998d).

The BOR conducted a survey of 137 training programs in 1930 and used the accumulated data to formulate specific guidelines for colleges and clinical laboratories operating such programs (Kotlarz, 1998c). The findings of the survey demonstrated the diversity of training programs, with respect to admission requirements, setting, coursework, and length of study (Kotlarz, 1998c). The "Essentials of an Acceptable School for Clinical Laboratory Technicians", published in 1931, underscored the technical and practical components of laboratory work, defined the length of the program, prerequisite coursework, and instructional methods (Kotlarz, 1998c). Schools which met these requirements were included in the first list of approved schools, published in 1933 (Kotlarz, 1998c). The BOR continued to exert a major influence on training programs, increasing the academic prerequisites and contributing to the perception that medical technologists were educated rather than trained (Kotlarz, 1998e).

In 1933, the BOR also developed and administered the first certification examination (Kotlarz, 1998c). Initially, applicants were required to take both written and practical tests, as well as possess designated personal qualifications (Montgomery, 1970). By 1944, the practical examination was eliminated (Kotlarz, 1998c). The BOR noted that only about 2% of applicants passing the written examination failed to pass the practical examination (Montgomery, 1970).
In addition, the standardized training provided by the approved schools was expected to identify and eliminate incompetent students (Montgomery, 1970). The format of the written examination continued to evolve over the next several years and by 1949 consisted entirely of multiple choice items (Montgomery, 1970). This enabled the examination to be graded mechanically and facilitated feedback to schools regarding their students and programs (Montgomery, 1970). This type of objective examination continues to be used today to evaluate applicants in general and specialty fields of the clinical laboratory sciences. Over the years, the BOR has continued to review the minimum academic and practical experience requirements for certification eligibility (White, 1965; Kotlarz, 1998c).

In 1948, the BOR consigned responsibility for the accreditation of schools of medical technology to the newly established Board of Schools (BOS) (Kotlarz, 1999a). The BOS was composed of pathologists and medical technologists and served in an advisory capacity to the Council on Medical Education and Hospitals (CMEH) of the American Medical Association (AMA) (Kotlarz, 1999a). The primary functions of the BOS were to promote and assist in the founding of new schools and to ensure their adherence to high standards (Kotlarz, 1999a). The BOS was also charged with inspecting all new schools within one year of accepting new students, those undergoing a change in directorship, or those experiencing any problems which might affect the program (Kotlarz, 1999a). Follow-up inspections were conducted every three to five years (Kotlarz, 1999a).

As the number of laboratory workers increased, they began to organize into professional societies to represent their specific interests, develop continuing
education opportunities, promote the profession of medical technology, and establish a degree of independence from pathologist control (Kotlarz, 1998d). Initially, the professional societies coordinated their annual meetings with those of the ASCP and the AMA so members could benefit from attending lectures and exhibits pertaining to current issues in laboratory medicine (Kotlarz, 1998d).

Over time, there was increasing friction between the pathologists and technical personnel, as the latter sought increased representation on ASCP committees, including the BOR (Kotlarz, 1998d). The BOR continued to deny registration to graduates of commercial schools and refused to renew the certification of registrants employed in proprietary laboratories (Kotlarz, 1999b). In 1969, the American Society for Medical Technologists (ASMT) filed a lawsuit claiming that the ASCP was attempting to control the certification of medical technologists and the accreditation of educational programs, through its control of the BOR and the BOS (Kotlarz, 1999b). Although the suit was dismissed, it generated enough attention to warrant a review by the Commissioner of the United States Office of Education (Kotlarz, 1999b). When the AMA Council of Medical Education requested continuing authority to accredit laboratory education programs through the BOS, it was denied on the basis of failing to employ the self-evaluation process in accreditation (Kotlarz, 1999b). In addition, it was noted that the BOS should function independently of the ASCP (Kotlarz, 1999b). These events contributed to the dissolution of the BOS in 1973 (Kotlarz, 1999b). Its functions were assumed by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS), an independently operating and
governed entity (Kotlarz, 1999b). NAACLS continues to oversee the evaluation and accreditation of all levels of clinical laboratory sciences educational programs.

Accreditation of Clinical Laboratory Sciences Education

Accreditation is a process of external peer review in which an agency grants public recognition to a program of study or an institution that meets established qualifications and educational standards. Accreditation of a specialized program is known as programmatic or specialized accreditation (Newell, 1993).

Specialized accreditation in the clinical setting is a practice begun almost 100 years ago, by the American College of Surgeons (ACS), in an attempt to protect the public through the voluntary self-regulation of medical practice (Dill, 1998). The Minimum Standards for Hospitals drafted by the ACS became the template for the standardization of hospital care. The ACS evolved into the Joint Commission on Accreditation of Hospitals, becoming the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) in 1987. The mission of JCAHO is to improve the safety and quality of care provided to the public through the provision of accreditation and related services that support improvement in health care organizations (www.jcaho.org). JCAHO accreditation is nationally recognized as a sign that health care organizations are committed to quality care through their compliance with rigorous performance standards (www.jcaho.org). To maintain JCAHO accreditation, health care organizations must submit to an
on-site inspection by a survey team every three years; laboratories must be
surveyed every two years (www.jcaho.org). In 1978, JCAHO entered into
collaboration with the College of American Pathologists (CAP) to monitor the
quality of services in hospital laboratories (www.jcaho.org).

Specialized accreditation has also permeated educational institutions and
the many programs they sponsor. The early efforts of medical professionals to
monitor their professional practices have burgeoned into nearly 100 specialized
and professional accrediting agencies involved in evaluating colleges and
universities (Dill, 1998). The primary objectives of specialized and professional
accreditation are to promote self-assessment and planning, while helping
institutions recognize the resource and delivery requirements for satisfactory
education in special fields (Dill, 1998). Specialized accreditation provides an
external review of the program and identifies areas for improvement.

The practice of self-assessment is especially evident in allied health
education, where the goal of specialized and professional accreditation is to
secure public health and safety by ensuring the provision of adequate education
and training designed to produce competent graduates. The advantages of
allied health program accreditation include confidence that: 1) a program meets
nationally accepted standards of educational quality; 2) graduates meet entry-
level standards of professional competence; 3) there is continuous self-
assessment to maintain educational standards; and 4) graduates are eligible for
certification, registration, and/or licensure (Newell, 1993.) In many states,
graduation from an accredited program is required prior to taking a certification
examination, applying for state licensure, and employment in the profession (Dill, 1998).

This study focused on those MLT/CLT programs accredited by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS). NAACLS is a non-profit organization that independently accredits programs in various clinical laboratory sciences programs (www.naacs.org). NAACLS was established in 1973 as the successor to the American Society of Clinical Pathologists (ASCP) Board of Schools (www.naacs.org). The ASCP and the American Society for Clinical Laboratory Science (ASCLS) are sponsoring institutions of NAACLS. Several other clinical laboratory sciences professional organizations are also affiliated with NAACLS. NAACLS is also recognized by the Council for Higher Education Accreditation (CAHEA) (www.naacs.org). NAACLS establishes, maintains, and promotes standards of quality for educational programs in the clinical laboratory sciences (NAACLS, 2005). Those programs seeking NAACLS accreditation must submit documentation pertaining to program sponsorship, resources, curriculum, students, operational policies, and evaluation (NAACLS, 2005). NAACLS also trains qualified volunteers to review program materials and conduct site surveys to evaluate compliance with established standards (www.naacs.org).

Certification

After a student receives an Associate of Science degree from an accredited MLT/CLT program, he/she is encouraged to seek certification from
one or more professional credentialing agencies. Although the certification procedure is optional on the part of the student, it is highly recommended, as certification indicates to the public and the employer that the applicant has successfully completed the course of study and achieved a minimum standard of competency in the discipline (Falcone, 2001). Another benefit of a national certification examination is the portability of credentials state-to-state (Falcone, 2001).

The current study is limited to certification examinations administered by the ASCP Board of Registry (BOR). The ASCP BOR was organized in 1928 to establish standards designed to assure competence of medical laboratory personnel and develop appropriate examinations for measurement of competence (www.ascp.org/bor). The ASCP offers examinations in various categories (i.e., Generalist, Blood Bank, Microbiology, etc.) and levels (i.e., technician, technologist, and specialist) to applicants meeting the prescribed academic and clinical requirements. A student attaining the minimum passing score (MPS) on an examination is eligible for certification in that category (www.ascp.org/bor).

Impact of the Collegiate Experience on Students

Many researchers have explored the effects of the collegiate experience on students. Boyer (1987) investigated the ways structures and procedures of colleges affected the lives of students. Assessment of the data gathered during site visits to church-affiliated institutions, selective private colleges, and public
universities revealed eight categories of concern: the transition from high school to college, the goals and curriculum of education, the priorities of the faculty, the condition and teaching of learning, the quality of campus life, the governing of the college, assessing the outcome, and the link between college and the world. Although the study was limited to baccalaureate education, many of the findings are applicable to two-year colleges, as well.

Jacob (1957) conducted an extensive review of research pertaining to value changes during the college years. A major finding of this effort was that students displayed greater uniformity with respect to values at the end of the college experience than was observed at the beginning. Jacob believed that these changes were as likely due to the selection and retention of students by a particular institution as they were to the effects of the college experience.

Jacob's initial findings sparked a flurry of research over the next several decades investigating the potential influence of the college environment on different characteristics of college students. Thousands of studies have been reviewed by Feldman and Newman (1969), Bowen (1977), and Pascarella and Terenzini (1991), among others. These studies provided consistent evidence that changes in college students are directly related to their college experiences and not just in response to maturation, social or political influences.

Two major models have emerged to catalog the many theories proposed to explain the concept of student change in the college environment. The developmental models concentrate on internal processes or dimensions of change (Pascarella & Terenzini, 1991) and underscore the qualitative differences
between discrete periods or stages that are presumed to unfold in a linear, sequential, and orderly fashion (Kuh, 1995). These models focus on outcomes of change over time in the ways that individuals think, value, and behave (Pascarella & Terenzini, 1991). The types of developmental changes that college students experience may be due to biological and psychological maturation, to individual experiences and the environment, or to the interaction of the individual and environment (Pascarella & Terenzini, 1991).

Psychosocial theorist Chickering (1969) identified seven vectors of development and associated elements to explain what happen to students during their college years. The vectors are essentially a series of tasks that the individual masters, such as achieving competence, managing emotions, developing autonomy, etc. The individual's age and maturity may influence the successful completion of these tasks and the approach to future challenges. Growth along the vectors may also be influenced by institutional characteristics, curriculum structure and teaching style, interaction with faculty, and student interaction with other peers and groups (Chickering, 1969). Other examples of research utilizing developmental models can be found in Perry (1970, 1981) and Kohlberg (1984).

The impact models place less emphasis on psychological processes, focusing instead on external environmental and sociological conditions and origins of change (Kuh, 1995). These models consider the sources of change, such as institutional characteristics, programs and services, student experiences, and faculty members (Pascarella & Terenzini, 1991).
Astin (1962) introduced one of the earliest impact models as a guide to studying college student development. Astin compared the student to a patient dependent on the healing skills of a physician, based on the fact that the goals of both medicine and education are to improve the condition of their clients (Astin, 1977). He stated that patients (students) are admitted to treatment facilities (colleges) because they need or want medical assistance (education). Medical facilities administer treatment programs based on a diagnosis of the patient’s illness; colleges administer educational programs that presumably are relevant to the student’s educational needs. Just as some patients do not benefit from medical treatment, so some students do not benefit from college education. At the same time, some patients improve and some students learn, even if their programs are ineffectual (Astin, 1977). This suggested that students assume a somewhat passive role in their own development. Later research demonstrated that students learn by becoming involved. Astin proposed that educational effectiveness is directly related to the ability of an institution to promote student involvement. One of the key concepts of his “theory of involvement” was the important role the institutional environment plays in providing numerous and varied opportunities for student interaction with other people and ideas. Consequently, the student assumed increased responsibility for the extent and nature of change and growth based on the utilization of the opportunities and resources (Astin, 1985).

Tinto’s theory of student departure is another model focusing on institutional impact. The intent of this longitudinal model was to explain the
factors influencing student attrition. Tinto proposed that students enter the higher education setting with individual patterns of personal and family characteristics, academic skills, and commitments to college attendance and goal attainment. He stated that initial goals and commitments are influenced by formal and informal academic and social encounters experienced by the student in the institutional environment. More positive encounters enhanced the ability of the student to integrate into the educational environment and strengthened the commitment to achieving the intended goals. Negative encounters decreased integration, distancing the student from academic and social groups, and promoted withdrawal from the academic setting (Tinto, 1987).

Weidman (1989) proposed a conceptual model of undergraduate socialization to explain the influences of psychological and social structure on student change. He recognized that students enter college with established background characteristics, such as socioeconomic status, aptitude, career choices, aspirations, and values. However, his model also sought to determine the relationship between additional pre-college pressures from parents, peers, employers, and community organizations and the choices students made within the educational setting. Weidman theorized that these groups continued to influence students, even as the socialization process incorporated formal and informal interactions with faculty and new peer groups. Weidman proposed that the socialization process contributed heavily to the decisions made by students with respect to goal attainment, including maintaining or changing original aspirations, attitudes, and beliefs held at entry to college.
Institutional environments, policies, programs, and services, together with the attitudes, values, and behaviors of the people who inhabit the institution all serve as possible influences on student change. The developmental models discussed above demonstrate that students are perceived as active participants in their own growth. The impact models focused more on the opportunities for change provided by the environment, through interpersonal interactions, academic experiences, and extracurricular activities.

An understanding of the influences on college students is essential to developing and maintaining successful programs, policies, and practices.

Factors Influencing Student Success

Academic achievement is one of the principal objectives of education and is measured by various outcomes, which serve as important indicators of educational quality and success. Initial attempts to select the students most capable of succeeding in a course of study emphasized demonstrated academic ability and proven scholastic performance. It has since been appreciated that many factors, both academic and non-academic, influence and interfere with academic achievement and present a challenge to students and instructors. Cognitive and non-cognitive factors have been studied together and separately to assess their relationship to predicting student success in a variety of educational programs. Understanding the extent to which academic achievement level varies as a function of teaching style, curriculum design, student motivation, personality, interests, and values, cultural expectations, and
other factors will assist faculty in planning and advising efforts relative to admission and completion of academic programs.

Cognitive factors

Pre-college variables, such as high school performance and standardized test scores, have been identified by researchers as reliable predictors of student success in college. High school rank, GPA, and SAT or ACT scores are commonly used by higher education institutions to forecast the academic performance and success of enrolling students. It has been demonstrated that students of higher academic ability and better academic preparation are more likely to persist and graduate than those of lower ability and less preparation (Astin, 1975; Tinto, 1993; Wilkie & Redondo, 1996). Hyers and Zimmerman (2002) found that high school rank showed a strong positive correlation with college graduation. Sixty-one percent of students with a rank over 60 graduated within three years, compared to 32.2% with a rank of 60 or below. Only 11.8% of students with a rank of 25 or less graduated. The same study also noted a positive, though weaker, correlation between ACT scores and graduation. A similar relationship between high school class percentile rank, ACT composite score, and subsequent achievement was observed in a study of health sciences majors by House (2000). A high correlation between high school GPA and retention was observed in a medical technology program (Knapp, 1984). Aldag and Kling (1984) found that ACT natural science subtest scores accurately predicted certification examination performance of medical laboratory technician program graduates. Heilman (1991) demonstrated that Nelson-Denny Reading
Test vocabulary and total scores, as well as ACT sub scores and composite scores, were correlated with final program GPA and certification examination score.

Early college variables have also been used to predict student success. Zimmerman (2000) demonstrated that the final grade in a five-week freshman orientation course was a robust indicator of persistence and graduation in a two-year technical college. Hyers and Joslin (1998) also found that orientation course grades correlated positively with persistence and graduation at their four-year liberal arts college. A relationship has also been observed between first-quarter GPA and graduation. Hyers and Zimmerman (2002) found that the graduation rate for the upper subgroup (A and B) was 5.6 times greater than for the lowest subgroup (D and F). In combination with pre-college variables, the results of their research reinforced that early college achievement is a strong indicator of student intent.

Pre-professional GPA in both general and science courses have been reported as useful predictors of success for medical laboratory students (Lundgren, 1968; Lanier & Lambert, 1981; Heilman, 1991) and other allied health students (Macomber & Sanders, 1984; Levine, Knecht., and Eisen, 1986). Aldag and Kling (1984) found that college GPA, together with the ACT natural science sub score, were the most significant contributors of performance on the certification examination for medical laboratory technician students. Cumulative GPA after one year of college was significantly correlated with subsequent academic achievement of health sciences majors (House, 2000). Knapp (1984)
found that earned GPA continued to be a strong predictor of future academic performance of medical technology students. In that study, first semester GPA showed a strong correlation with final college GPA. There was a significant difference in the first semester GPA of students who remained enrolled and those who withdrew.

Several studies have examined the relationship between grades earned in prerequisite and professional courses in order to predict success in a clinical laboratory science educational program. Academic preparation and achievement in clinical chemistry coursework has been studied (Wise, 1983; Lehman, Leiken, and Firestone, 1984). Both studies noted a positive correlation between selected pre-requisites and clinical chemistry grades. Academic preparation has also been linked to achievement in professional coursework and certification examination passage (Lin, Snyder, Agriesti-Johnson, and Powers, 1987). Jeff and West (1988) identified prerequisite courses that had high predictive values for success in a medical technology program. They examined students' grades in natural sciences and mathematics prerequisite courses and correlated them to specific professional courses. Correlations above 0.45 were observed with the predictor courses Microbiology, Mammalian Physiology, and Genetics. Conversely, low correlations were noted for courses such as Calculus, General and Analytic Chemistry, Organic Chemistry, and Physics.

Surveys have attempted to identify a core of prerequisite courses common to most programs and ascertain their relevance to the professional curriculum. Kasper, Rodak, Snyder, Wei, and Wilkey (1993) surveyed 403
medical technology programs and reported great variability in pre-professional coursework.

Considerable flexibility is granted by accrediting agencies with respect to guidelines for prerequisite coursework (Newell, 1993). NAACLS requires accredited programs to offer "a structured curriculum composed of general education, basic sciences, mathematics, and professional courses" (NAACLS standards, 2005). In addition, certification agencies require a minimum number of semester hours in biological sciences, chemistry, and mathematics to qualify for examination eligibility. No specific courses are stated as examination requirements (www.ascp.org/bor).

Non-cognitive factors

Many studies have investigated non-cognitive factors that influence student success. Nord, Brimhall, and West (1997) demonstrated that student achievement was influenced by the extent to which fathers provided academic guidance and support. Higher levels of achievement and greater enjoyment of school were observed in children whose fathers were more involved in their education. Similar results were reported for mothers. Students in grades 6 through 12 were less likely to be suspended or expelled when mothers were more involved (Nord, 1998). Alnabhan, Al-Zegoul, and Harwell (2001) demonstrated that Jordanian male students of better-educated parents achieved the highest GPA, while females exhibited higher achievement when fathers were less educated, regardless of the education level of the mother. Males and females displayed similar achievement when both parents had less education.
High socio-economic status has also been associated with higher standardized test scores, despite the education level of the parents (Grissmer, Flanagan, Kawata, Williamson, 2000; Pennock-Roman, 1994).

Student motivation has also been shown to influence student achievement. Anthony surveyed students and lecturers to identify specific factors that contributed to student success in first-year mathematics courses. Both study populations identified self-motivation as the most important factor related to levels of student achievement (Anthony, 2000). Motivation was highly associated with accomplishing the performance goals of assignment completion and examination success. Motivation was also responsible for advanced preparation for lectures, regular attendance at lectures, note-taking, and formation of study groups. Research indicates that students who do not successfully integrate within the institution’s social or academic environment are more likely to struggle academically, with a high probability of withdrawal (Braxton, Duster, and Pascarella, 1988; Nagda, Gregerman, Jonides, Von Hippel, and Lerner, 1998; Tinto, 1993).

The relationship of students’ appraisals of their abilities, continued enrollment, and academic achievement has also been examined. Academic self-concept and subsequent accomplishments are associated with success in mathematics (House, 1993; House, 1994; House, 1995) and sciences courses (House, 1995a; House, 1995b), as well as English (House, 1998), and psychology (House, 1996). A positive correlation has been demonstrated between students’ self-beliefs and academic performance on examinations in

Medical technology student personality characteristics were examined to determine their influence on certification examination performance. Initiative, comprehension, and judgment were found to correlate strongly with examination passage (Millstead, 1992). Vocational interests of CLT students were also related to program outcomes of graduation, voluntary withdrawal, and academic dismissal (Laudicina, 1994).

Differences between traditional and non-traditional students have also been shown to influence student achievement. Traditional students are defined as recent high school graduates, while non-traditional students are typically aged 25 years or older at the time of college enrollment. These two student groups differ in their expectations of and approach to the social and academic environments of higher education.

Wintre and Yaffee (2000) studied the adjustment of first-year students to the university setting. In addition to coping with transitions from adolescence to adulthood and high school to college, they found that young students also faced challenges related to academic and social adjustment, the development of autonomy, separation from friends and parents, and identity development.

Adult learners also have unique issues with adjustment to college. Many are returning to acquire the skills necessary for a career change. They may be married, have children, and work full or part-time, in addition to their coursework. Extensive research has focused on the needs of adult learners in order to
establish an environment more conducive to their educational needs and objectives. Non-traditional students encounter difficulty participating in campus-based activities (Graham & Donaldson, 1999). Persistence rates have been observed to be lower in adults who worked more hours and attended part-time (Naretto, 1995). A supportive social system correlated positively with the retention of adult learners (Ashar & Skenes, 1993; Nunn, 1994).

Rautopuro and Vaisanen (2001) compared both student groups with respect to goal orientations, study experiences, satisfaction with student-faculty interactions, and dropping out. Their objective was to identify whether adult learners and younger students achieved different outcomes from their university education. Significant findings were that younger students were more likely than non-traditional students to drop out during the first year of study. Younger students also achieved higher scores in core subjects as well as in general studies courses. Non-traditional students were more likely to drop out later in their studies. Older students were more satisfied with learning experiences at the beginning of their studies than younger students. No significant differences were detected between the groups related to the quality of student-teacher interaction. The authors concluded that the pattern of differences between the two groups could form the basis for consideration of alternative teaching and learning settings to facilitate optimal learning for each group.

Research indicates that positive faculty-student interactions are important in maximizing student learning. Boyer (1987) states "if faculty and students do not see themselves as having important business to do together, prospects for
effective learning are diminished” (p. 141). Knowing and learning are communal acts shared among individuals (Palmer, 1998). Therefore, the classroom can be thought of as a community setting, complete with social factors that have their own impact on student learning (Hirschy & Wilson, 2002). As students and instructors meet regularly, beliefs, norms, and other social factors appear that may promote or hinder learning (Fassinger, 1997). Differences in social class, race, age, and gender of both students and instructors can affect the classroom climate (Hirschy & Wilson, 2002). Instructors can influence the classroom climate by promoting a positive learning environment that values achievement, love of learning, competition, collaboration, or caring (Hallinan & Smith, 1989). Instructors also maintain an authority position in the classroom setting by designing the curriculum, assigning work, and evaluating student performance (Boyer, 1987; Hirschy & Wilson, 2002). Student development can be impeded by this unequal balance of power and structure (Falchikov, 1986). However, Falchikov (1986) also observed that instructors can use their authority to control student interactions in the classroom by promoting positive behaviors and discouraging negative ones. Similarly, Colbeck, Cabrera, and Terenzini., (2000a) found that instructors who incorporated collaborative and active learning activities into their courses, offered feedback to students, interacted frequently with students, were clear and organized, and treated students fairly avoided many of the negative effects of a competitive classroom environment. Braxton and Bayer (1999) identified seven norms to avoid when designing a supportive environment for student learning: publicly demeaning a student; inattentive
planning of learning activities; relating to students in an unprofessional, immoral manner; evaluating students in unfair or unmeritorious ways; being routinely unprepared for class, arriving late, or using profanity; failure to inform students about changes in class time or location; and cynical attitude toward teaching. Palmer (1998) stressed the necessity of creating learning communities, where instructors demonstrate enthusiasm for their subjects and students, create connections among themselves, their subjects, and students, and encourage students to be active in their own learning.

Student peers also exert considerable impact on the classroom environment, in the way individuals choose to respond and how they inhibit or encourage fellow student involvement (Hallinan & Smith, 1989). Fassinger (1995) demonstrated that student traits and classroom traits were better indicators of class participation or withdrawal than instructor traits of teaching style, approachability, and knowledge. His findings led him to suggest that instructors should focus on course design in order to build student confidence and promote cooperative efforts. Subsequent research by Fassinger (1997) observed that students' willingness to speak in class was based more on their sense of the friendliness of their peers and less on their instructor.

Other studies have identified differences in the ways male and female students respond to interactions with peers. Colbeck, Campbell, and Bjorkland (2000b) revealed that female engineering students perceived a difference in their treatment by male students when compared to how the males treated each other. However, the female students reported no perceived gender
discrimination by faculty. Reynolds and Nunn (1997) reported that a supportive classroom environment had more of an impact on female students, in terms of participation. Other variables that contributed to participation were confidence, class size, how often students speak with each other in class, interest in subject matter, whether contributing positively affects one's grade, the emotional climate of the class, and the gender of the student (Fassinger, 1997).

A variety of pedagogical methods are employed to promote student learning. These include lectures, laboratory activities, fieldwork, service learning, externships, electronic media, and Web-based learning. In shaping the curriculum, instructors consider a number of variables, such as the needs and backgrounds of students; learner characteristics; educational resources and classroom structure; and the intended outcomes of learning. A primary responsibility of an effective instructor is to incorporate one or more teaching methods in designing a curriculum that will maximize student involvement in learning, no matter where or how that learning takes place. Tinto (1993) believed that classrooms function as small communities of learning and that student involvement in those communities can increase retention and promote integration into the institutional environment.

Many research studies have focused on methods that promote active learning. Davis and Murrell (1993) found that active learning increased student involvement in learning with other students and facilitated students' accountability for their own intellectual development. Smith and MacGregor (1992) found that collaborative learning methods fostered an interdependent
community, as the classroom shifted from a teacher-centered to learner-centered environment. Students also demonstrated positive perceptions of their abilities in a collaborative learning environment (Colbeck, et al., 2000a).

In a cooperative learning setting, students work together in small groups, with each student responsible for a portion of the project or assignment. Davis and Murrell (1993) found that this type of learning strategy induced students to work together in a noncompetitive way. The positive peer relationships developed in this environment support different learning styles (Kreke, Fields, and Towns, 1998). Bose, Jarreau, Lawrence, and Snyder (2004) compared the performance of students instructed by cooperative learning activities and those taught by lecture. Although no significant difference was noted between the mean examination scores of both groups, all students perceived that the incorporation of cooperative learning techniques contributed to their ability to work in teams, an important attribute for laboratory professionals.

The learning community model has also been studied as a means of improving the curriculum, building community, and increasing retention. According to Gabelnick, McGregor, Matthews, and Smith (1990, p. 5) the learning community is a "purposeful restructuring of the curriculum to link together courses so that students find greater coherence in what they are learning and increased interaction with faculty and fellow students". Learning communities are being employed to address a variety of concerns in higher education: the disconnect between the expectations of career-oriented students and research-and-discipline-oriented faculty; insufficient scholarly interactions...
between students and between faculty and students; lack of integration between major and non-major courses; lack of resources and opportunities for faculty development; and the increasing complexity and interdependence of present-day issues (Hill, 1985). A review of the literature by Meyers (2003) indicated that learning communities can have a substantial effect on "the academic success of disadvantaged students, students of color, academically under prepared students, students needing remedial support, and non-traditional students".

Many studies have illustrated that experiences outside the classroom play an important role in student learning and personal development (Astin, 1977; Astin, 1993; Bowen, 1977; Feldman & Newcomb, 1969; Kuh, 1993; Pascarella & Terenzini, 1991). Kuh (1995) referred to these experiences as "the other curriculum". He interviewed seniors from twelve institutions to determine the out-of-class experiences that influenced intellectual, social, and emotional development and whether the type of experience differed by institution or student characteristics, such as sex and ethnicity (Kuh, 1995). Ranked in descending order, students credited specific leadership responsibilities, peer interactions, class-related activities, faculty contact, work, and travel as the activities most associated with gains in intellectual and personal development (Kuh, 1995).

Several researchers have examined the relationship between students' work hours and their academic achievement (Astin, 1977; Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993). Kuh (1995) observed that while working students benefited in terms of personal satisfaction and time management, working can also negatively impact academic performance and
personal well being. Orszag, Orszag, and Whitmore (2001) found that students working less than ten hours per week had slightly higher GPAs than similar students, while those working thirty-five or more hours per week reported negative effects on their studies, such as limited class schedules, reduced class choices, and restricted access to the library. Lillydahl (1990) also reported that students employed more than twenty hours per week experienced declines in academic performance. Gleason (1993) and Orszag, et al., (2001) demonstrated that working students were more likely to leave school than non-working students. The relation of a job to the academic environment was associated with increased retention. On-campus jobs may forge links to academic departments and foster integration into the campus community (Orszag, et al., 2001; Tinto, 1993).

Assessment

Assessment is an ongoing process for most allied health programs, due to mandated internal and external reviews. Outcome assessment is often used to evaluate aspects of clinical laboratory science education, at both the program and course levels. Gore (1991) first described the value of outcome assessment in clinical laboratory science education. Outcome measurement has since been used to determine the effectiveness of different educational formats. Zitzmann (1996) used outcome assessment to compare lecture and self-instructional methods in a Parasitology course. Analysis of the data demonstrated that there was no statistical difference in learning outcomes between the two methods,
supporting the incorporation of self-instructional modules into the curriculum. Bose, et al., (2004) also reported similar results after comparing the performance of students instructed by cooperative learning with those taught by lecture. Teshima (2001) demonstrated that students engaged in problem-based learning activities did significantly better on selected subtest areas of a national certification examination than those who did not participate in such activities. Schwabbauer (1997) described the application of outcome measurement and assessment in curriculum revision. Major objectives linked to measurable outcomes were identified to guide the revision process. Student performance data that reflected the effects of a more efficient and effective curriculum were increases in professional GPA, comprehensive examination mean scores, and certification examination mean scores and pass rates (Schwabbauer, 1997).

Community expectations of new graduates are high. Success in the workplace requires a specific skill set related to the clinical discipline, yet new graduates are also expected to possess generic skills that will allow them to function more effectively. Harris, Adamson, and Hunt (1998) surveyed faculty, graduates of a variety of allied health programs, and workplace supervisors to identify common attributes that would contribute to a multi-disciplinary approach to healthcare. Analysis of the survey responses identified eleven workplace dimensions that defined the adequacy of graduates' preparation for the workplace. In addition to profession-specific skills, these dimensions included: communication with clients, communication with health professionals and the general public, knowledge of the health industry, clinical skills, realistic
expectations of the workplace role, pursuit and application of knowledge, workplace management, applying evaluative approach, essential tasks, coping in the workplace, and ethical practice (Harris, et al., 1998). The authors proposed that this information might be useful to educators in the areas of accountability, quality assurance, and curriculum development.

Summary

The clinical laboratory sciences received professional recognition with the acceptance of the testing of blood and body fluids in patient diagnosis and treatment. Initially, laboratory personnel were trained and supervised by the pathologist. As testing methods and instrumentation became more sophisticated, it became apparent that an educated workforce was essential to providing accurate results and protecting the public. Based on the recommendation of a group of pathologists, a Board of Registry was established to classify technical professionals according to their education, training, and experience. The duties of the BOR expanded to include the development and administration of the first certification examination, as well as the establishment of guidelines for training programs. Eventually, accreditation of professional programs was relinquished to an independent agency, the National Accrediting Agency for Clinical Laboratory Sciences.

Accreditation of allied health programs, including clinical laboratory sciences educational programs, is modeled after the practice of self-regulation begun by the American College of Surgeons in the early 1900s. Today, many of
these educational programs seek specialized accreditation to ensure stakeholders that adequate education and training has been provided to graduates. Attaining certification in their chosen profession offers further assurance that the graduate has successfully completed a prescribed program of study and achieved a minimum standard of technical competence.

This study explored the effects of a variety of student and environmental factors on MLT/CLT students. Research has shown that a variety of factors, both cognitive and non-cognitive, influence student success in collegiate programs. Cognitive factors include pre-college predictors, such as high school GPA and standardized test scores; early college predictors, such as performance in an orientation course; and GPA in pre-professional coursework. Non-cognitive factors include family influence, student motivation, self-beliefs, adjustment to college life, faculty-student interactions, peer interactions, and pedagogical method.

An understanding of these factors may be helpful in selecting the students most likely to succeed in MLT/CLT programs, as well as designing the most effective curriculum to prepare a competent workforce.
CHAPTER 3

METHODOLOGY

Introduction

Some of the challenges encountered in allied health education include declining program enrollments, increasing program closures, a fluctuating economy, and increasing healthcare costs and regulation. It is reasonable, therefore, to examine the structure and function of remaining educational programs to ensure that graduate quality and number remain sufficient to meet future healthcare needs.

A descriptive study design was employed to compare selected characteristics associated with MLT/CLT education programs nationwide. A survey instrument was developed and sent to the national MLT/CLT program directors' population to collect the information necessary to identify and compare similarities and differences among programs.

Survey item responses were analyzed to identify those characteristics associated with successful MLT/CLT programs. Successful programs were defined as those whose students exhibited passing performance on a national certification examination, and employment related to their clinical laboratory science education within 12 months of graduation.
A theoretical framework based on principles extracted from Astin's I-E-O theory was presented, suggesting that input, environment, and outcome variables influence student academic performance. It was hypothesized that Astin's theory is consistent with MLT/CLT program variables, as reported by the program director.

Research Questions

The following research questions were formulated to obtain data to support the hypothesis that various factors in MLT/CLT education, such as student/program characteristics, affected student performance.

R.Q. 1 Is there a relationship between selected student characteristics and MLT/CLT student attrition? (Input: student variables)

R.Q. 2 Is there a relationship between prior education level and post-graduate performance? (Input: student variables)

R.Q. 3 Is there a relationship between selected curriculum characteristics, teaching methods and learning methods, and MLT/CLT student attrition and post-graduate performance? (Environment: institutional variables)

R.Q. 4 Is there a relationship between selected faculty characteristics and MLT/CLT student attrition and post-graduate performance? (Environment: institutional variables)

R.Q. 5 Is there a relationship between selected MLT/CLT in-
program assessment methods, and student attrition and post-graduate performance? (Outcome: certification examination passage and post-graduate employment)

Design of the Study

A descriptive study design was utilized to examine and compare selected variables associated with a national MLT/CLT program sample. These variables included:

1. Level of student ability prior to entry into an MLT/CLT program
2. Student demographic characteristics
3. Non-core and core course curricular structure
4. Teaching and testing methods
5. Students interactions
6. Didactic and clinical faculty education and experience
7. Quality of clinical training sites
8. Institutional characteristics

A sample of MLT/CLT programs was surveyed to identify the specific characteristics associated with each program. Data analysis sought to identify trends in characteristics among programs and to compare the characteristics of successful programs.
Population/Sample/Subjects

The primary data source was a survey instrument sent to program directors of the sample MLT/CLT programs, as identified by the 2002-2003 Health Professions Career and Education Directory (American Medical Association, 2002). The directory provides demographic information for each program, including supporting educational institution; address; program director; medical director; phone, fax, and e-mail; class capacity; program length; and tuition.

Two hundred and ten MLT/CLT programs are listed in this directory. A criterion-based approach was taken, delimiting survey requests to those programs awarding an Associate of Science degree and accredited by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS). This, therefore, represented the national population of NAACLS-accredited associate degree programs. One hundred and fifty MLT/CLT programs, with each major geographic region in the United States being adequately represented, (accounting for regional differences among programs), were surveyed.

Instrumentation/Collection of Data

A survey was utilized to gather information on selected student and institutional characteristics of the target population. As program director e-mail address declaration is an AMA requirement, an electronic survey protocol was utilized. Surveys and responses were transmitted electronically (Internet). All survey requests originated from the Cannon Center for Survey Research at the
University of Nevada, Las Vegas. All survey responses went directly to the data center, where they were organized and tabulated. At no time did the author have access to survey responses.

Survey construction was initiated by identifying survey items for each of the research questions. Fifty-five fixed-response survey questions were chosen to identify similarities and differences among MLT/CLT programs. Each program was assigned a code to maintain confidentiality.

A pilot study was conducted to assist in the preparation of the survey instrument. A cover letter and survey materials were distributed to ten MLT/CLT program directors and educators. Members of the pilot group were asked to complete the survey materials and review them for clarity and relevance. The recommendation to add an additional educational category, “High school diploma/GED and some college”, was incorporated into the final survey instrument.

A cover letter was included with each survey. The letter stated the purpose and significance of the survey, encouraged voluntary participation of the respondents, and outlined directions for the completion and return of survey materials. Respondents were also informed that confidentiality of survey responses and the results of data analysis would be strictly maintained by the principal investigator.

Respondents were requested to return completed surveys within two weeks of receipt. A reminder notice was sent to all program directors whose surveys had not been received by the stated deadline. This was also done via
electronic mail. Respondents were encouraged to submit surveys so that responses might be included in the final data analysis.

Appropriate authorization to conduct the study was obtained from the UNLV Office for the Protection of Research Subjects (OPRS), 4505 Maryland Parkway, Las Vegas, NV 89154. A copy of the cover letter and survey instrument are found in Appendix A. The OPRS Institutional Research Board approval is found in Appendix B.

Procedures for Analysis of the Data

A post hoc descriptive study was conducted to identify and compare selected characteristics of MLT/CLT programs. Data were analyzed using descriptive statistics and Pearson-product moment correlation coefficient. Data were reported in two ways. First, data from the survey items were presented with incidental observations. Second, survey items were presented in the context of the research questions.

Significance of the Study

Currently, there is no national or professionally mandated curriculum for medical laboratory technician training. The purpose of this study was to identify potential characteristics that make an MLT/CLT program more successful. These identified characteristics might then be used as the basis for developing a model program and curriculum for future MLT /CLT educational programs. Assessment is needed to determine the effectiveness of these training programs.
and maximize the number of graduates. The results of this research might suggest that individuals involved in program evaluation consider alternatives to the current curricular structure, methods of assessment, and other program-specific characteristics. Although this research effort is directed at MLT/CLT educational programs, similar studies might be useful at all levels of CLS education.

Delimitations and Limitations

The study was delimited by the following:

1. Inclusion of only Medical Laboratory Technician Associate Degree (MLT-AD) programs. Those programs granting certificates of completion were not studied.

2. Inclusion of only those programs accredited by the National Accrediting Agency Clinical Laboratory Sciences (NAACLS).

3. Inclusion of only fall admissions data for academic year 2002.

The study was limited by the following:

1. Results could not be generalized beyond this specific population.

2. Because a survey will be used to collect data, the study was dependent upon the respondents to fully and accurately report on the data requested. Threats to external validity, such as the Hawthorne effect, were beyond the control of the researcher.

3. Data acquisition was dependent on unbiased reporting by program directors.
4. The return of all surveys could not be guaranteed.

Summary

Research questions were developed to examine the relationships among input, environmental, and outcome variables associated with MLT/CLT educational programs. Data were collected utilizing a pilot study validated survey instrument delivered electronically to 150 program directors of accredited programs awarding Associate of Science degrees. Surveys were solicited, collected, and processed by the Cannon Center for Survey Research. A 43% response rate was attained. Descriptive statistics and Pearson Product Moment were used in the data analysis.

Selected characteristics may be useful in developing a model curriculum that will be relevant to the training of qualified laboratory professionals in an increasingly complex healthcare environment and tumultuous economy.

The substantial study delimitation was the restriction of the sample to those programs accredited by NAACLS and awarding an Associate of Applied Science degree. Contributing limitations were the inability to control survey response rate and respondent accuracy.
CHAPTER 4

RESULTS

Introduction

The purpose of the study was to examine and compare selected characteristics associated with MLT/CLT programs nationwide and determine their effect on program outcomes. These characteristics were associated with student, institutional, and post-graduate aspects of the MLT/CLT programs included in the study.

The MLT/CLT academic population was identified by the 2002-2003 Health Professions Career and Education Directory. Two hundred and ten MLT/CLT programs are listed in the directory. Those surveyed consisted of 150 accredited, associate degree-granting MLT/CLT programs nationwide, defining the American population of NAACLS-accredited Associate of Science programs.

The primary data source was a survey instrument delivered electronically to program directors to solicit the desired information. A pilot study was conducted to assist in the preparation of the survey instrument. The final questionnaire consisted of 55 fixed and open-ended items designed to identify similarities and differences among MLT/CLT programs. A cover letter was also included with each survey, delineating the purpose and significance of the
survey, as well as providing directions for the completion and return of the questionnaire.

Dissemination of the surveys, receipt of responses, and organization and tabulation of the data was conducted by the Cannon Center for Survey Research. One hundred fifty surveys were distributed. A 43% response rate (64/150) was achieved by the conclusion of the data collection period. Confidentiality was maintained throughout the data collection process.

Data were analyzed utilizing descriptive statistics, Pearson-product moment and the Statistical Package for the Social Sciences (SPSS) software program. Basic and aggregate results are presented in this chapter. Statistical details, including the data set, frequency tables, and correlation studies, are on the attached CD-ROM.

Principles extracted from Alexander Astin's I-E-O model were used as a foundation for considering the factors that affect MLT/CLT program student outcomes. It was hypothesized that Astin's theory is consistent with MLT/CLT program variables, as reported by the program director.

Research Questions

The following research questions were formulated to obtain data to support the hypothesis that various factors in MLT/CLT education, such as student/program characteristics, affected student performance.
R.Q. 1  Is there a relationship between selected student characteristics and MLT/CLT student attrition? (Input: student variables)

R.Q. 2  Is there a relationship between prior education level and post-graduate performance? (Input: student variables)

R.Q. 3  Is there a relationship between selected curriculum characteristics, teaching methods and learning methods, and MLT/CLT student attrition and post-graduate performance? (Environment: institutional variables)

R.Q. 4  Is there a relationship between selected faculty characteristics and MLT/CLT student attrition and post-graduate performance? (Environment: institutional variables)

R.Q. 5  Is there a relationship between selected MLT/CLT in-program assessment methods, and student attrition and post-graduate performance? (Outcome: certification examination passage and post-graduate employment)

Findings

Data were presented in two areas. Initially, survey item response data were presented for completeness. This analysis consisted of grouping the survey items and tabulating the responses. Selected incidental observations from these data were offered.
More importantly, subsequent data analysis was organized around the research questions. This analysis involved examination of the relationships between selected student and institutional variables, and student outcomes.

Survey Item Response Data

MLT/CLT program directors were asked to respond to 55 items which were used to address the research questions. For clarity, the survey items were organized into seven groups, which helped define data in the context of Astin’s Input-Environment-Outcome model. This schema was consistent with the research questions.

Group 1 – Student characteristics of age, marriage and minority status, and non-native English-speaking status were identified in Survey Items #14 through #18. These Survey Items are:

Survey Item #14 – For students admitted in Fall 2002, how many students would you estimate were between the ages of 18 to 24?
Survey Item #15 - For students admitted in Fall 2002, how many students would you estimate were age 25 or older?
Survey Item #16 - For students admitted in Fall 2002, how many students would you estimate were married?
Survey Item #17 - For students admitted in Fall 2002, how many students would you estimate were minority?
Survey Item #18 - For students admitted in Fall 2002, how many students would you estimate were non-native English-speaking?
Table 1  Student Characteristics

<table>
<thead>
<tr>
<th>Estimate</th>
<th>18-24 years (%)</th>
<th>≥ 25 years (%)</th>
<th>Married (%)</th>
<th>Minority (%)</th>
<th>Non-native English-speaking (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25%</td>
<td>(20/50) 40.0</td>
<td>(11/65) 16.9</td>
<td>(21/63) 33.3</td>
<td>(27/62) 43.5</td>
<td>(51/65) 78.5</td>
</tr>
<tr>
<td>26-50%</td>
<td>(18/50) 36.0</td>
<td>(23/65) 35.4</td>
<td>(22/63) 34.9</td>
<td>(15/62) 24.2</td>
<td>(12/65) 18.5</td>
</tr>
<tr>
<td>51-75%</td>
<td>(9/50) 18.0</td>
<td>(21/65) 32.3</td>
<td>(18/63) 28.6</td>
<td>(14/62) 22.6</td>
<td>(2/65) 3.1</td>
</tr>
<tr>
<td>&gt;76%</td>
<td>(3/50) 6.0</td>
<td>(10/65) 15.4</td>
<td>(2/63) 3.2</td>
<td>(6/62) 9.7</td>
<td>(0/65) 0.0</td>
</tr>
</tbody>
</table>

Group 2 – Prior levels of education, from high school through graduate degree, were identified in Survey Items #19 through #23. These Survey Items are:

Survey Item #19 – Prior to acceptance into your program, please estimate the percentage of students who were at each of the following educational levels: a high school diploma/GED only.

Survey Item #20 - Prior to acceptance into your program, please estimate the percentage of students who were at each of the following educational levels: a high school diploma/GED and some college.

Survey Item #21 - Prior to acceptance into your program, what percentage of students had an associate degree?

Survey Item #22 - Prior to acceptance into your program, what percentage of students held a baccalaureate degree?

Survey Item #23 - Prior to acceptance into your program, what percentage of students held a graduate degree or coursework?
Table 2  Educational Level Prior to Program Admission

<table>
<thead>
<tr>
<th>Estimate</th>
<th>High School Diploma/GED Only</th>
<th>High School Diploma/GED and Some College</th>
<th>Associate Degree</th>
<th>Baccalaureate Degree</th>
<th>Graduate Degree or Coursework</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25%</td>
<td>(26/67) 38.8</td>
<td>(12/49) 24.5</td>
<td>(66/67) 98.5</td>
<td>(58/67) 86.6</td>
<td>(66/67) 98.5</td>
</tr>
<tr>
<td>26-50%</td>
<td>(10/67) 14.9</td>
<td>(11/49) 22.4</td>
<td>(1/67) 1.5</td>
<td>(9/67) 13.4</td>
<td>(1/67) 1.5</td>
</tr>
<tr>
<td>51-75%</td>
<td>(11/67) 16.4</td>
<td>(15/49) 30.6</td>
<td>(0/67) 0.0</td>
<td>(0/67) 0.0</td>
<td>(0/67) 0.0</td>
</tr>
<tr>
<td>&gt;76%</td>
<td>(20/67) 29.9</td>
<td>(11/49) 22.4</td>
<td>(0/67) 0.0</td>
<td>(0/67) 0.0</td>
<td>(0/67) 0.0</td>
</tr>
</tbody>
</table>

Group 3 - Program characteristics were organized into five categories: admission criteria, student success indicators, minimum acceptable GPA, entrance constraints, and number of clinical sites. These characteristics are identified in Survey Items #1 through #8, and #52. These Survey Items are:

Survey Item #1 – What criteria are used to select students for program admission?

Table 3  Program Admission Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview</td>
<td>(32/68) 47.1</td>
</tr>
<tr>
<td>Grade Point Average</td>
<td>(40/68) 58.8</td>
</tr>
<tr>
<td>Writing Sample</td>
<td>(13/68) 19.1</td>
</tr>
<tr>
<td>Manual Dexterity Assessment</td>
<td>(1/68) 1.5</td>
</tr>
<tr>
<td>Community Service</td>
<td>(1/68) 1.5</td>
</tr>
<tr>
<td>Related Professional Experience</td>
<td>(12/68) 17.6</td>
</tr>
<tr>
<td>English Language Proficiency</td>
<td>(12/68) 17.6</td>
</tr>
<tr>
<td>Standardized Test</td>
<td>(40/68) 58.8</td>
</tr>
</tbody>
</table>
Forty programs (58%) reported the use of additional program admission criteria in the selection of MLT/CLT students. These criteria included ACT, reading placement or other standardized tests (10.3%), completion of specific high school math and science coursework (7.4%), and submission of reference letters (2.9%). No other significant trends were noted.

Survey Item #2 – What two indicators do you feel are the best predictors of student success in your program?

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview</td>
<td>(25/68) 36.8</td>
</tr>
<tr>
<td>Grade Point Average</td>
<td>(48/68) 70.6</td>
</tr>
<tr>
<td>Writing Sample</td>
<td>(5/68) 7.4</td>
</tr>
<tr>
<td>Manual Dexterity Assessment</td>
<td>(0/68) 0.0</td>
</tr>
<tr>
<td>Community Service</td>
<td>(0/68) 0.0</td>
</tr>
<tr>
<td>Related Professional Experience</td>
<td>(20/68) 29.4</td>
</tr>
<tr>
<td>English Language Proficiency Test</td>
<td>(6/68) 8.8</td>
</tr>
<tr>
<td>Other</td>
<td>(32/68) 47.1</td>
</tr>
</tbody>
</table>

Thirty-two programs (47.1%) reported additional indicators believed to predict student success in MLT/CLT programs. The most frequently listed indicator was performance in prerequisite coursework (18.0%), followed by behavioral attributes (10.5%), and ACT, SAT, or other standardized test scores (9%). No other significant trends were noted.

Survey Item #3 – What is the minimum GPA for prerequisite coursework?

Survey Item #4 – What is the minimum GPA for professional coursework?
Table 5 Minimum Acceptable GPA

<table>
<thead>
<tr>
<th>GPA range</th>
<th>Prerequisite Coursework</th>
<th>Professional Coursework</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Respondent (%)</td>
<td>Respondent (%)</td>
</tr>
<tr>
<td>2.0-2.5</td>
<td>(61/67) 89.7</td>
<td>(57/68) 83.8</td>
</tr>
<tr>
<td>2.6-3.0</td>
<td>(7/68) 10.3</td>
<td>(11/62) 16.2</td>
</tr>
<tr>
<td>&gt; 3.0</td>
<td>(0/68) 0.0</td>
<td>(0/68) 0.0</td>
</tr>
</tbody>
</table>

Survey Item #5 – What is the number of seats available?

Survey Item #6 – What is the number of applicants?

Survey Item #7 – What is the number of students admitted?

Survey Item #8 – What is the number of students enrolled?

Table 6 Program Entrance Constraints

<table>
<thead>
<tr>
<th># of Seats Available</th>
<th># of Programs</th>
<th>Average % of Applications Received</th>
<th>Average % of Students Enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>5</td>
<td>85.7</td>
<td>60.0</td>
</tr>
<tr>
<td>11-20</td>
<td>49</td>
<td>116.1</td>
<td>82.7</td>
</tr>
<tr>
<td>21-30</td>
<td>9</td>
<td>86.6</td>
<td>83.5</td>
</tr>
<tr>
<td>≥31</td>
<td>3</td>
<td>121.0</td>
<td>90.4</td>
</tr>
</tbody>
</table>

Survey Item #52 – Please indicate the number of full-service laboratories available for clinical practicum experience.
Table 7 Number of Clinical Sites

<table>
<thead>
<tr>
<th>Number of Clinical Sites</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>(12/67) 17.9</td>
</tr>
<tr>
<td>5-9</td>
<td>(29/67) 43.3</td>
</tr>
<tr>
<td>≥ 10</td>
<td>(26/67) 38.8</td>
</tr>
</tbody>
</table>

Group 4 – Identified in Survey Items #24 through #45 are curricular characteristics which were organized into eight categories: They are:

- Pre-admission criteria
- Subject area and curriculum structure
- Curriculum sequence
- Teaching methods
- Learning methods
- Testing methods
- Assessment of competency
- Embedded components

Survey Items #24 and #25 address aspects of pre-admission coursework.

Survey Item #24 – Please select the statement that best describes pre-admission curriculum requirements for your program.

Survey Item #25 – Are students required to complete additional prerequisite coursework prior to MLT/CLT admission?
Table 8  Pre-admission Curriculum Requirements

<table>
<thead>
<tr>
<th>Statement</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No pre-requisite coursework is required</td>
<td>(27/67) 40.3</td>
</tr>
<tr>
<td>Selected pre-requisites must be completed prior to admission</td>
<td>(38/67) 56.7</td>
</tr>
<tr>
<td>All college requirements for graduation must be completed prior to program admission</td>
<td>(2/67) 3.0</td>
</tr>
<tr>
<td>Additional pre-requisite coursework (i.e., biomedical ethics, statistics, computer information technology) required prior to program admission</td>
<td>(12/67) 18.5</td>
</tr>
</tbody>
</table>

Survey Items #26 through #33 requested information pertaining to MLT/CLT subject area curricular presence and organization.

Survey Items #26 through #33 – For the following subject areas (Urinalysis/Body Fluids, Microbiology, Clinical Chemistry, Instrumentation, Hematology, Immunohematology, Serology, Phlebotomy) please indicate which are included (lecture, laboratory, clinical practicum) as a part of your professional curriculum. Select all that apply for each subject area.
Table 9  Subject Areas and Structure of Professional Curriculum

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Subject Area Not Offered</th>
<th>Lecture Course</th>
<th>Laboratory Course</th>
<th>Clinical Practicum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinalysis/Body Fluids</td>
<td>(0/68) 0.0</td>
<td>(67/68) 98.5</td>
<td>(65/68) 95.6</td>
<td>(67/68) 98.5</td>
</tr>
<tr>
<td>Microbiology</td>
<td>(0/68) 0.0</td>
<td>(67/68) 98.5</td>
<td>(65/68) 95.6</td>
<td>(67/68) 98.5</td>
</tr>
<tr>
<td>Clinical Chemistry</td>
<td>(0/68) 0.0</td>
<td>(67/68) 98.5</td>
<td>(64/68) 94.1</td>
<td>(67/68) 98.5</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>(16/68) 25.0</td>
<td>(39/68) 57.4</td>
<td>(23/68) 33.8</td>
<td>(41/68) 60.3</td>
</tr>
<tr>
<td>Hematology</td>
<td>(0/68) 0.0</td>
<td>(65/68) 95.6</td>
<td>(66/68) 97.1</td>
<td>(66/68) 97.1</td>
</tr>
<tr>
<td>Immunohematology</td>
<td>(0/68) 0.0</td>
<td>(67/68) 98.5</td>
<td>(66/68) 97.1</td>
<td>(66/68) 97.1</td>
</tr>
<tr>
<td>Serology</td>
<td>(0/68) 2.9</td>
<td>(66/68) 97.1</td>
<td>(58/68) 85.3</td>
<td>(65/68) 95.6</td>
</tr>
<tr>
<td>Phlebotomy</td>
<td>(0/68) 0.0</td>
<td>(17/68) 83.8</td>
<td>(58/68) 85.3</td>
<td>(59/68) 86.8</td>
</tr>
</tbody>
</table>

Survey Items #34 through #36 were presented in open-ended format to elicit information regarding additional subject area content in the respondents' curricula. All responses may be found in the attached CD-ROM containing statistical detail. To facilitate understanding, responses have been roughly grouped and are presented.

Survey Item #34 – Please list any additional subject areas that are not listed as a lecture course.

Table 10  Additional Lecture Subject Area Content

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation course</td>
<td>(11/67) 16.5</td>
</tr>
<tr>
<td>Parasitology/Mycology</td>
<td>(9/67) 13.5</td>
</tr>
<tr>
<td>Coagulation</td>
<td>(4/67) 6.0</td>
</tr>
<tr>
<td>Advanced/Special topics</td>
<td>(4/67) 6.0</td>
</tr>
<tr>
<td>Laboratory Math</td>
<td>(2/67) 3.0</td>
</tr>
<tr>
<td>Review course</td>
<td>(2/67) 3.0</td>
</tr>
<tr>
<td>Immunology</td>
<td>(2/67) 3.0</td>
</tr>
</tbody>
</table>
Thirty-three programs (48.5%) indicated the inclusion of additional lecture subject areas. The most frequently listed course was an orientation course, followed by Parasitology/Mycology, and Coagulation. Advanced/Special topics included Laboratory Management, Teaching Techniques, and Molecular Diagnostics courses.

Survey Item #35 – Please list any additional subjects that are not listed as a laboratory course.

Table 11 Additional Laboratory Subject Area Content

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasitology/Mycology</td>
<td>(8/67) 12.0</td>
</tr>
<tr>
<td>Orientation course</td>
<td>(7/67) 10.5</td>
</tr>
<tr>
<td>Coagulation</td>
<td>(2/67) 3.0</td>
</tr>
</tbody>
</table>

Twenty-three programs (33.8%) indicated the inclusion of additional laboratory subject areas. Laboratory coursework in Parasitology/Mycology was the most frequently listed, followed by an orientation course.

Survey Item #36 – Please list any additional subject areas that are not listed as a clinical practicum.

Table 12 Additional Clinical Practicum Subject Area Content

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasitology/Mycology</td>
<td>(5/67) 7.5</td>
</tr>
<tr>
<td>Coagulation</td>
<td>(5/67) 7.5</td>
</tr>
<tr>
<td>Laboratory operations</td>
<td>(2/67) 3.0</td>
</tr>
<tr>
<td>Special chemistry</td>
<td>(2/67) 3.0</td>
</tr>
</tbody>
</table>
Sixteen programs (23.5%) indicated the inclusion of additional clinical practicum subject areas. Clinical experiences in both Parasitology/Mycology and Coagulation were most frequently listed, followed by Laboratory Operations and Special Chemistry.

Survey Items #37 through #40 solicited information pertaining to curriculum sequence, course availability, and student progression.

Survey Item #37 – Are students required to complete lecture and laboratory coursework prior to clinical practicum assignment?

Survey Item #38 – Are professional courses required to be taken in a particular sequence?

Survey Item #39 – Are students required to maintain full-time status in professional coursework upon admission to your MLT/CLT program?

Survey Item #40 – Are all required professional courses offered more than once a year?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completion of lecture and laboratory coursework prior to clinical practicum assignment required</td>
<td>(62/67) 92.5</td>
</tr>
<tr>
<td>Particular sequence of professional courses required</td>
<td>(61/67) 91.0</td>
</tr>
<tr>
<td>Maintenance of full-time student status required</td>
<td>(34/67) 50.7</td>
</tr>
<tr>
<td>All required professional courses offered more than once a year</td>
<td>(3/67) 4.5</td>
</tr>
</tbody>
</table>
Survey Item #41 requested information pertaining to all applicable teaching methods utilized.

Survey Item #41 – Please indicate all applicable teaching methods utilized in your program.

Table 14  Teaching Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>(67/68) 98.5</td>
</tr>
<tr>
<td>Self-guided Instructional Modules</td>
<td>(39/68) 57.4</td>
</tr>
<tr>
<td>Computer Tutorials</td>
<td>(61/68) 89.7</td>
</tr>
<tr>
<td>Laboratory Demonstrations</td>
<td>(65/68) 95.6</td>
</tr>
<tr>
<td>Internet-based Instruction</td>
<td>(44/68) 64.7</td>
</tr>
<tr>
<td>Other</td>
<td>(9/68) 13.2</td>
</tr>
</tbody>
</table>

Nine programs (13.2%) reported using additional teaching methods. These included group activities, case studies, group work, videos, and hands-on activities.

Survey Item #42 requested information pertaining to all applicable learning methods utilized.

Survey Item #42 – Please indicate all applicable learning methods utilized in your program.
Table 15 Learning Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Group (47/68)</td>
<td>69.1</td>
</tr>
<tr>
<td>Student Cohort (22/68)</td>
<td>32.4</td>
</tr>
<tr>
<td>Student Mentors (4/68)</td>
<td>5.9</td>
</tr>
<tr>
<td>Tutoring (37/68)</td>
<td>54.4</td>
</tr>
<tr>
<td>Open Lab Time (40/68)</td>
<td>58.8</td>
</tr>
<tr>
<td>Computer Tutorials (59/68)</td>
<td>86.8</td>
</tr>
<tr>
<td>Internet-based Assignments (48/68)</td>
<td>70.6</td>
</tr>
<tr>
<td>Other (3/68)</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Survey Item #43 requested information pertaining to all applicable testing methods utilized.

Survey Item #43 – Please indicate all applicable testing methods used to assess student mastery of key didactic concepts and technical skills during professional coursework.

Table 16 Testing Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective Questions (67/68)</td>
<td>98.5</td>
</tr>
<tr>
<td>Short Answer (64/68)</td>
<td>94.1</td>
</tr>
<tr>
<td>Essay (32/68)</td>
<td>47.1</td>
</tr>
<tr>
<td>Oral Presentation (43/68)</td>
<td>63.2</td>
</tr>
<tr>
<td>Laboratory Practical (65/68)</td>
<td>95.6</td>
</tr>
<tr>
<td>Other (6/68)</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Six programs (8.8%) reported utilizing other testing methods to assess student performance. The most frequently listed method was the use of case studies (4.5%), followed by written research paper (3.0%). No other significant trends were noted.
Survey Item #44 requested information on all applicable methods used to assess student competence upon completion of professional coursework.

Survey Item #44 – Please indicate all applicable methods used to assess student competence upon completion of professional coursework.

Table 17  Assessment of Student Competence

<table>
<thead>
<tr>
<th>Method</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit Interview</td>
<td>(18/68) 26.5</td>
</tr>
<tr>
<td>Written Examination</td>
<td>(61/68) 89.7</td>
</tr>
<tr>
<td>Practical Examination</td>
<td>(37/68) 54.4</td>
</tr>
<tr>
<td>Case Study Presentation</td>
<td>(11/68) 16.2</td>
</tr>
<tr>
<td>Capstone Project</td>
<td>(22/68) 32.4</td>
</tr>
<tr>
<td>Portfolio</td>
<td>(8/68) 11.8</td>
</tr>
<tr>
<td>Other</td>
<td>(11/68) 16.2</td>
</tr>
</tbody>
</table>

Eleven programs (16.2%) reported the use of additional methods to assess student competence upon completion of program requirements. These included competency testing (10.5%), oral presentations (1.5%), research projects (1.5%), and student surveys (3.0%). No other significant trends were noted.

Survey Item #45 requested information pertaining to incorporation of critical thinking, medical ethics, and cultural awareness into the lecture and laboratory curriculum.

Survey Item #45 – Please indicate whether any of the following components are embedded in didactic/laboratory coursework.
Table 18  Embedded Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Thinking</td>
<td>(66/68) 97.1</td>
</tr>
<tr>
<td>Medical Ethics</td>
<td>(60/68) 88.2</td>
</tr>
<tr>
<td>Cultural Awareness</td>
<td>(40/68) 58.8</td>
</tr>
</tbody>
</table>

Group 5 – Faculty characteristics were identified in Survey Items #46 through #51, and #53 through #55. Respondents were asked to provide information about the number and educational level of full- and part-time faculty, prior clinical experience, and student contact hours. Information was also solicited pertaining to the minimum education and experience of clinical preceptors, payment beyond salary, and the preceptor to student ratio. These Survey Items are:

Survey Item #46 – In addition to the program director, how many full-time faculty are there in your MLT/CLT program?

Survey Item #47 – How many part-time faculty are there in your program?

Survey Item #48 – What are the minimum qualifications for full-time didactic faculty in your MLT/CLT program?

Survey Item #49 – What are the minimum qualifications for part-time didactic faculty in your MLT/CLT program?

Survey Item #50 – Please estimate the average years of clinical experience attained by faculty prior to joining your program.

Survey Item #51 – Please estimate the average hours of actual student contact faculty spend each week outside of instructional time.
## Table 19  Full-time Faculty Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No faculty in addition to Program Director</td>
<td>(29/67) 43.3</td>
</tr>
<tr>
<td>1 additional faculty</td>
<td>(32/67) 47.8</td>
</tr>
<tr>
<td>2 additional faculty</td>
<td>(2/67) 3.0</td>
</tr>
<tr>
<td>3 additional faculty</td>
<td>(2/67) 3.0</td>
</tr>
<tr>
<td>4 or more additional faculty</td>
<td>(2/67) 3.0</td>
</tr>
<tr>
<td>Doctoral degree in CLS or related discipline required</td>
<td>(0/67) 0.0</td>
</tr>
<tr>
<td>Master's degree in CLS or related discipline required</td>
<td>(27/66) 40.9</td>
</tr>
<tr>
<td>Bachelor's degree in CLS or related discipline required</td>
<td>(36/66) 54.5</td>
</tr>
</tbody>
</table>

## Table 20  Part-time Faculty Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No part-time faculty</td>
<td>(21/67) 31.3</td>
</tr>
<tr>
<td>1 part-time faculty</td>
<td>(18/67) 26.9</td>
</tr>
<tr>
<td>2 part-time faculty</td>
<td>(6/67) 9.0</td>
</tr>
<tr>
<td>3 part-time faculty</td>
<td>(9/67) 13.4</td>
</tr>
<tr>
<td>4 or more part-time faculty</td>
<td>(13/67) 19.4</td>
</tr>
<tr>
<td>Doctoral degree in CLS or related discipline required</td>
<td>(0/67) 0.0</td>
</tr>
<tr>
<td>Master's degree in CLS or related discipline required</td>
<td>(3/54) 5.3</td>
</tr>
<tr>
<td>Bachelor's degree in CLS or related discipline required</td>
<td>(48/54) 84.2</td>
</tr>
</tbody>
</table>

## Table 21  Average Years of Prior Clinical Experience

<table>
<thead>
<tr>
<th>Number of Years</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>(2/66) 3.0</td>
</tr>
<tr>
<td>4 or more</td>
<td>(54/66) 97.0</td>
</tr>
</tbody>
</table>

## Table 22  Average Hours Student Contact Beyond Instructional Hours

<table>
<thead>
<tr>
<th>Number of Hours</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>(16/67) 23.9</td>
</tr>
<tr>
<td>4-6</td>
<td>(19/67) 28.4</td>
</tr>
<tr>
<td>&gt;6</td>
<td>(28/67) 41.8</td>
</tr>
<tr>
<td>No contact beyond stated office hours</td>
<td>(4/67) 6.0</td>
</tr>
</tbody>
</table>
Survey Item #53 – Are the preceptors responsible for clinical training required to have a minimum level of education and clinical experience?

Survey Item #54 – Do preceptors receive payment beyond salary?

Table 23  Clinical Preceptor Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Yes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum level of education and clinical experience required</td>
<td>(29/67) 43.3</td>
</tr>
<tr>
<td>Payment beyond salary received</td>
<td>(1/67) 1.5</td>
</tr>
</tbody>
</table>

Survey Item #55 – What is the preceptor to student ratio?

Table 24  Preceptor to Student Ratio

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Respondent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1</td>
<td>(54/67) 80.6</td>
</tr>
<tr>
<td>1:2</td>
<td>(8/67) 11.9</td>
</tr>
<tr>
<td>&gt;1:2</td>
<td>(1/67) 1.5</td>
</tr>
</tbody>
</table>

Group 6 – In-program student performance characteristics were identified in Survey Items #9 and #10. Respondents were asked to provide information pertaining to the number of students leaving the program through voluntary withdrawal or academic dismissal. These Survey Items are:

Survey Item #9 – For students admitted in Fall 2002, what is the number of students that voluntarily withdrew?
Survey Item #10 - For students admitted in Fall 2002, what is the number of students dismissed for academic reasons?

Table 25  In-program Student Performance

<table>
<thead>
<tr>
<th>Average Program Size (# Students Enrolled)</th>
<th>Number of Programs</th>
<th>Average % Voluntary Withdrawal</th>
<th>Average % Academic Dismissal</th>
<th>Average % Total Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>3</td>
<td>12.5</td>
<td>12.5</td>
<td>25.0</td>
</tr>
<tr>
<td>6-10</td>
<td>16</td>
<td>25.6</td>
<td>11.6</td>
<td>37.2</td>
</tr>
<tr>
<td>11-15</td>
<td>24</td>
<td>22.6</td>
<td>14.8</td>
<td>37.4</td>
</tr>
<tr>
<td>16-20</td>
<td>13</td>
<td>23.9</td>
<td>19.9</td>
<td>43.8</td>
</tr>
<tr>
<td>21-25</td>
<td>6</td>
<td>30.4</td>
<td>12.4</td>
<td>42.8</td>
</tr>
<tr>
<td>26-30</td>
<td>2</td>
<td>5.1</td>
<td>16.9</td>
<td>22.0</td>
</tr>
</tbody>
</table>

Group 7 – Graduate performance characteristics were identified in Survey Items #11 through #13. Respondents were asked to provide information pertaining to the number of students taking and passing a certification examination, and the number attaining employment related to their training within one year of graduation. These Survey Items are:

Survey Item #11 - For students admitted in Fall 2002, what is the number of graduates taking a certification examination?

Survey Item #12 - For students admitted in Fall 2002, what is the number of students passing a certification examination?

Survey Item #13 - For students admitted in Fall 2002, what is the number of graduates attaining related employment within one year of graduation?
Table 26  Graduate Performance on Certification Examination

<table>
<thead>
<tr>
<th>Average Program Size (# Students Enrolled)</th>
<th>Number of Programs</th>
<th>Average % of Students Taking Certification Examination</th>
<th>Average % of Students Passing Certification Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>3</td>
<td>75.0</td>
<td>83.3</td>
</tr>
<tr>
<td>6-10</td>
<td>16</td>
<td>56.6</td>
<td>82.2</td>
</tr>
<tr>
<td>11-15</td>
<td>24</td>
<td>52.8</td>
<td>85.1</td>
</tr>
<tr>
<td>16-20</td>
<td>13</td>
<td>43.8</td>
<td>85.9</td>
</tr>
<tr>
<td>21-25</td>
<td>6</td>
<td>44.9</td>
<td>90.3</td>
</tr>
<tr>
<td>26-30</td>
<td>2</td>
<td>45.8</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table 27  Graduate Employment

<table>
<thead>
<tr>
<th>Average Program Size (# Students Enrolled)</th>
<th>Number of Programs</th>
<th>Average % of Graduates Employed within one Year of Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>3</td>
<td>50.0</td>
</tr>
<tr>
<td>6-10</td>
<td>16</td>
<td>63.6</td>
</tr>
<tr>
<td>11-15</td>
<td>24</td>
<td>52.5</td>
</tr>
<tr>
<td>16-20</td>
<td>13</td>
<td>50.4</td>
</tr>
<tr>
<td>21-25</td>
<td>6</td>
<td>42.0</td>
</tr>
<tr>
<td>26-30</td>
<td>2</td>
<td>45.8</td>
</tr>
</tbody>
</table>

Research Questions in the Context of the Survey Items

The following research questions were developed using Astin's I-E-O model as the framework for examining the relationships between selected student and institutional variables, and student outcomes.

Research Questions 1 and 2 follow the model by examining student input variables and their possible relationship to student attrition, passage on a national certification examination, and employment.
Research Question 1 — Is there a relationship between selected student characteristics and MLT/CLT student attrition?

Survey Items #14 to #18 queried respondents on selected student characteristics. These characteristics were age, marital status, minority inclusion, and non-native English speaking. Responses to these items were then correlated to responses addressing student attrition. Student attrition was defined as voluntary withdrawal, and dismissal for academic reasons, and was addressed by Survey Items #9 and #10.

Student age, marriage, and minority status were not significant when considered in terms of student attrition. However, there was statistical significance when considering the percentage of students that are non-native English-speaking and voluntary withdrawal from the program.

Table 28  Selected Student Characteristics and Student Attrition

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Statistics</th>
<th># of students who voluntarily withdrew</th>
<th># of students dismissed for academic reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pct of students that are non-native English speaking</td>
<td>Pearson correlation</td>
<td>0.335**</td>
<td>-0.139</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.007</td>
<td>0.276</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>63</td>
<td>63</td>
</tr>
</tbody>
</table>

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

The data suggested that a relationship existed between the percentage of non-native English speaking students and voluntary withdrawal from MLT/CLT programs. Therefore, it appears that non-native English speaking students withdraw more often than native English speaking students.
Research Question #2 - Is there a relationship between prior education level and post-graduate performance?

Survey Items #19 to #23 queried respondents on prior educational level, defined as high school diploma/general equivalency diploma (GED) only, high school diploma/GED and some college, associate degree, baccalaureate degree, and graduate degree or coursework. Responses to these items were then correlated to responses to survey items #11, 12, and 13, which addressed post-graduate performance.

Academic level, defined as a high school diploma/ GED only, high school diploma/GED and some college, bachelor's degree, and graduate degree or some coursework was not significant when considered in terms of passage on a national certification examination and subsequent employment. However, there was statistical significance when considering the associate degree and examination passage and employment.

Table 29 Prior Educational Level and Post-graduate Performance

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Statistics</th>
<th># of graduates taking certification exam</th>
<th># of students passing certification exam</th>
<th># of graduates attaining related employment within 1 year of graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pct of students with an Associate degree</td>
<td>Pearson correlation</td>
<td>0.378**</td>
<td>0.424**</td>
<td>0.368**</td>
</tr>
<tr>
<td></td>
<td>Significance N</td>
<td>0.002</td>
<td>0.001</td>
<td>0.003</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
The data suggested that students possessing an associate degree prior to entering an MLT/CLT program were more likely to pass a national certification examination and achieve employment in a field related to their training within one year of graduation. However, since only 1.5% of respondents reported admitting students with an associate degree, this relationship was deemed too small to be meaningful.

Research Questions 3 and 4 address the I-E-O model by examining environmental variables and their possible relationship to student attrition, certification examination passage, and employment.

Research Question #3 - Is there a relationship between selected curriculum characteristics, teaching methods and learning methods, and MLT/CLT student attrition and post-graduate performance?

Survey Items #24 to #40, and #45 queried respondents on pre-admission curriculum requirements, curriculum characteristics, and student progression. Survey Items #41 and #42 solicited information pertaining to teaching and learning methods. Responses to these items were then correlated to responses to Survey Items #9 and #10, which addressed student attrition, and Survey Items #11 to #13, which addressed post-graduate performance.

Pre-admission curriculum requirements included the specification for any of the following prior to MLT/CLT program admission: no pre-requisite coursework; selected pre-requisite courses (i.e., college-level math, English, Biology, and Chemistry); all college requirements for graduation; additional specific pre-requisites (i.e., biomedical ethics, statistics, and computer information technology).
Curriculum characteristics included subject area, curriculum structure (i.e., lecture, laboratory, clinical practicum requirement), and the incorporation of critical thinking, medical ethics, and cultural awareness.

Student progression included requirements for completing lecture and laboratory courses prior to clinical practicum, taking professional courses in a particular sequence, maintaining full-time status, and offering all professional courses more than once per year.

Teaching methods included lecture, self-guided instructional modules, computer tutorials, laboratory demonstrations, and Internet-based instruction. Learning methods included study groups, cohorts of students admitted together, student mentors, tutoring, open lab time, computer tutorials, and Internet-based assignments.

With respect to preadmission curriculum requirements, none of the prerequisite requirements was considered significant in terms of student attrition.

When considering curriculum characteristics, only the requirements for a lecture course in Instrumentation and a clinical practicum in Immunohematology were considered significant when considered in terms of student attrition. No other subject area, curriculum structure, or embedded component demonstrated statistical significance when considered in terms of student attrition.

With respect to student progression, requiring students to maintain full-time status was associated with decreased voluntary withdrawal.

In reference to teaching and learning methods, no method demonstrated statistical significance when considered in terms of student attrition.
Table 30  Curriculum Characteristics and Student Attrition

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Statistics</th>
<th># of students who voluntarily withdrew</th>
<th># of students dismissed for academic reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture Course/Instrumentation</td>
<td>Pearson correlation</td>
<td>-0.041</td>
<td>-0.296*</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.745</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Clinical Practicum/Immunohematology</td>
<td>Pearson correlation</td>
<td>-0.631**</td>
<td>0.110</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.000</td>
<td>0.383</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Students required to maintain full-time status in professional coursework</td>
<td>Pearson correlation</td>
<td>-0.268*</td>
<td>0.193</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.031</td>
<td>0.124</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>65</td>
<td>65</td>
</tr>
</tbody>
</table>

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

The data also suggested that students in those programs with an Instrumentation lecture course (57.4%) were less likely to be dismissed for academic reasons. The data further suggested that students in those programs providing a clinical practicum in Immunohematology were less likely to voluntarily withdraw. However, since 97.1% of respondent programs provide this experience, this relationship was unable to be explained. It also appears that the requirement to maintain full-time status demonstrated statistical significance when considered in terms of student attrition.

With respect to pre-admission curriculum requirements, the requirement for additional, specific pre-requisite courses was not significant when considered in terms of related employment as an indicator of post-graduate performance.
However, having no pre-requisites was significant when considered in terms of related employment as an indicator of post-graduate performance. This may be a factor of some programs admitting students who are employed in a related clinical field. This is noted for further study.

When considering curriculum characteristics, the requirement for a clinical practicum in Immunohematology, the sequence of professional coursework, and maintenance of full-time student status, were significant when considered in terms of certification examination as an indicator of post-graduate performance. No other subject area or embedded component demonstrated statistical significance when considered in terms of post-graduate performance.

In reference to teaching and learning methods, no method demonstrated statistical significance when considered in terms of post-graduate performance.
Table 31  
Curriculum Characteristics and Post-graduate Performance

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Statistics</th>
<th># of graduates taking certification exam</th>
<th># of students passing certification exam</th>
<th># of graduates attaining related employment within 1 year of graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No prerequisite coursework required</td>
<td>Pearson correlation</td>
<td>0.231</td>
<td>0.140</td>
<td>0.330**</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.071</td>
<td>0.283</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>62</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Selected prerequisites required</td>
<td>Pearson correlation</td>
<td>-0.255*</td>
<td>-0.173</td>
<td>-0.315*</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.046</td>
<td>0.181</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>62</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Clinical Practicum Immunohematology</td>
<td>Pearson correlation</td>
<td>-0.277*</td>
<td>-0.142</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.027</td>
<td>0.267</td>
<td>0.720</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>64</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Particular sequence of professional courses required</td>
<td>Pearson correlation</td>
<td>0.256*</td>
<td>0.237</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.042</td>
<td>0.061</td>
<td>0.647</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>64</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Maintenance of full-time student status required</td>
<td>Pearson correlation</td>
<td>0.333*</td>
<td>0.362*</td>
<td>0.201</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.007</td>
<td>0.004</td>
<td>0.113</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>64</td>
<td>63</td>
<td>63</td>
</tr>
</tbody>
</table>

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

The data suggested that students in those programs requiring no prerequisite coursework were more likely to attain post-graduate employment. Conversely, students in those programs mandating specific pre-admission curriculum requirements were less likely to attain employment in a field related to their training within one year of graduation. The data also suggested that students enrolled in a clinical practicum in Immunohematology were less likely to
take a national certification examination. However, those students in programs requiring a particular sequence of professional courses were more likely to take a national examination, and those required to maintain full-time status were more likely to pass the examination.

Research Question #4 - Is there a relationship between selected faculty characteristics and MLT/CLT student attrition and post-graduate performance?

Survey Items #46 to #51 queried respondents on the characteristics of full-time and part-time faculty, while Survey Items #53 to #55 solicited information on clinical faculty. Responses to these items were then correlated to responses to Survey Items #9 and #10, which addressed student attrition, and Survey Items #11 to #13, which addressed post-graduate performance.

For both full-time and part-time faculty, the number, minimum qualifications, average years of clinical experience, and student contact beyond office hours were not considered significant in terms of student attrition. There was statistical significance when considering the ratio of students to full-time faculty in terms of student attrition. To assist in this perspective, a full-time faculty/student ratio was calculated and used to examine the relationship with attrition.

For clinical faculty, neither payment beyond salary nor the preceptor to student ratio was considered significant in terms of student attrition. However, there was statistical significance when considering the minimum qualifications and clinical experience of the clinical preceptors and student attrition.
Table 32  Faculty Characteristics and Student Attrition

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Statistics</th>
<th># of students who voluntarily withdrew</th>
<th># of students dismissed for academic reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students enrolled/# full-time faculty</td>
<td>Pearson correlation</td>
<td>0.203</td>
<td>0.390*</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.250</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Preceptors Required to Have a Minimum Level of Education and Clinical Experience</td>
<td>Pearson correlation</td>
<td>-0.292*</td>
<td>-0.165</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.018</td>
<td>0.189</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>65</td>
<td>65</td>
</tr>
</tbody>
</table>

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

The data suggested that students in those programs with higher student to full-time faculty ratios were more likely to be dismissed for academic reasons. The data also suggested that students were less likely to voluntarily withdraw when minimum qualifications and clinical education were required for preceptors.

For both full-time and part-time faculty, the minimum qualifications, average years of clinical experience, and student contact beyond office hours were not considered significant in terms of post-graduate performance. For clinical faculty, the minimum qualifications, payment beyond salary, and the preceptor to student ratio were not considered significant in terms of post-graduate performance. However, there was statistical significance when considering the relationship between the number of full-time faculty and the number of students taking and passing a national certification examination, and gaining subsequent employment. A full-time faculty/student ratio was calculated
and used to examine the relationship to these outcomes. There was also statistical significance when considering the relationship between the number of part-time faculty and the number of students taking and passing a certification examination. A part-time faculty/student ratio was calculated and used to examine the relationship with certification examination passage.

Table 33  Faculty Characteristics and Post-graduate Student Performance

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Statistics</th>
<th># of graduates taking certification exam</th>
<th># of students passing certification exam</th>
<th># of graduates attaining related employment within 1 year of graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students enrolled/# full-time faculty</td>
<td>Pearson</td>
<td>0.370*</td>
<td>0.458**</td>
<td>0.510**</td>
</tr>
<tr>
<td>Students enrolled/# part-time faculty</td>
<td>correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.031</td>
<td>0.007</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>34</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Students enrolled/# part-time faculty</td>
<td>Pearson</td>
<td>0.342*</td>
<td>0.328*</td>
<td>0.247</td>
</tr>
<tr>
<td>Students enrolled/# part-time faculty</td>
<td>correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.023</td>
<td>0.032</td>
<td>0.106</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>44</td>
<td>43</td>
<td>44</td>
</tr>
</tbody>
</table>

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

The data suggested that students in programs with lower student to faculty ratios were more likely to take and pass a national certification examination. The data further suggested that students in programs with lower student to full-time faculty ratios were more likely to attain post-graduate employment.

Research Question 5 addressed the I-E-O model by examining the possible relationship between assessment methods and the outcome variables,
student attrition, passage on a national certification examination, and employment.

Research Question #5 - Is there a relationship between selected MLT/CLT in-program assessment methods, and student attrition/post-graduate performance?

Survey Items #43 and #44 queried respondents about the evaluation methods used to assess student performance during the program and upon completion of professional coursework. These items addressed the methods used to assess student mastery of fundamental didactic concepts and technical skills during professional coursework, as well as those used to assess student competence upon completion of professional coursework. Responses to these items were then correlated to responses to Survey Items #9 and #10, which addressed student attrition, and Survey Items #11 to #13, which addressed post-graduate performance.

Methods utilized to assess performance throughout the program included objective questions, short answer, essay, oral presentation, and laboratory practical. Methods used to assess competence upon completion of program requirements included exit interview, written examination, practical examination, case study presentation, capstone project, and portfolio.

With respect to methods utilized to assess performance during the professional program, only the requirement for the submission of a portfolio was significant when considered in terms of student attrition. No method demonstrated statistical significance when considered in terms of student performance on a national certification examination and subsequent employment.
Table 34  Assessment Methods and Student Attrition

<table>
<thead>
<tr>
<th>Survey Items</th>
<th>Statistics</th>
<th># of students who voluntarily withdrew</th>
<th># of students dismissed for academic reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio</td>
<td>Pearson correlation</td>
<td>0.349**</td>
<td>-0.231</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>0.004</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>65</td>
<td>65</td>
</tr>
</tbody>
</table>

With respect to methods utilized to assess competence upon the completion of program requirements, no method demonstrated statistical significance when considered in terms of student attrition, performance on a national certification examination, and subsequent employment.

The data suggested that when a portfolio is required to document aspects of program performance students are more likely to voluntarily withdraw from the program.

Summary

Initial data analysis consisted of grouping the survey items and tabulating the responses. Survey items were organized into seven groups to facilitate data analysis and reporting as follows: student characteristics, prior level of education, program characteristics, curriculum characteristics, faculty characteristics, in-program performance, and post-graduate performance.

Student characteristics - Seventy-six percent of respondent programs indicated that 50% or fewer students were aged 18 to 24 years, while approximately 68% of programs indicated that 26 to 75% of their students were
25 years or older. More than half of programs (64%) reported that 26 to 75% of students were married, while one-third reported that 25% or fewer students were married. Approximately 44% of respondents indicated that less than 25% of enrollment consisted of minority students. An additional 24% indicated that 26 to 50% of students were minority, while the remaining 32% indicated that greater than half of enrolled students were minority. The majority of respondents (80%) reported that less than one-quarter of students were non-native English-speaking.

Prior level of education - Approximately 40% of respondents reported that less than one-quarter of admitted students possessed only a high school diploma or GED. About 30% reported more than three-quarters of students at that educational level prior to program admission. Most programs (75%) reported that the majority of accepted students had some college coursework beyond high school. Less than 17% of respondents reported accepting students already possessing a college degree or graduate coursework.

Program characteristics - Grade point average and interview were the two most commonly utilized program admission criteria (59% and 47%, respectively). Approximately 19% of respondents included a writing sample, while 18% required related professional experience and English language proficiency testing as part of their criteria. The majority of respondents (71%) indicated that grade point average was the best predictor of student success, followed by interview (37%) and related professional experience (29%). Although grade point average was consistently used by most respondent programs in selecting
students, and as a predictor of future success, more than 80% of program directors reported 2.0 as the minimum acceptable GPA for pre-requisite and professional coursework.

Most programs (49) reported a capacity of 11 to 20 seats. Nine programs reported a capacity of 21 to 30 seats. Five reported 10 or fewer available seats, while only three reported greater than 30 seats. For programs reporting 11 to 20 and ≥31 available seats applications exceeded the number of seats, yet the average percent enrollment was only 83% and 90%, respectively. The smallest programs achieved only 60% enrollment, while those with 21 to 30 seats achieved 84%.

Over 80% of respondents reported having five or more clinical sites for practical training experiences.

Curriculum characteristics – More than half of the respondent programs (~57%) reported that completion of selected pre-requisites (i.e., math, English, chemistry, and biology) was required prior to program admission, while approximately 40% required no pre-requisite coursework at all. Less than 20% required additional, specific coursework (i.e., biomedical ethics, statistics, and computer information technology) prior to admission.

The majority of programs (> 95%) included lecture, laboratory, and clinical practical components in the major subject areas of Urinalysis/Body Fluids, Microbiology, Clinical Chemistry, Hematology, and Immunohematology. Less than 60% of programs offered a lecture or clinical practicum in Instrumentation, while only 34% offered a laboratory course and 25% did not offer this subject
area at all. An average of 85% of respondents included Phlebotomy as part of their MLT/CLT training requirements. A small percentage of programs (< 14%) offered a lecture course in Parasitology and Mycology; however, a corresponding laboratory and clinical practicum were not always included in the curriculum. Less than 20% of respondents reported offering an orientation course.

Over 92% of programs stated that lecture and laboratory coursework must be completed prior to proceeding to a clinical experience. Similarly, most programs (91%) reported that the curriculum was based on a structured sequence of professional courses. About half of the respondent programs required full-time student status. Less than 5% of programs reported offering professional courses more than once per year.

Over 95% of programs reported utilizing traditional lecture and laboratory methods in the classroom, followed by computer tutorials (88%), Internet-based instruction (65%), and self-guided instructional models (57%). The most frequently reported learning methods included computer tutorials (87%), Internet-based assignments (71%), involvement in a study group (69%), utilizing open lab time (59%), and tutoring (54%). The majority of respondents (>94%) reported using objective questions, short answer questions, and laboratory practical exams to assess student performance during professional coursework. Oral presentations (63%) and written essays (47%) were also used. Student competence upon completion of program requirements was most frequently assessed by written examination (90%), practical examination (54%), and capstone project (32%). Approximately 27% of respondents indicated that an
exit interview is also required. Additional requirements, such as case study presentation, portfolio, and competency testing were reported by less than 17% of respondents.

Almost all programs (97%) embedded critical thinking components into the curriculum and 88% included medical ethics; however, only 59% included cultural awareness training.

Faculty characteristics – Forty-three percent of respondents indicated that the program director was the only full-time faculty. Forty-eight percent of the responding programs reported employing only one additional full-time faculty member. Very few programs (9%) reported hiring two or more additional faculty. Slightly less than one-third (31%) of respondents hired no part-time faculty, while 27% reported hiring at least one. The remaining programs (42%) reported hiring two or more part-time faculty.

No programs reported requiring a doctoral degree for full or part-time employment. A master’s degree was required by 41% of respondents for full-time employment, but only by 5% for part-time employment. Fifty-five percent of programs reported requiring a bachelor’s degree for full-time employment, while 84% required it for part-time employment. Almost all programs (97%) reported hiring faculty with four or more years of clinical experience. Forty-three percent of respondents reported establishing minimum levels of education and experience for clinical preceptors.

Fifty-two percent of respondents reported faculty averaged 1-6 hours of student contact per week beyond instructional hours, while 42% reported more
than six hours per week. For clinical faculty, student contact was high (1:1) in 81% of respondent programs. Twelve percent reported a preceptor to student ratio of 1:2.

In-program performance – Twenty four programs reported an average program size of 11 to 15 students, sixteen reported 6 to 10 students, thirteen reported 16 to 20 students, and six reported 21 to 25 students. Only three programs reported 5 or fewer students, while two reported more than 25. For those programs enrolling between 6 and 20 students, dismissal for academic reasons rose (12 to 20%) as program size increased, while voluntary withdrawal remained fairly constant at an average of 24%. For programs enrolling 21 to 25 students, dismissal for academic reasons was about 12%, while voluntary withdrawal was the highest of any program size (30%). Programs enrolling 5 or fewer students or greater than 25 students experienced the lowest overall attrition rates; however, data may not be reliable due to the small number of programs.

Post-graduate performance – The average percentage of students taking the certification examination decreased as program size increased. Seventy-five percent of students in programs enrolling five or fewer students took the certification examination. In programs enrolling 6 to 15 students, 50% took the exam, while an average of 45% of students in the largest programs took the exam. For all program sizes the average percentage of students passing the exam was greater than 80%. The percentage of students passing the exam increased with program size, with 90% of students in programs with 21 to 25.
students passing the exam, and 100% of students in programs with 26 to 30 students passing. Only two programs enrolled 26 to 30 students; therefore, data may not be reliable for examination passage.

For programs enrolling 20 or fewer students, the average percentage of graduates obtaining employment in a field related to their training within one year of graduation was 54%. Employment was highest (64%) for graduates of programs enrolling 6 to 10 students. For programs enrolling more than 20 students, the average percentage of employment was 44%.

Subsequent data analysis was based on the research questions and focused on potential associations between selected student and institutional variables, and student outcomes. The research questions were formulated to support the hypothesis that Astin's I-E-O theory is consistent with MLT/CLT program variables.

Research questions 1 and 2 examined student input variables and their possible relationship to student attrition, passage on a national examination, and employment. The characteristics of age, marital status, minority inclusion, and non-native English speaking were considered as input variables. Student attrition was defined as voluntary withdrawal and dismissal for academic reasons. Voluntary withdrawal from MLT/CLT programs was strongly correlated with non-native English speaking students.

Prior educational level was also considered as an input variable. Academic levels were defined as high school diploma/general equivalency diploma (GED) only, high school diploma/GED and some college, associate
degree, baccalaureate degree, and graduate degree or coursework. Only possession of an associate degree prior to MLT/CLT program admission demonstrated a strong correlation with passing a national certification examination and attaining related employment within one year of graduation. Since less than 2% of respondent programs reported admitted students with an associate degree, this relationship was deemed too small to be interpreted.

Research questions 3, 4 and 5 examined the relationship between environmental variables and student attrition, passage on a national examination, and employment. Environmental variables included pre-admission and professional curriculum, teaching and learning methods, student progression, faculty characteristics, and assessment.

Preadmission requirements were not considered significant in terms of student attrition. However, having no pre-requisites was significant when considered in terms of related employment as an indicator of post-graduate performance.

Attrition was decreased in those programs incorporating a lecture course in Instrumentation and a clinical practicum in Immunohematology. No other subject area, curriculum structure, or embedded component appeared to contribute to student attrition. In addition, no teaching or learning methods appeared to contribute to student attrition. Students were less likely to withdraw when required to maintain full-time status. Students were also less likely to voluntarily withdraw when clinical preceptors possessed a minimum level of education and experience. Students were more likely to voluntarily withdraw
when submission of a portfolio was required as a component of assessment during the professional program.

Students enrolled in a clinical practicum in Immunohematology were less likely to take a national certification examination. However, those students in programs requiring a particular sequence of professional courses were more likely to take a national examination, and those required to maintain full-time status were more likely to pass the examination. No other subject area or embedded component appeared to demonstrate an association with postgraduate performance. No teaching and learning methods appeared to demonstrate an association with postgraduate performance. Students in programs with lower student to faculty ratios were more likely to pass a national certification examination. Those in programs with lower student to full-time faculty were more likely to gain employment in a field related to their training upon graduation. No assessment method utilized during or upon completion of professional coursework appeared to contribute to performance on a national certification examination or employment.
CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents a discussion on the analysis of selected characteristics associated with national MLT/CLT programs and their effect on program outcomes. Within this study, student, institutional, and post-graduate aspects of the MLT/CLT programs were related to program outcomes.

Introduction

The clinical laboratory sciences profession evolved as the relationship of analytical test results and patient diagnosis became widely accepted. The education of clinical laboratory personnel parallels the growth of the profession. As testing methods and instrumentation became more advanced, a formally trained workforce became necessary to assume the tasks previously performed by a pathologist. Initially, training programs focusing on practical instruction were established in clinical institutions. Eventually, colleges and universities established professional and liberal arts programs for laboratory technician education. As the number and type of training programs increased, the need for guidelines to assure the provision of adequate education and training became apparent. Consistent with other allied health education cultures, laboratory
sciences program accreditation was established. To further provide evidence of competence, graduate performance was also assessed via a certification examination, and a registry was established to classify certified professionals according to their education, training, and experience.

Today, most allied health programs, including those in the clinical laboratory sciences, limit enrollment, have low student to faculty ratios, and are expensive to run due to recurring costs associated with laboratory course work. Supplementary costs are also incurred obtaining and maintaining the specialized accreditation required for most professional educational programs. In addition to campus-based course work, many programs also require students to fulfill clinical training requirements at affiliate institutions.

The American Society of Clinical Pathology Board of Registry regularly conducts surveys of clinical laboratory salaries and staffing, as well as characteristics of medical laboratory sciences programs. The most recent biennial Wage and Vacancy Study reported vacancy rates for several staff categories, even as wages continue to increase (Stewart, Ward-Cook, & Tannar, 2005). Despite the availability of positions and increases in entry-level salaries, the most recent Survey of Medical Laboratory Science Programs reported increased enrollments in only about 50% of active programs (Ward-Cook, Chapman, & Lindler, 2003). Program directors also indicated challenges pertaining to recruitment of qualified students, maintaining adequate clinical training sites, and promoting the clinical laboratory science profession.
Astin's impact model was used as a guide for considering the factors that affect student outcomes in MLT/CLT programs. Input, environmental, and outcome variables were identified for study. Input and environmental variables included faculty and student quality, program structure, clinical training, and performance assessment. Outcome variables included attrition, certification examination passage, and post-graduate employment.

A literature review was conducted to more fully understand the types of influences exerted on college students. Cognitive and non-cognitive factors have been shown to have considerable effects on academic achievement. Cognitive factors included pre-college predictors, such as high school GPA and standardized test scores; early college predictors, such as orientation course performance; and GPA in prerequisite and professional coursework. Non-cognitive factors included family influence, student motivation, self-beliefs, adjustment to college life, faculty-student interactions, and pedagogical method.

It is reasonable to expect that similar influences might exist for students in allied health professional programs. A greater awareness of the presence and extent of these factors may lead to increased recruitment and retention, curriculum development and revision, and improved graduation and certification examination pass rates. Assuring that only qualified students graduate is essential to providing a competent workforce to meet projected healthcare needs.
Findings and Conclusions

Findings and conclusions based on incidental observations

Survey responses provided raw data which were offered to assist perspective. While not related directly to the research questions, they do offer the reader increased understanding of the study.

Most MLT/CLT programs attracted students of all ages, with enrollment of younger students (18-24 years) averaging 8% higher than older students (≥ 25 years). Only one-third of respondent programs reported that the majority of enrollment (> 50%) consisted of married students. Both traditional and non-traditional students face distinct challenges in their adjustment to college life. Research has focused on identifying the needs of both groups with the goal of creating an environment that will attract and retain these students (Wintre & Yaffee, 2000; Graham & Donaldson, 1999; Naretto, 1995; Ashkar & Skenes, 1993; Nunn, 1994; Rautopuro & Vaisanen, 2001).

Enrollment of minority students seemed to fluctuate. Forty-four percent of respondents indicated less than 25% minority enrollment; 24% reported 26-50% minority enrollment, and the remaining 32% reported greater than 50% minority enrollment. The majority of programs (80%) reported that less than 25% of enrollment consisted on non-native English speaking students. These data may reflect the native population of the geographic area or a lack of targeted potential student recruiting.

Most programs utilized two admission criteria: interview (47%) and GPA (59%). Interview (37%) and GPA (71%) were also used as predictors of student
success. An additional 30% of respondents considered related professional experience as a success predictor. The use of GPA is certainly consistent with the literature in terms of forecasting student success (Astin, 1975; Tinto, 1993; Wilkie & Redondo, 1996; Knapp, 1984). Research has shown that ACT composite and subtest scores are reliable predictors of student achievement in MLT/CLT programs, as are the Nelson-Denny Reading Test vocabulary and total scores (House, 2000; Aldag & Kling, 1984; Heilman, 1991).

The majority of programs (74%) reported a capacity of 11 to 20 seats. Although the number of applications exceeded the available seats, the average percent enrollment for these programs was only 83%. This supports the understanding that competition for available seats in many allied health disciplines is strong and students often apply to different programs simultaneously. In addition, entry-level salaries for MLT/CLT graduates are not as high as in some other professions (Stewart, et al., 2005).

Most programs reported that the majority of accepted students (75%) had some college coursework beyond high school. This was consistent with the traditional model of requiring prerequisite coursework followed by most professional programs (57%). Fifty-five percent of respondents require the completion of selected pre-requisites prior to program completion, while 40% require no prerequisite coursework. This is consistent with studies that demonstrated a positive correlation between selected prerequisites and achievement in professional courses and certification examination passage (Wise, 1983; Lehman, et al., 1984; Lin, et al; 1987; Jeff & West, 1988).
The majority of programs (> 94%) offer lecture, laboratory, and clinical practicum experiences in the major clinical disciplines of Urinalysis and Body Fluids, Microbiology, Clinical Chemistry, Hematology, and Immunohematology. Less than 20% of offered an orientation course. Research indicates that orientation course grades are a reliable indicator of persistence and graduation (Zimmerman, 2000; Hyers & Joslin, 1998; Hyers & Zimmerman, 2002).

Most programs (91%) reported that the curriculum was structured around a particular sequence of professional courses. About half of the respondent programs required students to maintain full-time status. Very few programs offered professional coursework more than once per year. These constraints may affect recruitment and retention of non-traditional students.

Although most programs (> 95%) utilized traditional lecture and laboratory methods in the classroom, a variety of other methods were also used to convey key curriculum concepts and techniques. Inclusion of multiple pedagogical methods in developing a curriculum has been shown to be effective in maximizing student involvement (Tinto, 1993). Collaborative and cooperative learning activities may be particularly beneficial in promoting the “team” approach that is necessary for successful transition to the clinical workplace (Smith & MacGregor, 1992; Colbeck, et al., 2000a; Davis & Murrell, 1993; Kreke, et al., 1998; Bose, et al., 2004).

Most programs also reported using traditional objective test questions and written examinations to assess in-program and post-program student performance. This is consistent with preparation for the national certification
examination, which is reference-based and presented in a multiple choice format. However, additional methods were also reported to assess mastery of didactic concepts and technical skills. Most programs included assessments designed to evaluate writing and presentation skills, attributes that have been identified as being important in the workplace.

Most learning methods focused on computer tutorials (87%), internet-based assignments (71%), study groups (69%), and open lab time (59%). Only one-third of programs reported promoting student cohorts as a learning method. In addition, very few programs (< 6%) use student mentors. This report is noteworthy, as student peers play a significant role in the classroom environment. Research supports the effectiveness of curriculum design in facilitating positive student interactions, participation, and learning (Fassinger, 1997; Reynolds & Nunn, 1997). Research also indicates that peer perception may have more of an influence on learning than the instructor (Hallinan & Smith, 1989; Fassinger, 1995). Utilization of student cohorts and peer mentors may increase student quality and retention in professional programs.

Nearly all programs incorporated critical thinking activities (97%) into the curriculum and most included medial ethics (88%). However, only 59% included cultural awareness training. Such training may also be valuable to instructors in designing curriculum to meet the needs of all students. It may also significantly impact recruitment and retention of non-traditional populations.

Many programs (43%) reported the Program Director as the only full-time faculty. Forty-eight percent of respondents indicated hiring one additional full-
time faculty. Less than 10% of programs reported hiring more than two additional full-time faculty. Slightly less than one-third of programs hired no part-time faculty, while the remaining employed one or more. Almost all programs (97%) reported hiring faculty with 4 or more years of clinical experience. In addition to instructional time, 42% of programs reported spending more than 6 hours in student contact. Student contact was also high for clinical faculty in the majority of programs (81%). Studies have shown that positive faculty-student relationships are important in optimizing student learning (Boyer, 1987; Palmer, 1998; Hirschy & Wilson, 2002; Braxton & Bayer, 1999). Of concern in CLS educational programs are the low numbers of full-time faculty and the reliance on part-time faculty. Retention of part-time faculty from semester to semester is less predictable than full-time positions. This affects the quality and consistency of instruction, as well as the quality of faculty-student relationships. Too great a reliance on part-time faculty may contribute to decreased retention in MLT/CLT programs and certification examination passage.

Findings and conclusions based on research questions

An analysis of the data, as they related to the research questions, suggests that there is a need for MLT/CLT Program Directors to be vigilant in recruitment practices, in order to seat students with strengths. These students seem to perform better during the program and perform better in post-graduate certification examinations.
Research questions 1 and 2 examined the relationship between input variables (student characteristics and prior educational levels) and attrition, certification examination passage, and employment.

R.Q. 1 Is there a relationship between selected student characteristics and MLT/CLT student attrition?

The data suggested that a relationship existed between the percentage of non-native English speaking students and voluntary attrition from MLT/CLT programs. Non-native English speaking students withdrew more often than native English speaking students. Programs may need to revise their recruitment and retention efforts to ensure that the proportions of student and graduate ethnicities reflect the communities in which they will be practicing. More programs may also want to consider including the results of standardized test scores in the admissions process.

R.Q. 2 Is there a relationship between prior education level and post-graduate performance?

There was statistical significance when considering the associate degree and examination passage and employment. Possession of an associate degree correlated strongly with certification examination passage and subsequent employment. However, less than 2% of programs admit students already possessing an associate degree. It is not reasonable to expect that programs would consider a 2+1 curriculum structure. Greater attention should be given to choosing the most appropriate prerequisite courses to support the professional curriculum and transition to the workplace.
Research questions 3, 4, and 5 examined the relationship between environmental variables (curriculum, teaching and learning methods, student progression, faculty characteristics, and assessment methods) and attrition, certification examination passage, and employment.

R.Q. 3 Is there a relationship between selected curriculum characteristics, teaching methods and learning methods, and MLT/CLT student attrition and post-graduate performance?

Attrition appeared to be decreased in those programs incorporating an "Instrumentation" lecture course. Instrumentation concepts are among the most difficult for students to master. New technologies emerge rapidly in the clinical laboratory sciences and transcend all areas of the laboratory. A strong foundation in operational principles is critical for students in terms of future employment. Attrition was also decreased when students were required to maintain full-time status. Full-time status allows students to progress more quickly to program completion, certification examination eligibility and employment. However, the requirement for full-time status may eliminate a potential pool of students whose unique needs may prevent them from attending full-time.

The sequence of professional coursework and maintenance of full-time student status were significant when considered in terms of certification examination. Enforcing a particular sequence of courses allows program administrators to more effectively advise students and track their progress. Maintaining full-time status promotes increased retention of key concepts and
reinforcement of technical skills. Students in programs requiring a particular sequence of professional courses were more likely to take a national examination, and those required to maintain full-time status were more likely to pass the examination. These students may feel better-prepared and more confident in their ability to pass the examination.

When no prerequisite coursework was required students were more likely to attain post-graduate employment. It is possible that some students in these programs may have been concurrently or previously employed in a related field, giving them an advantage over other applicants. Students in those programs mandating specific pre-admission curriculum requirements were less likely to attain employment in a field related to their training within one year of graduation. It is possible that the selected prerequisites did not provide the foundational skills (i.e., mathematics, communications) required in the workplace. Attempts have been made to identify a core of prerequisite courses that would be most relevant to professional coursework (Kasper, et al., 1993). This has proved unsuccessful, perhaps due to the broad guidelines permitted by the accrediting agencies with respect to prerequisite coursework (Newell, 1993; NAACLS, 2004).

Program size was related to attrition, certification examination passage and post-graduate employment. Most programs (83%) reported an average program size of 6 to 20 students. The average percentage of dismissal for academic reasons rose as program size increased. The average percentage of students taking the certification examination decreased as program size increased. For students actually taking the examination, pass rates for all
program sizes averaged above 80%, with pass rates increasing with program size. The average percentage of employment also decreased as program size increased. One factor contributing to attrition and failure to apply for the certification examination may be the increased faculty-student ratio as program size increases. Higher pass rates in the larger programs may be related to the potential availability of more resources, such as reference and other study materials. Decreased employment may be related to the lack of enough clinical sites to provide maximum exposure of students to potential employers during clinical practicum experiences.

R.Q. 4 Is there a relationship between selected faculty characteristics and MLT/CLT student attrition and post-graduate performance?

Attrition was increased in programs with higher student to full-time faculty ratios. In MLT/CLT programs with lower student to full-time faculty ratios, students were more likely to take and pass a national certification examination. A positive correlation was also observed for part-time faculty and examination passage. Faculty quality and experience are not the issue in MLT/CLT educational programs. However, the number and availability of faculty is a major concern. Although part-time faculty provide valuable resources in terms of education and current clinical experience, their availability from semester to semester cannot be guaranteed due to their primary work schedules and other factors. This affects the quality and consistency of professional instruction. Part-time faculty may only interact with students during the scheduled class time, due to limited time on campus and lack of assigned office space. Reliance on part-
time faculty may decrease the interaction between students and full-time faculty, interrupt the flow of important programmatic information, and increase the administrative burdens of full-time faculty.

Attrition was decreased when clinical preceptors possessed adequate education and experience. In addition to training MLT/CLT students, clinical preceptors model what a laboratory professional actually does in the clinical setting. Providing a positive and realistic clinical practicum experience is essential to facilitating the transition from the educational program to the workplace.

R.Q. 5 Is there a relationship between selected MLT/CLT in-program assessment methods, and student attrition and post-graduate performance?

Only the requirement for the submission of a portfolio was significant when considered in terms of student attrition. No other method of in-program or post-program assessment demonstrated statistical significance when considered in terms of student performance on a national certification examination and subsequent employment. Most programs use objective methods to assess student performance in preparation for the national certification examination. Submission of a portfolio entails compiling samples of laboratory activities, case studies, presentations and other projects that have been completed over the span of the professional program. This would be a time-consuming and labor-intensive undertaking in a rigorous professional program when other adequate assessment methods are already in place.
Study Strengths, Weaknesses, and Limitations

The study was effective in providing information about student characteristics; program demographics; curriculum structure; teaching, learning, and assessment methods; and other resources associated with MLT/CLT educational programs. Analysis of the data demonstrated homogeneity among programs in terms of student selection methods, curriculum structure, teaching and learning styles, and evaluation of student performance. It also demonstrated areas of concern, with respect to recruitment and retention of qualified applicants, high student to faculty ratios, reliance on part-time faculty, failure of all qualified applicants to take a national certification examination, and pass rates of slightly above 80% for those students that do take the exam.

A major weakness of the study was the attempt to cover a wide range of programmatic issues. An Internet-based survey instrument was used to collect program data. The survey was comprised of 55 items and may have appeared too long to respondents. Many responses relied on memory, which may have contributed to inaccuracies in reporting, or detailed sourcing, which may have contributed to non-participation. Although the computerized format was the most efficient and economical way to distribute the survey to participants, it may not have been the most convenient format for respondents. It required respondents to proceed in a linear fashion through the survey and complete it in one sitting. A traditional mail-in survey may have increased accuracy and the response rate by allowing more time to access the information need to answer some survey items.
The study may have been limited by the small $n$. The target population consisted of 150 NAACLS-accredited MLT/CLT associate degree programs. The survey response rate was 42%. Although this is an acceptable response rate, caution should be exercised before generalizing these results to the entire population. Another limitation was that many of the independent variables were a function of program size, which tends to be small in most allied health disciplines. It may have been more effective to use continuous data, rather than categorical, for this study.

Recommendations for Further Study

MLT/CLT programs seem especially vulnerable to student inadequacies. Program success, as measured by decreased attrition, certification examination passage, and post-graduate employment is dependent upon more qualified student selection. Therefore, it may be beneficial to study the association of recruiting and selection practices, minimum GPA requirements, and general intelligence tests with attrition and student performance. Future research could be directed at assessing the support systems provided to non-native English-speaking students. The effect of providing scholarships to encourage full-time student commitment could also be studied.

Given the small number of MLT/CLT programs nationwide, a detailed qualitative study may be more sensitive in identifying and understanding significant, influential program traits. A qualitative study would permit a more in-depth consideration of imperceptible factors, such as faculty personality, student
perception, employer and stakeholder satisfaction, and certification examination preparation.

Additional environmental variables, such as sponsoring institution support, campus climate and facilities, faculty development, instructional budget, and technological resources, should be examined to determine whether Astin's theory is consistent with these expanded characteristics. Further consideration could also be given to quality and availability of clinical affiliates, degree of urbanization, and the impact of cultural diversity.

Finally, it may be worthwhile to determine the effect of input and environmental variables associated with other allied health disciplines on program outcomes, in comparison with MLT/CLT programs.

Summary

The purpose of the study was to examine the relationship between selected input and environmental variables and MLT/CLT program outcomes. Principles extracted from Alexander Astin's I-E-O model were used as a foundation for considering the factors that affect MLT/CLT program student outcomes. It was hypothesized that Astin's theory was consistent with MLT/CLT program variables.

A comprehensive review of the literature was conducted to gather information pertaining to the development of clinical laboratory sciences educational programs, as well as the cognitive and non-cognitive factors
impacting student success. A variety of sources were consulted within the
disciplines of clinical laboratory science, allied health, and general education.

Input, environmental, and outcome variables related to MLT/CLT
programs were identified for study. A set of research questions was designed to
examine the relationships among the variables, in support of the hypothesis. A
survey instrument was constructed to gather data from program directors of 150
Associate degree-granting, NAACLS-accredited MLT/CLT programs, as
identified by the Health Professions Career and Education Directory. Electronic
survey distribution, response tabulation, and data organization was managed by
the Cannon Center for Survey Research. Authority to conduct the study was
granted by the Office for the Protection of Human Subjects.

Data were analyzed using descriptive statistics and Pearson product-
moment correlation coefficient. Analysis of the data demonstrated that the
majority of MLT/CLT programs were fairly homogeneous in terms of selection
criteria; curriculum structure; teaching, learning, and evaluations methods; and
faculty quality.

Several factors were identified as influencing student success. These
included program size, English-speaking ability, enrollment status, course
sequence, faculty-student ratio, clinical preceptor quality, and portfolio
submission. Students in smaller programs were more likely to stay enrolled,
pass the certification examination, and gain employment. Non-native English-
speaking students were more likely to voluntarily withdraw from the professional
program than their English-speaking counterparts. Full-time students enrolled in
a structured sequence of professional courses were more likely to complete the program and pass the national certification examination. Students were also more likely to remain enrolled when full-time faculty-student ratios were low. Clinical preceptor academic level also contributed to retention. Attrition increased when portfolio submission was required as a component of performance assessment.

Generally, the study supports Astin's theoretical constructs. Students who are academically better-prepared, enrolled in a structured curriculum, and involved with faculty are more successful in meeting program outcomes. In other words, the hypothesis of the study that various factors in MLT/CLT education, such as student/program characteristics, affect student performance is supported. One possible modification to that construct is that its application may be more important in professional programs that accept academically marginal students.

Knowledge of the factors that impact student success in MLT/CLT programs and the application of Astin's I-E-O theory may strengthen and support existing educational programs by guiding student selection and curriculum design, increasing retention, certification examination passage, and eventual employment. The broader impact will be in providing a technically competent workforce of clinical laboratory practitioners.
Patricia R. Castro, M.S., MT (ASCP), BB  
Principal Investigator  
9136 W. Hammer Lane  
Las Vegas, Nevada, 89149  

December 15, 2004

Dear Colleague,

I am a doctoral student at the University of Nevada, Las Vegas, in the Department of Educational Leadership. My dissertation research topic involves examining and comparing selected characteristics associated with medical laboratory technician and clinical laboratory technician associate degree programs, with the intention of identifying the relationship between these characteristics and successful program outcomes.

As the program director or education coordinator of an MLT/CLT program, I hope you will consider participating in this research project. The information you can provide is indispensable to the success of the project and will be greatly appreciated. The results of this research will provide information to administrators, program personnel, students, and other stakeholders involved in program evaluation.

Participation in the research project is voluntary. If you would like to participate, please read the attached informed consent and complete the survey. Confidentiality of survey responses and the results of data analysis will be strictly maintained by the principal investigator. Results of data analysis will be shared with all programs interested in receiving an executive summary.

I look forward to learning about your programs and thank you in advance for your cooperation in helping me to achieve this goal. Please contact me via e-mail patricia_castro@ccsn.edu or phone (702-651-5819) with any questions or concerns.

Sincerely,
Patricia R. Castro
1. What criteria are used to select students for program admission? Select all that apply.

- 1. Interview
- 2. GPA
- 3. Writing Sample
- 4. Manual Dexterity Assessment
- 5. Community Service
- 6. Related Professional experience
- 7. English Language Proficiency Standardized Test
- 8. Other

2. Which two indicators do you feel are the best predictors of student success in your program?

- 1. Interview
- 2. GPA
- 3. Writing Sample
- 4. Manual Dexterity Assessment
- 5. Community Service
- 6. Related Professional experience
- 7. English Language Proficiency Standardized Test
- 8. Other

3. What is the minimum acceptable GPA for PREREQUISITE coursework?

- 2.0 - 2.5
- 2.6 - 3.0
- more than 3.0

4. What is the minimum acceptable GPA for PROFESSIONAL coursework?

- 2.0 - 2.5
- 2.6 - 3.0
- more than 3.0
Complete the following information about students admitted to your program in the Fall of 2002.

5. # of seats available

6. # of applicants

7. # of students admitted

8. # of students enrolled

9. # of students who voluntarily withdrew

10. # of students dismissed for academic reasons

11. # of graduates taking certification exam

12. # of students passing certification exam

13. # of graduates attaining related employment within 1 year of graduation

14. In Fall, 2002, how many students would you estimate were between the ages of 18 to 24?
   - less than 25%
   - 26% to 50%
   - 51% to 75%
   - more than 76%
15. In Fall, 2002, how many students would you estimate were age 25 or older?
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

16. In Fall, 2002, how many students would you estimate were married?
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

17. In Fall, 2002, how many students would you estimate were minority?
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

18. In Fall, 2002, how many students would you estimate were non-native English speaking?
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

19. Prior to acceptance into your program, please estimate the percentage of students who were at each of the following educational levels. A HIGH SCHOOL DIPLOMA /GED ONLY.
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%
20. Prior to acceptance into your program, please estimate the percentage of students who were at each of the following educational levels. A HIGH SCHOOL DIPLOMA /GED and SOME COLLEGE.
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

21. Prior to acceptance into your program, what percentage of students had an ASSOCIATE DEGREE?
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

22. Prior to acceptance into your program, what percentage of students held a BACCALAUREATE DEGREE
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

23. Prior to acceptance into your program, what percentage of students held a GRADUATE DEGREE or COURSEWORK
- less than 25%
- 26% to 50%
- 51% to 75%
- more than 76%

24. Please select the statement that best describes pre-admission curriculum requirements for your program.
- 1. No pre-requisite coursework is required
- 2. Selected pre-requisites (i.e., college level math, English, biology, and chemistry) must be completed prior to admission
- 3. All college requirements for graduation (i.e. general education) must be completed prior to program admission
25. Are students required to complete ADDITIONAL PRE-REQUISITE COURSEWORK (i.e. biomedical ethics, statistics, computer information technology) prior to MLT/CLT admission?
   ☐ Yes
   ☐ No

For the following subject areas please indicate which are included as a part of your professional curriculum. Select all that apply for each subject area.

26. URINALYSIS /BODY FLUIDS
   ☐ Lecture course
   ☐ Laboratory course
   ☐ Clinical practicum
   ☐ Not offered

27. MICROBIOLOGY
   ☐ Lecture course
   ☐ Laboratory course
   ☐ Clinical practicum
   ☐ Not offered

28. CLINICAL CHEMISTRY
   ☐ Lecture course
   ☐ Laboratory course
   ☐ Clinical practicum
   ☐ Not offered

29. INSTRUMENTATION
   ☐ Lecture course
   ☐ Laboratory course
   ☐ Clinical practicum
   ☐ Not offered

30. HEMATOLOGY
   ☐ Lecture course
   ☐ Laboratory course
   ☐ Clinical practicum
   ☐ Not offered
31. IMMUNOHEMATOLOGY
- Lecture course
- Laboratory course
- Clinical practicum
- Not offered

32. SEROLOGY
- Lecture course
- Laboratory course
- Clinical practicum
- Not offered

33. PHLEBOTOMY
- Lecture course
- Laboratory course
- Clinical practicum
- Not offered

34. Please list any additional subjects areas that are not listed as a LECTURE COURSE

35. Please list any additional subjects areas that are not listed as a LABORATORY COURSE

36. Please list any additional subjects areas that are not listed as a CLINICAL PRACTICUM
37. Are students required to complete lecture and laboratory coursework prior to clinical practicum assignment?
  - Yes
  - No

38. Are professional courses required to be taken in a particular sequence?
  - Yes
  - No

39. Are students required to maintain full-time status in professional coursework upon admission to your MLT/CLT program?
  - Yes
  - No, students proceed through the program at their own pace

40. Are all required professional courses offered more than once a year?
  - Yes
  - No

41. Please indicate all applicable TEACHING methods utilized in your program.
  - Lecture
  - Self-guided instructional modules
  - Computer Tutorials
  - Laboratory demonstrations
  - Internet-based instruction
  - Other

42. Please indicate all applicable LEARNING methods utilized in your program.
  - Study Groups
  - Cohorts of students admitted together
  - Student mentors
  - Tutoring
  - Open lab time
  - Computer tutorials
  - Internet-based assignments
  - Other
43. Please indicate all applicable testing methods used to assess student mastery of key didactic concepts and technical skills DURING professional coursework.

- Objective questions
- Short Answer
- Essay
- Oral Presentation
- Laboratory
- **Laboratory practical**
- Other

44. Please indicate all applicable methods used to assess student competence upon COMPLETION of professional coursework.

- Exit interview
- Written examination
- Practical examination
- Case study presentation
- Capstone project
- Portfolio
- Other

45. Please indicate whether any of the following components are embedded in didactic/laboratory coursework.

- Critical thinking
- Medical ethics
- Cultural awareness

46. In addition to the Program Director, how many full-time faculty are there in your MLT/CLT program? (Full-time = teaching a full course load of MLT/CLT professional courses)?

- 0
- 1
- 2
- 3
- 4 or more
47. How many part-time faculty are there in your MLT/CLT program? (Part-time = teaching less than a full course load of MLT/CLT professional courses)?

- 0
- 1
- 2
- 3
- 4 or more

48. What are the minimum qualifications for full-time didactic faculty in your MLT/CLT program?

- Doctoral degree in CLS or related discipline
- Masters degree in CLS or related discipline
- Bachelors degree in CLS or related discipline
- Other

49. What are the minimum qualifications for part-time didactic faculty in your MLT/CLT program?

- Doctoral degree in CLS or related discipline
- Masters degree in CLS or related discipline
- Bachelors degree in CLS or related discipline
- Other

50. Please estimate the average years of clinical experience attained by faculty prior to joining your program.

- 1 year
- 2 years
- 3 years
- 4 or more years

51. Please estimate the average hours of actual student contact (i.e., student advising, special projects) faculty spend each week outside of instructional time.

- None beyond stated office hours
- 1 - 3 hours
- 4 - 6 hours
- More than 6 hours
52. Please indicate the number of full-service laboratories available for clinical practicum experience?
   - 0
   - 1 - 4
   - 5 - 9
   - 10+

53. Are the preceptors responsible for clinical training required to have a minimum level of education and clinical experience (i.e., baccalaureate degree and 2+ years of experience)?
   - Yes
   - No

54. Do preceptors receive payment beyond salary?
   - Yes
   - No

55. What is the preceptor to student ratio?
   - 1 : 1
   - 1 : 2
   - > 1 : 2
   - Other

56. Thank you for your commitment to clinical laboratory sciences education and your participation in this research effort. Are you interested in receiving a summary of the results of the study?
   - Yes
   - No

57. If yes, please include your contact information here. Your answers will be separated from this field for final analysis.
APPENDIX B

Office for the Protection of Human Subjects Approval
From: OPRSHumanSubjects@ccmail.nevada.edu
Subject: Protocol approval in OPRS: Meacham - Environmental Factors Affecting Retention and Graduation in...
Date: Tue, 26 Oct 2004 13:08:34 -0700
To: meachamp@ccmail.nevada.edu
Cc: patricia_castro@ccsn.edu

This is an automatically generated email. If you already received this information from OPRS, please disregard.

Social/Behavioral IRB - Expedited Review
Approval Notice
DATE: October 26, 2004
TO: Dr. Paul Meacham
College of Education
FROM: Office for the Protection of Research Subjects
Notification of IRE Action by Dr. Michael Stitt
Chair, UNLV Social/Behavioral Sciences Institutional Review Board
RE: Status of Human Subject Protocol Entitled: Environmental Factors Affecting Retention and Graduation in MLT/CLT programs: An Exploratory Study OPRS# 0410 - 1377

This memorandum is notification that the protocol for the project referenced above has met the criteria for exemption from full committee review by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in regulatory statues 45CFR46.110. The protocol has been submitted through the expedited review process and has been approved.

The protocol is approved for a period of one year from the date of IRE review. Work on the project may proceed as soon as you receive written notification from OPRS.

Should the use of human subjects described in this protocol continue beyond October 25, 2005, it would be necessary to request an extension 30 days before the expiration date. Should there be any change(s) to the protocol, it will be necessary to request such change in writing through the Office for the Protection of Research Subjects.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@ccmail.nevada.edu or call 895-2794.

Office for the Protection of Research Subjects (OPRS)
4505 Maryland Parkway Box 451037
Las Vegas, NV 89154-1037
Office (702) 895-2794 Fax (702) 895-0805

Research Administration Building 103 M/S 1037
OPRSHumanSubjects@ccmail.nevada.edu
Website: http://www.unlv.edu/Research/OPRS/


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VITA

Graduate College
University of Nevada, Las Vegas

Patricia R. Castro

Home Address:
9136 Hammer Lane
Las Vegas, NV 89149

Degrees:
  Bachelor of Science, Medical Technology, 1980
  C. W. Post Center of Long Island University

  Master of Science, Biology, 1997
  University of Nevada Las Vegas

Dissertation Title: Environmental Factors Affecting Retention and Graduation in MLT/CLT Programs

Dissertation Examination Committee:
  Committee Chair, Paul Meacham, Ph.D.
  Committee Member, Gerald Kops, J.D., Ph.D.
  Committee Member, Robert Ackerman, Ph.D.
  Committee Member, Penny Amy, Ph.D.