AN EXPLORATORY STUDY OF

CLINICAL LABORATORY SCIENCE PROGRAMS IN TEXAS

A Thesis

by

MARGARET A. RENFRO

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,	Lori Graham
Committee Members,	Courtney West
	Cynthia Meininger
Head of Department,	Paul Ogden

December 2015

Major Subject: Education for Healthcare Professionals

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ABSTRACT

Currently there is a shortage of clinical laboratory scientists in Texas. The workers needed to reduce this shortage are graduating from university-based and hospital-based programs across the state. There is little literature pertaining to the efforts being taken by these programs to reduce the workforce shortage and the barriers that impede these efforts. Assessing the current status of clinical laboratory science (CLS) programs in Texas by comparing program structure and gathering program director feedback regarding program needs, professional trends and student recruitment will provide a starting point for understanding how to address the CLS workforce shortage in Texas. This study provides basic knowledge about the status of the state's programs in order to guide further study and future improvement efforts.

A survey was sent to 14 program directors in Texas, and three directors from each program type responded. The results of these six survey responses were analyzed both quantitatively and qualitatively. General themes emerged from the data, and these themes were used to compare and contrast the different program types. Multiple barriers to CLS education were identified that were common to both groups, such as a lack of recognition of the career and a lack of funds to further educational efforts. Suggestions were also made as to how to address these barriers in order to reduce the CLS workforce shortage in Texas. The findings from this study should provide a starting point for future research.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Graham, and my committee members, Dr. West and Dr. Meininger, for their guidance, support and patience throughout the course of this research.

Thanks also go to my colleagues and the department faculty and staff for making my time at Texas A&M University a great experience. I also want to extend my gratitude to all the Texas program directors who were willing to participate in the study.

Finally, thanks to all of my family and friends for their encouragement, patience and many prayers.

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CHAPTER I

INTRODUCTION AND PROBLEM

Clinical laboratory scientists are responsible for performing the testing that provides vital information to the healthcare professionals diagnosing, treating and monitoring patients. This profession is an integral part of the healthcare team and plays a critical role in multiple aspects of patient care. Clinical laboratory scientists, or medical technologists, are one of the many laboratory professionals involved in this important, but often overlooked, area of healthcare.

There are two main pathways for becoming a clinical laboratory scientist. A degree can be obtained from a university-based or hospital-based clinical laboratory science (CLS) program. Upon completion of this degree, students must pass a certification examination, such as the American Society for Clinical Pathology (ASCP) Board of Certification (BOC) exam, in order to become a certified clinical laboratory scientist, also known as a medical technologist. The university-based and hospital-based CLS programs share many similarities as well as some important differences. University-based programs typically require four years and classes are conducted at the university with clinical rotations completed at surrounding affiliated hospitals. Hospital-based programs typically last 12 to 18 months and accept students who have already completed the required prerequisite coursework at an affiliated university. Clinical coursework is taught by hospital staff and clinical rotations are completed at the hospital. These programs result in students being prepared to work as medical technologists, as opposed

to medical technicians who are prepared through associate degree programs. Some CLS programs offer "bridge programs" which allow medical technicians to complete the necessary further coursework to qualify for the medical technologist certification exam. While the core requirements might be the same for both university-based and hospital-based programs, the ways in which they are obtained differ between programs. This study outlines these similarities and differences as a way to assess the current status of CLS programs in Texas.

Assessing the status of CLS programs in Texas is an important task due to the current workforce shortage of CLS professionals nationwide. A vacancy survey conducted by the ASCP in 2011 reported vacancy rates ranging from 5.1% to 11.6%, and the Bureau of Labor Statistics estimates a 14% workforce growth by the year 2022 (Garcia et al., 2011; U.S. Department of Labor, 2014). This personnel shortage will continue to grow as the current workforce ages unless more students graduate from accredited CLS programs. The National Accrediting Agency for Clinical Laboratory Science (NAACLS) is the largest CLS accrediting body in the United States. There are currently 14 NAACLS accredited CLS programs in Texas. Nine of these programs are university-based and five are hospital-based. These programs will produce the graduates needed to fill the growing job vacancies in Texas and across the nation. Assessing their structure and current status is an important step in understanding how to address the problem of the workforce shortage.

Another step in understanding how to address the workforce shortage is gathering the ideas of CLS program directors. These program directors can provide information

on their current recruitment efforts, barriers their program has faced and their outlook on the workforce shortage. Starting with the individual programs in Texas is starting at the source of the shortage. The program directors will be able to provide insight as to what might be keeping students from applying to their programs and how attendance might be increased in the future. This study surveyed the 14 NAACLS-accredited program directors in Texas in order to obtain these insights. Assessing the current status of CLS programs in Texas by comparing program structure and gathering program director feedback will provide a starting point for understanding how to address the CLS workforce shortage in Texas.

Statement of the Problem

There is a current shortage of clinical laboratory scientists in Texas, and it is estimated that there will need to be an additional 22,700 CLS employees nationwide by the year 2022 (U.S. Department of Labor, 2014). The current and estimated shortage, combined with the aging baby-boomer workforce, could result in a crisis for both private and hospital laboratories. There are only 14 NAACLS-accredited programs in Texas and there is very little existing literature about the efforts these programs are taking to address the workforce shortage. This study adds to the small body of literature pertaining to CLS and CLS education.

Purpose of the Study

The purpose of this study was to assess the current status of CLS programs in Texas by comparing program structure and analyzing program director insights regarding program needs, professional trends and student recruitment. This study

provides basic knowledge about the status of the state's programs in order to guide further study and future improvement efforts.

Research Questions

1. What are the similarities and differences between university-based and hospital-based CLS programs in Texas?
2. What are some of the barriers that CLS programs face?
3. How can the state produce enough clinical laboratory scientists to reduce the workforce shortage?

CHAPTER II

LITERATURE REVIEW

This study adds to a very limited field of research in clinical laboratory science education. Some research has been conducted regarding student recruitment, the workforce shortage and BOC exam pass rates, but none of these fields have combined their themes or used their results to compare CLS program types. Any type of research in the area of CLS education is needed, but this study provides novel information that can be used by both hospital-based and university-based programs to improve their programs, inform future decisions and possibly make a case for their necessity and relevance.

A search of the literature relating to CLS education yields very few results. The field of CLS in general has little published research compared to other health-related fields, which is an issue described by Rohde, Falleur, Redwine and Patterson (2010) in an article addressing CLS faculty and student scholarship. There are only a handful of journals dedicated to laboratory medicine and none of them are specific to education in CLS. The focus of this study, assessing the status and comparing the structure of CLS programs, has no directly related literature in any of the few laboratory science journals. Therefore, this study provides much needed information in the area of CLS education.

In each type of program, students spend time in both the classroom and clinical setting. Students in university-based programs awarding a degree spend considerably more time in the classroom with clinical rotations typically being performed in the final

semesters. Hospital-based programs are usually completed by students who have previously fulfilled prerequisites and are now receiving clinically related education and training. The ASCP BOC examination is completed at the end of each type of program by all students wishing to be certified as a clinical laboratory scientist. Therefore, this comprehensive exam is the best representation of a student's instructional comprehension and laboratory competence at the time of program completion. The article by NAACLS (2009) outlines ways in which university and hospital programs can justify the need for their program to administrators. This study provides further evidence for the necessity of these programs by highlighting the workforce shortage and outlining the strengths of each type of program.

CLS education has faced barriers in both the hospital and university setting. Decreased funding in both areas has resulted in a decrease in the number of educational programs available to students (NAACLS, 2009). Budget cuts in allied health departments often lead to the closure of university-based CLS programs while budget cuts or staffing shortages lead to the closure of hospital-based programs (NAACLS, 2009). In hospital-based programs, the implementation of the Medicare Prospective Payment Systems changed laboratories from a source of revenue to a cost center, thereby straining the available funds for extraneous budget items such as CLS programs (Bailey et al., 2013).

The decrease in CLS education programs is mirrored by a decrease in the number of available CLS personnel to fill the growing job vacancies in the field. Clinical laboratory science is facing a personnel shortage that is well-documented in the

literature. The current workforce is aging and the number of CLS graduates lags behind the projected demand (Beck & Doig, 2007). Nationwide laboratories require 5,000 laboratory technologists each year for optimal staffing, but programs are graduating only 1,500 technologists annually (Slagle, 2013). This shortage is exacerbated by the decrease in programs. Therefore, it is important to determine the most effective methods of each type of program in training and recruiting new laboratory personnel to fill the growing vacancies.

In addition to the growing number of program closures despite their increasing need, the issue of student recruitment is also of concern. The CLS programs that are available face the task of raising awareness of the profession and recruiting students. Strategic recruiting is necessary and must overcome the lack of recognition for laboratory personnel in the healthcare environment (Garcia & Fisher, 2013). A study by Slagle (2013) highlights the need for effective recruitment strategies for laboratory personnel and the need for greater recognition of the profession in order to attract students. Another study by McClure (2009) points out the lack of knowledge about the field and the problem of recruitment and retention in the CLS profession. To address the lack of recognition of the CLS field, the ASCP Task Force on the Laboratory Professionals Workforce (2013) suggests targeting STEM (science, technology, engineering and math) students in high school and college in order to raise awareness of the profession among students with corresponding interests. The information gathered by this project can be used as a recruitment tool in both the high school and college settings. This study examines the barriers faced by various university-based and

hospital-based CLS programs and strategies used to overcome these barriers in order to lessen the workforce shortage. A better understanding of the effectiveness of these methods can be used to inform recruiting decisions and provide support for the validity of the programs.

Even after student recruitment issues have been addressed, retention of new graduates in the laboratory is also of concern. A study by McClure (2009) regarding student perceptions of the CLS profession revealed multiple factors that affect a student's decisions to remain in the laboratory, including a salary appropriate for the knowledge required for the profession and opportunities for career advancement within the laboratory. A similar study by Beck and Doig (2007) of newly graduated clinical laboratory scientists working in the laboratory also found that salary and opportunities for career growth were identified as factors that would influence the decision to stay in the laboratory field. Both studies pointed out that CLS is viewed as an interesting career and that both students and new employees plan to stay in the profession, but barriers such as salary, growth opportunities, and lack of recognition within the healthcare field may influence their decisions. This study asked program directors to indicate if they believe that these and other barriers are affecting both the viability of their programs and the workforce shortage in Texas. Additional evidence in this area can only strengthen the efforts of directors when justifying their program and when trying to address the growing shortage of clinical laboratory scientists in Texas.

Finally, this study evaluates the status of different types of CLS programs by comparing program structure and outcomes and uses information provided by program

directors to give direction for the future of CLS education in Texas. The literature provided supports the need for such a study by outlining the shortage in both CLS programs and personnel, which can be aided by effective CLS programs that attract students and prepare them for the BOC examination and the workforce.

CHAPTER III

METHODS

The purpose of this study was to assess the current status of CLS programs in Texas by comparing program structure and analyzing program director opinions.

Research Design

This study employed a mixed-methods design to most effectively make use of both the quantitative and qualitative data gathered from the survey. This design allowed a more complete understanding of the data by explaining quantitative survey results with qualitative development. Responses were categorized into themes for both the university-based and hospital-based programs, which allowed the perspectives of both groups to be compared to each other.

Sampling

The sample population for this study included all of the NAACLS-accredited program directors in Texas. This includes nine university-based program directors and four hospital-based program directors. The 14 programs and directors are distributed throughout the state of Texas. This convenience sample was purposefully selected based on location and accreditation standards. Surveying program directors in Texas was more feasible than surveying a larger, more dispersed population. Since the NAACLS requires all accredited programs to adhere to a set of standard guidelines pertaining to coursework and clinical hours, this made the comparison of these programs more practical.

Instrumentation

Instrument #1

General information gathered from program websites was used to create comparison tables listing information in five categories for each of the CLS programs in Texas. This information was also requested on a survey sent to the 14 CLS program directors. The five categories included: location, maximum class size, number of affiliates, average BOC score for the past five years and overall and science GPA requirements. The tables consist of separate university-based and hospital-based program tables as well as a combined table (see Tables 1 – 3 in Appendix A). This quantitative information was used when comparing program structure to assess the status of CLS programs.

Instrument #2

The second instrument is a survey distributed to each of the 14 program directors (see Appendix B for survey questions). This survey was created and disseminated online using Qualtrics survey software. The use of an online survey made distribution convenient, and the results could be viewed and analyzed using the survey software. This survey contained 16 questions for both university-based programs and hospital-based programs. The information collected through this survey included director feedback about retention, recruitment and program barriers. This qualitative information was used to gather director insights regarding their program and the workforce shortage. Information was also requested to be used for Instrument #1.

Data Analysis

Average BOC exam scores were analyzed quantitatively using an independent samples t-test to determine if there was a significant difference between BOC exam scores for university-based and hospital-based programs. Survey responses were analyzed qualitatively to develop descriptions and observe emerging themes. Both types of results were interpreted through a qualitative lens that allows the study objective and research questions to be more effectively addressed.

The quantitative data collected for the comparison table required little analysis. Results are listed in their appropriate categories. Each student who completes the BOC exam receives a score on a scale of 0 to 1000. These scores are reported to the school or program from which the student graduated. A score of greater than 400 is considered passing. The average BOC exam score from the past five years for each of the 14 schools in Texas was requested. The average exam score from each school was used to calculate an average exam score for the two categories being studied: hospital-based vs. university-based programs. This average score was used to determine variance and standard deviation for the two groups. These values were used to perform the independent samples t-test. Two independent samples t-test analyses were conducted based on two different sets of mean scores. Both the unweighted and weighted averages were calculated and used to compare the difference in means, based on different sample sizes due to the low survey response rate (See Table 4 in Appendix A).

The survey responses were analyzed qualitatively by categorizing responses into themes. These themes are referred to throughout the paper when discussing the current

situation and suggestions for the future, as well as when comparing the two types of programs. Multiple survey questions had Likert-type scale responses. These responses included “Never” (1), “Rarely” (2), “Sometimes” (3), “Often” or “Most of the Time” (4), and “All of the Time” or “Always” (5). Responses that were ranked “Sometimes”, “Often”, “Most of the Time”, “All of the Time” or “Always” on these Likert-type scale questions were documented and the most common responses were recorded for each group. These common responses were then compared between the two groups and responses shared by both groups are referred to as common responses for the whole of the group. For questions allowing multiple answers without ranking, the responses identified by more than one director for each group and common between the two groups are also referred to as common responses for the whole. Responses to open-ended questions were analyzed to create themes and themes common between the two groups are referred to as common themes or responses.

This combination is the best possible methodology for this type of study as it combines definite numerical data along with director insight to give a well-rounded depiction of each program type. This study employed statistical analysis of numerical data using an independent samples t-test to determine significance, as well as categorized survey responses.

CHAPTER IV

RESULTS

Response Rate

Six of the 14 program directors asked to participate responded to the survey (43% response rate). Of these six, three were from university-based programs and three were from hospital-based programs. As there are nine university-based CLS programs in Texas, this resulted in a 33% response rate for university-based programs. Program directors from three of the five hospital-based programs responded resulting in a 60% response rate.

BOC Exam Scores

The five-year average of BOC exam scores for the university-based programs was 520.7 (SD = 72.45) and the average for the hospital-based programs was 609.0 (SD = 168.5). These values were used to perform an independent samples t-test to determine if there was a statistically significant difference between university-based and hospital-based BOC exam scores (see Table 4 in Appendix A). This test determined that there was not a significant difference between the means of the two groups, t (4) = -0.8341, p > 0.4.

Due to the low survey response rate and obtaining only one average score for each program, an independent samples t-test was also conducted using the weighted average for each program type. This weighted average simulated a larger sample size by taking into consideration the class size of each program. The five-year weighted average

of BOC exam scores for the university-based programs was 534.5 (SD = 53.54) and the weighted average for the hospital-based programs was 614.4 (SD = 132.9). Using these values, the t-test determined that there was a statistically significant difference between the means of the two groups t (201) = - 5.119, $p < 0.0001$.

University-based Programs

When asked to identify the barriers their program has encountered, the most common responses from university-based program directors were locating qualified instructors (67%) and lack of recognition of the CLS major (67%). Other barriers identified were gaining hospital affiliates (33%), placing all students for clinical rotations (33%), inadequate resources for research (33%), and inadequate support from university administration (33%). There were also other barriers identified through open-ended questions, including the CLS program being hidden in larger departments with other healthcare career degrees, issues associated with an administration that does not understand the complexity of the program or the training restraints, and trouble obtaining funding for research. Many possible solutions to these barriers were suggested in the open-ended format, including having faculty members from other departments recommend students for the CLS program, taking "at risk" students even if they are less likely to pass the BOC exam on the first try and growing the program's own faculty. When asked about what the program does for advertising and recruiting, responses ranked as "Always" included targeting other science majors (4.33 out of 5), recruiting at junior colleges (3.67 out of 5), and making sure the link for the CLS major is easily found on the school website (3.67 out of 5). Program directors were also asked why

their program does not accept more students. The top responses were an inability to place more students in clinical rotations (67%) and insufficient laboratory space for classes (67%). Other responses were a lack of funds to hire additional staff (33%) and a lack of qualified instructors to hire (33%). One program responded that they are able to accept all qualified students (33%). The most common response when asked how they have dealt with a lack of clinical rotation sites or staff was to provide online courses (67%), and other responses included actively seeking out hospital affiliates (33%) or that this was not a problem encountered by the program (33%).

Directors indicated that over the past five years, the greatest percentage of students in the program have transferred from another science major (65%). The next highest percentage are students that started as a CLS major (13.33%), then students using the major to fulfill requirements for a further degree (11.67%) or students who transferred from a non-science major (10%). Responses regarding the student to teacher ratio for CLS classes showed that the approximate ratio is 20:1 (33%) or greater (67%). One-hundred percent of program directors also indicated that the number of applicants over the past five years has increased. Program directors were also asked about the employment history of their students upon graduation. The responses showed that "Most of the Time" students find a job at a hospital affiliated with the university (3.67 out of 5) or one of the hospital's satellite locations (4.0 out of 5). Students have also been hired at both local and non-local hospitals that are not affiliated with the program (3.5 out of 5) and that some students pursue an unrelated career (2.67 out of 5) or continue to further their education (3.0 out of 5).

Open-ended questions were also used to ask directors about their specific programs. When asked to identify key factors used when explaining the necessity or assets of their program to university administrators, the program directors listed using employment history for students following graduation, explaining how the requirements for student laboratory skills must meet entry-level requirements for rotations and having graduates in the community become teachers for new CLS students. When asked how their program was started, some directors responded that the program started as a hospital-based program that was eventually moved to the university. Directors also responded that working with other science departments and developing new and flexible options has helped their program to remain viable.

The program directors were also asked about the CLS workforce shortage in Texas. The most common response as to the cause of this shortage was the salary difference between clinical laboratory scientists and other health care professionals (100%), followed by a lack of job recognition (67%), ineffective recruitment (67%) and a lack of advancement opportunities (33%). When asked what would be most helpful in reducing the workforce shortage in Texas, responses included more advancement opportunities (33%), recognition of the program and the service CLS provides to the community (33%), and providing "bridge" programs for clinical laboratory technicians to become clinical laboratory scientists (33%).

Hospital-based Programs

When asked to identify the barriers their program has encountered, the most common response from hospital-based program directors was locating qualified

instructors (67%). Other barriers identified were decreased funding/budget cuts (33%), inability to train more than 4 to 5 students per year (33%), and finding clinical instructors or working around technologist's schedules (33%). Responses to an open-ended question yielded possible solutions to these barriers such as attending university fairs and increasing the laboratory size or the number of full-time employees to handle the increased workload. When asked about what the program does for advertising and recruiting, responses ranked as "Always" included offering tours for interested high school or college students (4.0 out of 5), attending college fairs (3.33 out of 5) and making sure the link for the CLS major is easily found on the hospital website (5.0 out of 5). Program directors were also asked why their program does not accept more students. The responses were an inability to place more students in clinical rotations (33%), insufficient laboratory space for classes (33%), not enough full-time employees to act as bench instructors (33%) and a lack of funds to hire additional staff (33%). The most common responses when asked how they have dealt with a lack of clinical rotation sites or staff was to divide clinical rotations among multiple hospitals (33%) and provide incentives for clinical instructors (33%). Other responses included only accepting a few students each year (33%) or that this was not a problem encountered by the program (33%).

Directors indicated that over the past five years, the greatest percentage of students in the program are 3 + 1 CLS majors (61.67%) and the next highest percentage is 4 + 1 CLS majors (38.33%). Responses regarding the student to teacher ratio for CLS classes include a 5:1 ratio (67%) and a 10:1 ratio (33%). All program directors also

indicated that the number of applicants over the past five years has increased (100%). Program directors were also asked about the employment history of their students upon graduation. The responses showed that "Most of the Time" students find a job at the program's base hospital (4.0 out of 5). Students have also been hired at satellite hospitals (2.67 out of 5), other local hospitals (2.33 out of 5), non-local hospitals (3.67 out of 5), or they may continue to further their education (2.67 out of 5), pursue an unrelated job (1.0 out of 5) or be unable to find a job (1.0 out of 5).

Open-ended questions were used to ask directors about their specific programs. When asked to identify key factors used when explaining the necessity or assets of their program to hospital administrators, the program directors listed hiring graduates for the base and satellite hospitals and providing opportunities for Continuing Education for bench technologists. When asked how their program was started, one response was that the program started as a university-based program that was moved to the hospital as staff members desired more control over program procedures. Other responses included initiation by the Clinical Pathology department of the hospital due to a need for technologists in the area.

The program directors were also asked about the CLS workforce shortage in Texas. The most common response as to the cause of this shortage was the salary difference between clinical laboratory scientists and other health care professionals (100%), followed by a lack of job recognition (67%), too few CLS programs (67%) and a lack of advancement opportunities (67%). When asked what would be most helpful in

reducing the workforce shortage in Texas, responses included more advancement opportunities (67%) and having more CLS programs in Texas (33%).

CHAPTER V

DISCUSSION

The purpose of this study was to assess the current status of CLS programs in Texas by comparing program structure and analyzing program director opinions. After recording the responses provided by the directors of both university-based and hospital-based programs, it is important to explore the responses that were common between the two groups as these might identify the most difficult barriers or the most effective solutions regarding CLS education. The common barriers identified by both university-based and hospital-based program directors were locating qualified instructors, finding clinical instructors, working around technologists schedules and a lack of recognition of the major or profession. The inability to find instructors is not a surprising finding given the current CLS workforce shortage, and these barriers are supported by evidence presented in the literature (Beck & Doig, 2007; McClure, 2009). While clinical instructors are not required to have any additional training, instructors hired by university-based programs must meet the faculty requirements of the university, which may make the search for qualified instructors more difficult. Both the university and hospital groups suggested increasing the laboratory size and number of full-time employees in order to handle the student load as possible solutions to the barriers identified. In regards to advertising and recruiting, the responses common to both groups were attending job fairs or college fairs and ensuring that the link to the major or program is easily found on the appropriate website. Due to the lack of recognition of the

profession, both of these responses are important tactics that can be used to increase knowledge of the career. Attending job or college fairs can increase the visibility of the profession or major, and a clearly visible link can encourage exploration by interested students.

When asked why their program does not accept more students, the common responses between university-based and hospital-based program directors included an inability to place more students at clinical rotation sites, insufficient laboratory or classroom space for classes and a lack of funds to hire additional staff. Both types of programs are affected by a lack of resources necessary for growing their program. Despite the number of common problems between the groups, there were no common solutions to dealing with the lack of clinical sites or staff.

Hospital-based program directors indicated that over the past five years, the most common type of students enrolled in their program were 3 + 1 CLS majors. These are students who have completed the prerequisite coursework at an affiliated hospital and are now enrolled in a hospital-based program to complete the clinical portion of their degree. The most common type of students for university-based programs over the last five years are students who transfer to the CLS major from another science major. This finding supports the known lack of recognition of the major or profession by suggesting that students might have started as a CLS major if they were aware of the option. This also highlights the need for program directors to talk to other science department faculty and career counselors at the high school and college level in order to raise awareness of the profession and major.

When comparing the actual structure of university-based and hospital-based programs, there are few similarities between the factors of interest for this study. Class sizes and number of affiliates are larger for university-based programs, but the overall and science GPA requirements are similar for both types of programs. There is also a larger student to teacher ratio for the university-based programs that correlates to the larger class sizes. Both program types indicated an increase in the number of applicants over the past five years. While this is a positive finding, the lack of resources needed by both program types to increase the number of students that they are able to accept might result in programs not being able to take advantage of this increase in applicants.

Another factor to consider when comparing university-based and hospital-based programs is the average BOC exam score. To compare the difference between these scores, an independent samples t-test was performed using the average BOC exam score for the past five years from each program. This t-test was performed twice using both the normal, unweighted averages for each program type and the weighted averages based on maximum class size (see Table 4 in Appendix A). The two t-tests yielded differing results. Both of these results have been included due to the possibility of each being true. The first, unweighted t-test showed that there was not a statistically significant difference between the average exam scores for the two program types. This has positive implications for CLS education by suggesting that students are equally well-prepared for the BOC exam regardless of the type of program from which they graduate. The second, weighted t-test showed that there was a statistically significant difference between the average scores. In this scenario, students from the hospital-based programs

performed better overall on the BOC exam in the last five years than students from university-based programs. This could be due to smaller class sizes, the setting of the classes or the amount of time that the students are enrolled in the program. This second t-test was included to show what the results might look like if a larger data set had been collected from the program directors. However, there is no definite way to prove from this data that the hospital-based programs performed better overall than the university-based programs. Both scenarios provide an additional measure to compare and contrast the two program types.

Upon graduation, both program types indicated that students are most likely to find a job at the program's base hospital, a hospital affiliated with the program or a satellite location of these hospitals. This is an encouraging finding considering the employment history of graduates was identified as a key factor for justifying program usefulness to administrators. Hiring graduates was the only common response between groups when asked what assets of the program they point out to university or hospital administration. While this was the only common response, it is an important one as programs are producing the technologists needed in their area and also producing possible future faculty or clinical instructors for their program.

The survey included a question asking directors how their specific program was initiated. The only common response was that the program had started as the opposite type before moving to its current group, and while this is an interesting finding, it does not provide any helpful suggestions for the creation of future programs. The responses given by each type of program, however, can provide possible suggestions for the

creation or continuation of new programs in the future. The directors of university-based programs responded that their program has continued to remain successful by working with the other science departments to encourage CLS and maintaining flexibility while developing new options for learning. One of these options indicated by university-based program directors is the use of online courses. Considering that the university-based programs are able to accept more students, this could be an option that hospital-based programs could consider as a way to increase their attendance capability. The university-based programs might also consider some of the ways that the hospital-based programs have dealt with the lack of training sites or staff, such as providing incentives for the clinical instructors at their affiliated hospitals. In order to address the CLS workforce shortage in Texas, program directors should consider all options that have had a positive response.

In response to the question regarding the largest contributors to the CLS workforce shortage in Texas there were multiple common responses between the university and hospital groups, including salary differences between clinical laboratory scientists and other health care professionals, a lack of job recognition and a lack of advancement opportunities within the laboratory. The common response regarding what would be most helpful in reducing the workforce shortage was increased advancement opportunities for clinical laboratory scientists in the laboratory. These three responses are common themes in the area of CLS and the workforce shortage. As outlined by both Beck and Doig (2007) and McClure (2009), these themes are common to both CLS students and recently graduated employees. In order to address the current and growing

CLS workforce shortage, these are concerns that should be addressed by program directors and brought to the attention of university and hospital administrators.

There are multiple other results identified in this study that are supported by the body of knowledge concerning CLS education and the workforce shortage. Decreased funding and budget cuts (NAACLS, 2009), a decrease in the number of clinical laboratory scientists in the laboratory (Beck & Doig, 2007), lack of recognition of the profession (McClure, 2009) and issues regarding student recruitment (Garcia & Fisher, 2013) were all identified by this survey and supported by evidence found in the current literature. This study supports these previously identified barriers to CLS education, but simply identifying the issues is not the only objective of this study. In order to address how the state can produce enough clinical laboratory scientists to reduce the workforce shortage gap, the solutions to these barriers must also be explored. There was only one solution identified by program directors that was supported by evidence presented in the literature. Targeting STEM students and students with corresponding science or healthcare interests was a response common to both university-based and hospital-based programs. This was a suggestion made by the ASCP Task Force on the Laboratory Professionals Workforce (2013) in regards to addressing the lack of recognition of the profession. While there was only one common answer between the two groups, the responses given by each director could be useful to other directors in regards to student recruitment. Responses such as talking to career counselors, providing laboratory tours for interested students and attending fairs or conferences to increase visibility were

identified by directors as possible recruitment tactics that could help to increase awareness of the clinical laboratory science career.

Another possible recruitment tool is the comparison table created for this study. This table identifies a few of the attributes of the 14 NAACLS-accredited CLS programs in Texas. This table could be used by both types of program directors as well as career counselors to show students the options available and the similarities and differences between the types of programs. While the purpose of this study is to provide basic knowledge about the status of the state's programs in order to guide further study and future improvement efforts, this table can be a tangible product of the study that can be used to further student recruitment.

Limitations

The limitations of this study with the greatest potential impact are the small sample size and low survey response rate. There was only a 42.8% overall response rate, and responses were not distributed equally between the groups (33.3% for university-based and 60% for hospital-based). The sample population was also not randomly selected. These factors limit the ability of the study to make broad generalizations about this population, but possible solutions and helpful insights from program directors may still be identified without having to apply to the entire group.

Other limitations include the time limit imposed on the study, which may have caused participants to feel pressure to finish or prevented them from finishing. A fear of identification by the responses provided and possible repercussions could have influenced the information given or the willingness to respond at all. Directors were also

limited to choosing the responses provided when there was not a free text option. These limitations may have a potential impact on the results of this study, but do not exclude the study from reporting useful results.

Delimitations

This study was limited to only NAACLS-accredited CLS programs and their directors in the state of Texas. This delimitation resulted in a small sample population, but was more feasible than surveying all directors nationwide and provided answers from both university-based and hospital-based programs. The survey also included multiple Likert-type scaled responses rather than multiple open-ended questions in order to encourage participation.

CHAPTER VI

CONCLUSIONS

This study was concerned with assessing the current status of CLS programs in Texas by comparing university-based and hospital-based programs, investigating what types of barriers these programs face and using this information to provide suggestions as to how the state can reduce the current CLS workforce shortage. Many comparisons were made between the two program types, and the similarities reinforce the findings of previous studies regarding the barriers to CLS education and the CLS profession, such as a lack of recognition of the profession, a general lack of funds and a lack of advancement opportunities. The differences between the two types of programs can be viewed as possible new strategies for recruitment and retention based on the successes of other programs. Both the university-based and hospital-based programs have found strategies that work for them, and this study will allow each type to learn from the other in order to work together to reduce the CLS workforce shortage by continuing to produce new CLS graduates.

There are many future implications for the results obtained from this study. The purpose of this study was to provide basic knowledge about the status of the state's programs in order to guide further study and future improvement efforts. A next step in the development of this type of information would be to compare the results from the state of Texas with results from programs nationwide. A more focused study could also be performed to explore only university-based or hospital-based programs. A study with

a larger population pool or better response rate would yield more generalizable data or data that is more easily compared. The small amount of previous research in this area leaves a wide range of opportunities for future study.

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APPENDIX A

TABLES

Table 1 University-based Programs

University-Based Programs	Class Size	Number of Affiliates	Average BOC Score	Overall/Science GPA
1	18	7	N/A	2.0/2.0
2	30	12	N/A	2.0/2.5
3	24	18	N/A	2.5/2.8
4	90	62	504	2.0/2.0
5	20	N/A	N/A	2.5/2.5
6	70	25	600	2.5/2.5
7	30	N/A	N/A	2.5/2.5
8	20	28	N/A	2.5/2.5
9	24	6	458	2.5/2.5

Table 2 Hospital-based Programs

Hospital-Based Programs	Class Size	Number of Affiliates	Average BOC Score	Overall/Science GPA
10	8	4	583	2.75/2.5
11	6	1	789	2.5/2.5
12	5	1	455	2.5/2.5
13	20	1	N/A	2.5/2.5
14	4	5	N/A	N/A

Table 3 University and Hospital Comparison

	Number of Programs	Average Class Size	Average Number of Affiliates	Average BOC Score	Average Overall/Science GPA
University-Based Programs	9	36	23	520.7	2.3/2.4
Hospital-Based Programs	5	9	2	609.0	2.5/2.5

Table 4 T-test Comparison

	University-based Programs			Hospital-based Programs		
Assigned Program Numbers	6	9	4	10	11	12
Max. Class Size	70	24	90	8	6	5
5-yr. Avg. Exam Score	600	458	504	583	789	455
Unweighted Program Average	520.7			609.0		
N	3			3		
t	-0.8341					
p	0.4511					
Weighted Program Average	534.5			614.4		
N	184			19		
t	-5.119					
p	< 0.0001					

APPENDIX B

SURVEY

Q1 Please click the link below to read the consent form before deciding if you wish to participate in this study.

Q2 If you agree to be in this study, please click "Yes" to begin the survey. If you do not wish to be in this study, please click "No".

- ❍ Yes (1)
- ❍ No (2)

Q24 Are you the director of a university-based or hospital-based program?

- ❍ University-based program (1)
- ❍ Hospital-based program (2)

Q2 Identify the barriers your program has encountered? (Please check all that apply.)

- ☐ Gaining hospital affiliates (1)
- ☐ Placing all students for clinical rotations (2)
- ☐ Locating qualified instructors (3)
- ☐ Keeping qualified instructors (4)
- ☐ Decreased funding/budget cuts (5)
- ☐ Lack of recognition of major (6)
- ☐ Finding qualified students (7)
- ☐ Inadequate resources for research (8)
- ☐ Inadequate support from university administration (9)
- ☐ Other (If other, please specify.) (10) _____

Q32 What are possible solutions to any of the barriers identified?

Q3 Indicate how often you utilize each of the following to advertise and recruit for your program.

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	All of the Time (5)
Link to major is easily found on college website (1)	❍	❍	❍	❍	❍
Job fairs (2)	❍	❍	❍	❍	❍
Recruiting at junior colleges (3)	❍	❍	❍	❍	❍
Targeting local high school students (4)	❍	❍	❍	❍	❍
Targeting STEM students (5)	❍	❍	❍	❍	❍
Targeting other science majors (biology, chemistry, microbiology, etc.) (6)	❍	❍	❍	❍	❍
Talking to career counselors about recommending the major (7)	❍	❍	❍	❍	❍
CLS students have a group	❍	❍	❍	❍	❍

or club that advertises during fundraisers or projects (8)					
Posters or other advertisements used where most science classes are held (9)	❍	❍	❍	❍	❍

Q4 Why does your program not accept more students? (Please check all that apply.)

- ❑ Small number of applicants (1)
- ❑ Few qualified applicants (2)
- ❑ Lack of funds to hire additional staff (3)
- ❑ Lack of qualified instructors to fill openings (4)
- ❑ Inability to place more students at clinical rotation sites (5)
- ❑ Insufficient classroom or laboratory space to accommodate more students (6)
- ❑ No desire to increase size of program (8)
- ❑ Other (If other, please specify.) (7) _____

Q5 What are some of the ways you've dealt with the lack of training sites or staff?

(Please check all that apply.)

- ❑ Provide on-line courses (1)
- ❑ Actively seek out new hospital affiliates (2)
- ❑ Provide incentives for new instructors (3)
- ❑ Provide incentives for affiliated labs (4)
- ❑ Increase hands-on training in classroom labs in place of time in hospital labs (5)
- ❑ Other (If other, please specify.) (6) _____

Q7 For the past five years, what is the approximate proportion of each type of student?

_____ Started at the university as a CLS major (1)

_____ Transferred to CLS from another science major (2)

_____ Transferred to CLS from a non-science major (3)

_____ Used CLS degree to fill requirements for a further degree (MD, PA, PT, DDS, etc.) (4)

Q26 Please provide the following information:

Maximum Program Class Size (1)

Number of Hospital Affiliates (2)

Overall GPA Requirement (3)

Science GPA Requirement (4)

Q27 For the past five years, what is the average ASCP Board of Certification exam score?

Q28 What is the approximate student to teacher ratio for didactic courses within the program?

- 5:1 (1)
- 10:1 (2)
- 15:1 (3)
- 20:1 (4)
- Greater than 20:1 (5)
- Other (If other, please specify.) (6) _____

Q8 The number of applicants over the past five years has

- ❍ Decreased (1)
- ❍ Stayed the same (2)
- ❍ Increased (3)

Q9 Upon graduation, how common is it for your students to:

	Never (1)	Rarely (2)	Sometimes (3)	Most of the Time (4)	Always (5)
Find a job at a university-affiliated hospital (1)	❍	❍	❍	❍	❍
Find a job at a satellite of an affiliated hospital (2)	❍	❍	❍	❍	❍
Find a job at a local, unaffiliated hospital (3)	❍	❍	❍	❍	❍
Find a job at a non-local, unaffiliated hospital (4)	❍	❍	❍	❍	❍
Be unable to find a job (5)	❍	❍	❍	❍	❍
Pursue an unrelated job (6)	❍	❍	❍	❍	❍
Continue further education full-time (7)	❍	❍	❍	❍	❍

Q34 When explaining the necessity or assets of your program to university administrators, what are the key factors you refer to? Is there anything specific that you've found especially helpful or persuasive during these conversations?

Q35 How did your program get started? Who was involved? How have you continued to secure your place at the university?

Q10 What do you think are the largest contributors to the workforce shortage in Texas? (Please check top 3)

- ❑ Lack of job recognition (1)
- ❑ Lack of advancement opportunities (2)
- ❑ Salary differences compared to other health care professionals (3)
- ❑ Unequal geographic distribution of CLS programs (4)
- ❑ Ineffective recruitment (5)
- ❑ Too few CLS programs (6)
- ❑ Decreased interest in science-related majors (7)
- ❑ Other (If other, please specify.) (8) _____

Q11 Which of the following would be most helpful in closing the workforce shortage gap in Texas?

- ❍ Providing "bridge" programs for technicians to become technologists (1)
- ❍ More advancement opportunities within the hospital (2)
- ❍ More CLS programs in Texas (3)
- ❍ Less rigorous certification processes (4)
- ❍ Other (If other, please specify.) (5) _____

Q12 Identify the barriers your program has encountered? (Please check all that apply.)

- ❑ Gaining university affiliates (1)
- ❑ Placing all students for clinical rotations (2)
- ❑ Locating qualified instructors (3)
- ❑ Keeping qualified instructors (4)
- ❑ Decreased funding/budget cuts (5)
- ❑ Lack of recognition of profession (6)
- ❑ Finding qualified students (7)
- ❑ Finding clinical instructors (bench techs) or working around tech schedules (8)
- ❑ Inadequate support from hospital administration (9)
- ❑ Other (If other, please specify.) (10) _____

Q36 What are possible solutions to any of the barriers identified?

Q13 Indicate how often you utilize each of the following to advertise and recruit for your program.

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	All of the Time (5)
Link to program is easily found on hospital website (1)	❍	❍	❍	❍	❍
Job fairs (2)	❍	❍	❍	❍	❍
College fairs (3)	❍	❍	❍	❍	❍
Targeting local high school students (4)	❍	❍	❍	❍	❍
Targeting STEM students (5)	❍	❍	❍	❍	❍
Offering tours	❍	❍	❍	❍	❍

for interested high school or college students (6)					
Talking to career counselors at affiliated universities about recommending the program (7)	❍	❍	❍	❍	❍
Attending conferences and conventions to increase the visibility of your program (8)	❍	❍	❍	❍	❍
Posters or other advertisements used in the hospital (9)	❍	❍	❍	❍	❍

Q14 Why does your program not accept more students? (Please check all that apply.)

- ❑ Small number of applicants (1)
- ❑ Few qualified applicants (2)
- ❑ Lack of funds to hire additional staff (3)
- ❑ Lack of qualified instructors to fill openings (4)
- ❑ Inability to place more students in clinical rotations (5)
- ❑ Insufficient classroom or laboratory space to accommodate more students (6)
- ❑ No desire to increase size of program (8)
- ❑ Other (If other, please specify.) (7) _____

Q15 What are some of the ways you've dealt with the lack of training sites or staff?

(Please check all that apply.)

- ❑ Provide on-line courses (1)
- ❑ Divide clinical rotations among multiple hospitals (satellites, other local hospitals, private labs, etc.) (2)
- ❑ Provide incentives for classroom instructors (3)
- ❑ Provide incentives for clinical instructors (4)
- ❑ Increase hands-on training in classroom lab in place of time in hospital lab (5)
- ❑ Other (If other, please specify.) (6) _____

Q17 For the past five years, what is the approximate proportion of each type of student?

_____ 3+1 CLS major (1)

_____ 4+1 Science major (2)

_____ 4+1 Other major (3)

Q29 Please provide the following information:

Maximum Program Class Size (1)

Number of Clinical Rotation Sites (2)

Overall GPA Requirement (3)

Science GPA Requirement (4)

Q30 For the past five years, what is the average ASCP Board of Certification exam score?

Q31 What is the approximate student to teacher ratio for didactic courses within the program?

- ❍ 5:1 (1)
- ❍ 10:1 (2)
- ❍ 15:1 (3)
- ❍ 20:1 (4)
- ❍ Greater than 20:1 (5)
- ❍ Other (If other, please specify.) (6) _____

Q18 The number of applicants over the past five years has

- ❍ Decreased (1)
- ❍ Stayed the same (2)
- ❍ Increased (3)

Q19 Upon graduation, how common is it for your students to:

	Never (1)	Rarely (2)	Sometimes (3)	Most of the Time (4)	Always (5)
Find a job at your hospital (1)	❍	❍	❍	❍	❍
Find a job at a satellite hospital (2)	❍	❍	❍	❍	❍
Find a job at a different local hospital (3)	❍	❍	❍	❍	❍
Find a job at a non-local hospital (4)	❍	❍	❍	❍	❍
Be unable to find a job (5)	❍	❍	❍	❍	❍

Pursue an unrelated job (6)	❍	❍	❍	❍	❍
Continue further education full-time (7)	❍	❍	❍	❍	❍

Q20 What do you think are the largest contributors to the workforce shortage in Texas?

(Please check top 3)

- ❑ Lack of job recognition (1)
- ❑ Lack of advancement opportunities (2)
- ❑ Salary differences compared to other health care professionals (3)
- ❑ Unequal geographic distribution of CLS programs (4)
- ❑ Ineffective recruitment (5)
- ❑ Too few CLS programs (6)
- ❑ Decreased interest in science-related majors (7)
- ❑ Other (If other, please specify.) (8) _____

Q21 Which of the following would be most helpful in closing the workforce shortage

gap in Texas?

- ❍ Providing "bridge" programs for technicians to become technologists (1)
- ❍ More advancement opportunities within the hospital (2)
- ❍ More CLS programs in Texas (3)
- ❍ Less rigorous certification processes (4)
- ❍ Other (If other, please specify.) (5) _____

Q22 When explaining the necessity or assets of your program to hospital administrators, what are the key factors you refer to? Is there anything specific that you've found especially helpful or persuasive during these conversations?

Q23 How did your program get started? Who was involved? How have you continued to secure your place in the hospital?