Predictors of Success on the MLT and MLS Board of Certification Exam

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ABSTRACT

The American Society for Clinical Pathology Board of Certification (BOC) is a final determinant of competency and a benchmark standard for medical laboratory technician (MLT) and medical laboratory sciences/scientist (MLS) program accreditation. Thus, enrolling students who are likely to pass the BOC exam is crucial for university programs. Four years of graduate data from one university with accredited MLT and MLS programs were retrieved. Correlations were conducted between BOC scores and preadmission grade point average (PA-GPA), mode of instruction (online vs face to face), and years to graduation. Age at graduation and sex were also considered in the analysis. Of 437 graduates, 205 were MLT students (116 online and 89 face to face), and 232 were MLS students (151 online and 81 face to face). MLS students were required to have an MLT degree from any National Accrediting Agency for Clinical Laboratory Science–accredited institution prior to admission into the MLS program. Stepwise linear regression analysis revealed PA-GPA as the most influential predictor of BOC scores in both the MLT ($r = .490, n = 205, p < .001$) and MLS programs ($r = .313$, $n = 232$, $p < .001$). Sex demonstrated an unexpected statistically significant correlation at the MLS level, revealing higher scores in male students. Negative, nonstatistically significant correlations were seen between BOC scores and age and years to degree completion. A positive nonstatistically significant correlation was seen favoring face-to-face students. Institutions should consider PA-GPA a primary screening tool for program admission.

ABBREVIATIONS: ASCP - American Society for Clinical Pathology, BOC - Board of Certification, MLS - medical laboratory sciences/scientist, MLT - medical laboratory technician, NAACLS - National Accrediting Agency for Clinical Laboratory Science, PA-GPA - preadmission grade point average.

INDEX TERMS: clinical laboratory sciences, medical laboratory sciences, education, certification.

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INTRODUCTION

Medical laboratory technicians (MLTs) and medical laboratory scientists (MLSs) play a crucial role in patient diagnosis and treatment. The Board of Certification (BOC) exam serves as a final determinant of competency for MLT and MLS graduates and a principal measure in accreditation of university programs.[1] As such, higher-education institutions are tasked with enrolling student who meet criteria for admissions and are likely to successfully finish a program and pass the certification exam. The National Accrediting Agency for Clinical Laboratory Science (NAACLS) requires programs to meet or exceed a 3-year average pass rate of 75% or higher within 1 year of graduation.[2]

Although many students successfully graduate, not all are able to pass the BOC exam. This constitutes a significant problem given the weight of the BOC in security of employment and maintenance of program accreditation. Thus, it is pertinent to analyze some of the factors that may influence pass rates prior to admitting students into a program. Preadmission grade point average (PA-GPA) is a common screening tool. However, when assessing successful passing of certification and licensure exams in the health professions, including MLT and MLS, most studies primarily consider graduation GPA and science GPA. A gap in the literature demonstrates a need to correlate PA-GPA with national certification/licensure exam success.

Thus, more research specific to MLT and MLS programs is needed.

Studies in the health professions demonstrate the influence of GPA in certification and licensure exams. In nursing, a retrospective analysis of campus students at a bachelor level, all with a cumulative GPA of 2.5 or above at program completion, showed that students with GPAs higher than 3.5 were 167 times more likely to pass the corresponding national exam on the first attempt.[3] Another study of 55 nursing students with a preadmission science GPA between 3.0 and 4.0 found a GPA of 3.43 or above predicted successful graduation but did not predict first-time pass rates in the nursing licensure exam.[4] In MLS, a higher science PA-GPA correlates with higher first-time BOC pass, whereas nonscience GPA demonstrated a lower correlation.[5] In addition to PA-GPA and science GPA,

graduation GPA has also been found to be a significant predictor of BOC scores.[6]

Although GPA is a common determinant of academic success, factors such as demographics, time lapse to completion, and delivery mode also warrant consideration. Currently, there are over 200 MLT and MLS programs in the United States accredited by NAACLS, with more than 30 that offer hybrid or fully online degrees.[2] Research shows that clinical skills can be acquired virtually as effectively as they can in traditional face-to-face education.[11] Thus, educational choices in MLS continue to expand into online delivery to help meet the increased demand for laboratory professionals in rural areas.[1] Consequently, whether a student graduates from a face- to-face or a hybrid/online program may be an influential factor. Findings from a retrospective study of face-to-face students who took the BOC exam between 2006 and 2015 demonstrated a positive correlation between a comprehensive exam and BOC scores.[10] Additionally, admissions data from 117 online students and 115 traditional students from the same MLS program unveiled a positive correlation between graduation GPA and BOC scores, with a stronger correlation observed in students taking courses online.[5]

Regarding time to graduation, a higher cumulative GPA is a significant predictor of on-time graduation.[7] In MLS cohorts, students who graduated on time had higher GPAs preadmission, compared with students who were dismissed or delayed in graduation.[8] In terms of BOC exam success, no current studies were found specifically evaluating time to graduation and BOC pass rates. However, an evaluation of over 9000 BOC scores in MLS showed higher scores in graduates who took the exam no later than 90 days after graduation.[9]

In nursing, no significant differences in age, gender, and student success were found in traditional vs online students.[13] However, the same study showed that face-to-face students finished at a significantly faster pace and were generally younger than online students.[13] In web- based courses, female students received higher grades than male students.[14]

Regardless of GPA, demographics, delivery method, and time lapse to graduation, all graduates are held to the same standards of employment eligibility: completion of an accredited MLT or MLS program followed by American Society for Clinical Pathology (ASCP) certification as an MLT or MLS.

MATERIALS AND METHODS

The purpose of this retrospective study was to evaluate 4 years of data of graduates from an MLT and MLS NAACLS-accredited university program in the Midwest, with a goal to update preadmission criteria based on previous trends. Correlations determined the relationship between BOC scores and PA-GPA, mode of instruction, and time lapse to degree completion. PA-GPA was of primary concern given the relatively low (2.5) overall PA-GPA acceptance requirement. Yearly program reviews revealed a trend of lower BOC pass rates at the MLS level that warranted investigation. Mode of instruction and time lapse to completion were also explored to determine other reasons for the trend besides PA-GPA. A project proposal was evaluated and approved by the university's institutional review board prior to data retrieval. Both programs were offered in the same academic institution. For the MLT program, students may have matriculated directly from high school or during their sophomore year of college. For the MLS program, students had successfully completed an MLT in the same institution or in another NAACLS-accredited institution, along with MLT certification by ASCP. Students completing the degree online, whether it be MLT or MLS, were required to complete rotations face to face in their geographical region, whereas all didactic content was taken online.

Sample Description

Five-hundred ninety-nine students graduated with associates and/or bachelor's degrees in MLS between August 15, 2015 and August 15, 2019. Excluded from the pool of participants were 133 students who had not taken the corresponding BOC exam at the time of data retrieval, 16 who took the BOC exam more than 1 year after graduation, and 5 who had no record of program start date. According to Laerd Statistics, multiple regression can be performed only on data that meet assumptions of homoscedasticity, multicollinearity, and leverage points and lack highly influential points.[15] If assumptions are violated, corrections need to be made to the data, or another statistical test must be used.[15] In the study, 8 participants demonstrated values that were flagged as highly influential during assumptions testing in SPSS. To facilitate regression analysis, the 8 participants were excluded. After exclusions, 437 graduates were included in the study, of which 205 were MLT graduates and 232 were MLS graduates. Students included in the study took the corresponding BOC exam (MLT or MLS) within 1 year of graduation.

Figure 1 shows a breakdown of each program by mode of instruction. Of the MLT graduate pool, 116 received the degree online and 89 were traditional face-to-face students. Of the MLS graduate pool, 81 were traditional students and 151 graduates received the degree online.

Students completing the program online were required to complete rotation face to face in their state of residence, usually in their place of employment or another affiliated clinical laboratory.

Demographics in Table 1 show student age range was broadest at the MLT level, with students ranging from 19 to 60 years old at the time of graduation. The median ages of students in the face- to-face and online MLT program were 23 and 31, respectively. The MLS program had a median age of 25 for face-to-face students and 34 for

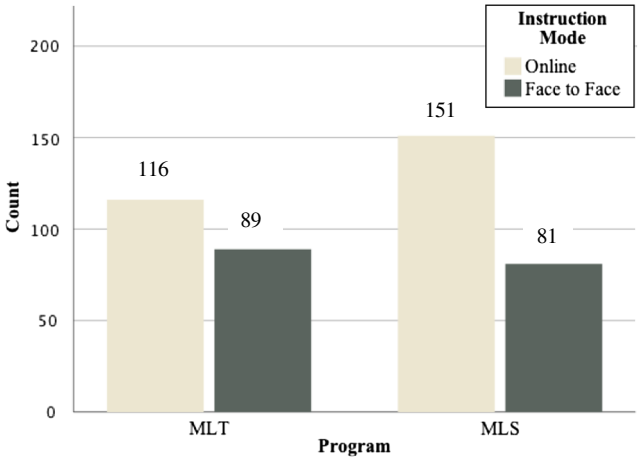

Figure 1. **Participant count by program and instruction mode $N = 437$.**

those online; the latter encompassed the oldest group of participants. Although Hispanic and Asian graduates were present in both programs and modes of instruction, most were Caucasian.

Data Collection and Analysis

The PA-GPA used in the study was the overall GPA on the student record at the time of program application for MLT or MLS. Years to completion were calculated per program, counting days to completion between the first MLS course and graduation. Days were converted into years in Microsoft Excel. Participants were categorized into online and face to face as recorded in graduation records. Age at graduation and sex were also recorded and added to the analysis. Age at graduation was calculated in Microsoft Excel by subtracting the a student's date of birth from the date at graduation. Sex was recorded as male or female as reported by students and stored in university records.

To align with NAACLS accreditation benchmarks, first-year BOC scores were evaluated but not first-time scores. For participants who took the exam more than once, the BOC score of the last attempt within 1 year of graduation was recorded. Each BOC score was recorded as a numeric continuous variable. Statistical analysis was performed by program (MLT and MLS), as each degree has individual certification requirements. BOC scores were compared to 3 main predictors: PA-GPA, time to degree completion, and instruction mode (online vs face to face). Multiple stepwise linear regression using SPSS determined a model of predictors that best forecasted BOC scores. Pearson correlations further assessed relationships between BOC scores and each predictor alone. Because PA-GPA was found to be the strongest predictor, correlations for the remaining variables were conducted controlling for PA-GPA.

RESULTS

Preadmissions Grade Point Average

Regression and Pearson correlation results are displayed in Tables 2 and 3, respectively.

At the MLT level, PA-GPA demonstrated a statistically significant, positive correlation with BOC scores ($r = .490$, $n = 205$, $p < .001$). In the MLS program, a 2-step model also revealed a statistically significant, positive correlation ($r = .313$, $n = 232$, $p < .001$). Sex was included in the model

Table 1. **Participant demographics by program and instruction mode ($N = 437$)**

		Program			
		MLT ($n = 205$)		MLS ($n = 232$)	
		Face to Face	Online	Face to Face	Online
Sex	Male	45	23	44	31
	Female	44	93	37	120
Race/ethnicity	White/Caucasian	70	90	66	115
	Black or African American	0	6	1	7
	Native Hawaiian or other Pacific Islander	0	1	0	1
	Asian	3	5	5	14
	Hispanic	6	6	5	6
	American Indian or Alaska native	0	2	0	1
	Unknown	10	6	4	7
Age at graduation	Median	23	31	25	34
	Minimum	19	21	21	22
	Maximum	44	60	39	58

Participants graduated from 1 or both MLS programs, using either face-to-face or online delivery. AAS, Associate of Applied Science; BS, Bachelor of Science; MLS, medical laboratory sciences/scientist; MLT, medical laboratory technician.

Table 2. Stepwise linear regression

			Unstandardized Coefficients		Standardized Coefficient				
Program	*Step*	*Predictor*	*B*	*SE*	*Beta*	R_2	R_2 *change*	*F*	*p*
MLT $n = 205$	1	(Constant)	127.142			.240	.240	64.244	<.001
		PA-GPA	132.180	16.491	.490				
MLS $n = 232$	1	(Constant)	196.298			.098	.098	24.992	<.001
		PA-GPA	73.986	16.893	.276				
	2					.128	.030	16.753	.006
		Sex	34.283	12.293	.176				

Dependent variable = BOC score, measured as a continuous, scale variable. SE = standard error of B. 0 = female; 1 = male. PA-GPA = continuous scale variable from 0.0–4.0.

Table 3. Pearson correlations between predictor variables and BOC scores

Program	Predictors	Pearson Correlation	BOC Score
MLT $n = 205$	PA-GPA*	Pearson correlation	.490
		p	.000
	Instruction mode	Pearson correlation	.308
		p	.068
	Years to graduation	Pearson correlation	–.172
		p	.181
	Age at graduation	Pearson correlation	–.131
		p	.370
	Sex	Pearson correlation	.165
		p	.086
MLS $n = 232$	PA-GPA*	Pearson correlation	.313
		p	.000
	Instruction mode	Pearson correlation	.181
		p	.362
	Years to graduation	Pearson correlation	–.010
		p	.914
	Age at graduation	Pearson correlation	–.138
		p	.202
	Sex*	Pearson correlation	.234
		p	.006

*Correlation with BOC score is significant at the ($p < .05$) (2-tailed).

as a significant predictor and showed a statistically significant positive correlation ($r = .234$, $n = 232$, $p < .001$) demonstrating higher scores in the male student population.

As demonstrated by the R^2 change (Table 2), PA-GPA accounted for 24% of the variance in BOC scores for MLT and 9.8% of the variances of BOC scores for MLS.

Time to Degree Completion

In the MLT program, a negative correlation was found between years to graduation and BOC scores, but the correlation was not statistically significant ($r = –.172$, $n = 205$, $p = .181$). The MLS program also showed a negative, nonstatistically significant correlation ($r = –.010$, $n = 232$, $p = .914$).

Instruction Mode

At the MLT level, a positive correlation between instruction mode and BOC scores was seen in favor of face-to-face students. The correlation was not statistically significant ($r = .308$, $n = 205$, $p = .068$). A positive, not statistically significant correlation was also seen in the MLS program ($r = .181$, $n = 232$, $p = .362$).

Demographic Variables

Age at Graduation

Negative correlations between age and BOC scores were seen in both programs.

Correlations were not statistically significant at the MLT level ($r = –.131$, $n = 205$, $p = .370$) or at the MLS level ($r = –.138$, $n = 232$, $p = .202$).

Sex

In the MLT program, there was a positive correlation between sex and BOC scores favoring male students. After controlling for PA-GPA, the correlation was not statistically significant ($r = .165$, $n = 205$, $p = .086$). At the MLS level, sex was included as a predictor in the regression model showing a positive correlation that was statistically

significant ($r = .234$, $n = 232$, $p < .001$), also favoring male students. The correlation remained statistically significant after controlling for PA-GPA ($r = .234$, $n = 232$, $p < .005$).

DISCUSSION

PA-GPA

MLT and MLS programs are tasked with preparing students to enter the workforce and relieve the shortage of laboratory personnel in the health care field. At the same time, programs must meet rigorous accreditation standards, among which are BOC pass rates. The results of this analysis suggest that PA-GPA is the most valuable predictor of BOC scores at both the MLT and MLS levels. The influence of PA-GPA was expected, as similar results were seen in the nursing and MLS fields.[3,5] This finding provides a foundation on which to base criteria for admission.

Historically, the study institution's MLS program has enrolled online students with lower GPAs (as low as 2.0) to expand the student pool and relieve the widespread shortage of laboratory professionals. Although it is not the norm to accept students with GPAs under 2.5 in the study institution, exceptions to this rule have historically allowed educational opportunities for students who work in entry-level laboratory positions and demonstrate ample experience and good work ethic. Such students may not be scholastically inclined and may not have previously considered a college education but are often loyal and come highly recommended by their employers who can offer full clinical support. Although it is rewarding to provide such educational opportunities through flexible preadmission criteria, it is also crucial to consider the requirement for these students to pass the BOC.

When applying the stepwise regression model in Table 2 to the study institution, minimum PA- GPAs of 2.8 for MLT and 3.6 for MLS guarantee a score of 450 or above on the BOC (passing score is 400 or above). However, it is important to consider that this is not a perfect model, as in this study PA-GPA accounted for 24% of the variance in BOC scores for MLT and 9.8% of the variances of BOC scores for MLS. Regardless, the statistically significant correlation between PA-GPA and BOC scores suggests the use of PA-GPA as a primary admission tool, as the correlation demonstrates that BOC scores increase as PA-GPA increases. In terms of pre admission criteria, incremental increases in PA-GPA requirements may be necessary, particularly in programs approaching substandard pass rates on the BOC. In fact, the findings of the current study prompted an increase of the PA-GPA requirement from 2.5 to 2.75 in both programs in the study institution.

Time to Degree Completion

A negative correlation was noted between years to degree completion and BOC scores. The lack of statistical significance may be attributed to the way years-to-graduation were documented in the study. Time to degree completion was underestimated in both programs, as each participant's timeframe began with the enrollment date in the first MLT or MLS course, with no regard to courses taken prior to program admission, such as science courses. The timeframe limitation is especially noteworthy at the MLS level, as most students in the MLS program took science prerequisites during or prior to the MLT program. Nevertheless, limiting the timeframe to only MLT or MLS courses allowed for consistency given the diversity of students, locations, and timing of non-MLT/MLS courses in their education. Unfortunately, no current studies were found evaluating time to graduation and BOC pass rates. However, a faster trajectory to graduation is desirable, as passing BOC scores are more likely in graduates who take the exam no later than 90 days after graduation.[9]

Instruction Mode

Instruction mode and BOC scores demonstrated a nonsignificant correlation favoring traditional face-to-face education. These findings opposed some of the literature that found online students in MLS scored higher than their traditional counterparts.[5] The results were attributed to online students' increased ability to handle pressure because of maturity and experience level.[5] In contrast, higher BOC scores noted in face-to-face students in the study institution may have resulted from stricter preadmission requirements currently in place in the campus program, particularly PA-GPA. In addition, MLS campus students seem to face fewer family, work, and life demands than online students. It is important to note that research suggests that online and traditional education are equally effective, even when teaching clinical skills.[11] Thus, university programs should continue to offer online instruction in MLS, as it is a way to relieve the personnel shortage and reach students in rural areas lacking MLS programs.

Demographics

The finding of male students obtaining significantly higher scores than females was unforeseen and contradicted the findings in the literature.[14,15] Historically, female students outnumber male students in the programs evaluated. This occurrence may be due to premedical students in the campus program who use MLS as a degree of choice prior to applying to medical school.

Traditionally, premedical students at this institution are high-achieving, predominantly male students in the MLS campus program.

STUDY LIMITATIONS

This study was performed at a single institution and did not address all areas of interest and potential BOC influencers, such as science GPA and graduation GPA.

The regression model, although helpful, is not flawless. In the MLS participant pool, there was no categorization between students pursuing an MLS as a premedical track and students seeking the degree as a career.

Furthermore, we made no delineation between students who completed both programs (MLT and MLS) in the same institution where the study took place, vs completing the MLT years prior in another institution before enrolling in the MLS program. Given that completion of an MLT program is a prerequisite for admission to the MLS program in the study institution, completion of both degrees (MLT and MLS) in the same university vs completion of the MLT in another institution may be an influential factor at the MLS level and an interesting factor to consider in a future study. Other future studies should target time to completion and BOC scores as well as correlations between low PA-GPA (under 3.0) and BOC scores, as the reasons for low PA-GPA may vary greatly per student.

CONCLUSION AND IMPLICATIONS FOR PRACTICE

Adequate preparation in MLT and MLS programs comes from didactic education and proficiency in clinical skills. BOC pass rates provide a basis for program accreditation and a comprehensive measure of a student's education and work readiness. As such, screening of student applicants in MLT and MLS programs deserves careful consideration. University programs should continue to offer education in a variety of formats, encourage timely graduation, and advise graduates to take the BOC exam soon after graduation. As a suitable predictor of BOC scores, PA-GPA should be used as a primary screening component to ensure student readiness for the program and increased likelihood of passing the BOC while continuing to meet ongoing benchmarks for program accreditation.

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