

# Medical Laboratory Science Graduate Management Curriculum Development Using Managerial Survey Responses

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## ABSTRACT

A Midwestern medical laboratory science program conducted an online survey to assess current perception of supervisors/leads and managers/directors of their educational preparedness to perform 30 managerial tasks. The purpose of the survey is to collect data that will be used as one of the resources in developing the Master of Medical Laboratory Science (MMLS) curriculum. Results from the survey indicated that one-third or more felt at least well-prepared to perform training and monitor quality while greater than one-third felt at least not very well-prepared to perform other managerial tasks. These tasks included negotiating contracts, other finance tasks, and human resources (HR) tasks such as interviewing applicants, hiring employees, writing job descriptions, and evaluating employee performance. Other tasks that respondents felt not well-prepared to perform were preparation for laboratory inspection/assessment as part of regulatory compliance tasks, equipment performance, monitoring, method validation, interdisciplinary team participation, and managing projects. Investigators also surveyed managers/directors regarding their perceived and expected preparedness of newly hired/recently promoted managers to perform the same tasks. For all 30 tasks, expectations were higher than perceived performance.

**ABBREVIATIONS:** ASCLS - American Society for Clinical Laboratory Science, ASCP - American Society for Clinical Pathology, BOC - Board of Certification, BS - Bachelor of Science, CLMA - Clinical Laboratory Management Association, CE - continuing education, CLS - clinical laboratory science, HR - human resources, LIS - laboratory information system, MLS - medical laboratory science, MMLS - Master of Medical Laboratory Science, NAACLS - National Accrediting Agency for Clinical Laboratory Sciences, SOP - standard operating procedure, SWOT - strengths, weaknesses, opportunities, and threats.

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**INDEX TERMS:** clinical laboratory science, clinical laboratory management, curriculum, education, management education, medical laboratory science, management education.

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## INTRODUCTION

A Midwestern, 3 + 1, university-based, medical laboratory science (MLS) program is developing a Master's degree in Medical Laboratory Science (MMLS). In deliberating the emphasis of the MMLS degree program curriculum, MLS administration, faculty, and current practitioners concluded that laboratory management was the appropriate focus. This decision was based in part on anecdotal communications to program administration. Because of practitioner shortages, Bachelor of Science (BS) in MLS practitioners are promoted to managerial positions without sufficient management-related education, experience, or available mentoring. The Bureau of Labor Statistics projects a 14% growth in MLS workforce needs between 2016–2026<sup>1</sup> while the American Society for Clinical Pathology (ASCP) reported average clinical laboratory vacancies of 8.7%, with a 19.2% expected retirement rate between 2014–2019.<sup>2</sup> During this time, the expected retirement rate of administrative personnel will be higher than that for nonadministrative personnel.<sup>3,4</sup>

Although the Clinical Laboratory Management Association (CLMA) recognizes current personnel shortages and supports leadership development through education,<sup>5</sup> there are neither universally accepted accreditation nor professional organization MMLS references available to guide curricular development. When considering a BS of MLS-level management curriculum, routinely referenced resources do not provide clear direction as to what specific management-related content to include.<sup>6–8</sup> Inconsistent terminology among these routinely referenced resources may intensify this ambiguity. The National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) program accreditation standards require curricular inclusion of the following management-related topics: government regulations and standards, administration principles and practices, quality assurance/quality improvement principles and practice, and educational

methodologies.<sup>6</sup> The ASCP Board of Certification (BOC) MLS examination includes questions over quality assessment and troubleshooting, purchasing, inventory control, competency, education and communication, and laboratory information systems (LIS).<sup>7</sup> The ASCP Diplomate in Laboratory Management certification examination addresses financial, operations, personnel, and quality management, providing descriptions in the examination content outline.<sup>8</sup> Examples of management-related areas in the American Society for Clinical Laboratory Science (ASCLS) MLS entry-level curriculum include health care reform, regulations, general and financial management theory, information systems, and human resources (HR).<sup>9</sup>

In a 2007, an ASCLS white paper proposed a levels-of-practice model based on highest education obtained ranging from high school to doctorate. It indicated that at the Master's practitioner group, management and/or education skills are an additional focus. Suggested management skills for this practitioner group include compliance/coding/regulatory, quality management, risk/patient safety management, operations/business management, and technical management.<sup>10</sup> The primary purpose of this study was to examine clinical laboratory administrators' self-perception of their educational preparedness to perform 30 managerial tasks and their expected preparedness of newly hired/recently promoted managers. The 30 managerial tasks were categorized as finance, HR, quality, regulatory, equipment acquisition/validation, and other duty tasks. The resulting managerial perception data will be one resource to develop an MMLS degree program with a management focus; other resources include professional experiences as well as documents from the ASCLS BOC and NAACLS.<sup>6-8,10</sup>

## METHODS

Data for this Institutional Review Board-approved study were collected as part of a larger MLS practitioner, managerial-task performance, and self-reported task preparedness online survey. The Bureau of Sociological Research at a sister campus collaborated with investigators in developing survey questions and in administering the survey. When writing survey questions, investigators also consulted accreditation/professional organization documents, laboratory management course resources, and professional experiences of faculty with management experience. After beta-testing a cohort known to the authors, they surveyed a convenience sample of clinical laboratory practitioners over 4 weeks using purchased ASCP and CLMA email databases. Survey reminder emails were not sent because of additional costs associated with database use. Participants self-categorized using survey-provided definitions as either a manager/director, supervisor/lead, or staff MLS. This study focused on the manager/director and supervisor/lead responses. Participants self-reported how their formal education prepared them to perform

30 managerial tasks (ie, 5 = very well, 4 = well, 3 = somewhat well, 2 = not very well, 1 = not at all well, not applicable). The manager/director participants also reported the expected skill level (ie, 5 = very skilled, 4 = skilled, 3 = somewhat skilled, 2 = not very skilled, 1 = not at all skilled) and perceived preparedness level (ie, 5 = very prepared, 4 = prepared, 3 = somewhat prepared, 2 = not very prepared, 1 = not at all prepared) of the same tasks for newly hired/recently promoted laboratory managers under their supervision.

Prior to data analysis, investigators categorized tasks as education and training, finance, HR, quality, regulatory, other duties, and equipment acquisition/validation. Excel was used for initial mean determination. An analysis of variance (SAS version 9.4) determined the statistical significance among the educational groups for self-reported preparedness to perform the tasks ( $P < 0.05$ ). For overall statistically significant  $P$  values, pairwise comparisons were made among the educational groups using Turkey's adjustment for multiple comparisons. A 2-tailed t-test (SAS version 9.4) determined the statistical difference between managers'/directors' expected and perceived preparedness of newly hired/recently promoted managers to perform the 30 tasks ( $P < 0.05$ ).

## RESULTS

### Response Rate

The acceptable, comprehensive survey total response rate was 242 (3% overall response rate); acceptable surveys were finished in their entirety. Fifty-three respondents identified as a certified supervisor/lead MLS (ie, spends >50% of their time directly supervising other employees, with the primary function of assisting the clinical laboratory director/manager/section manager with day-to-day laboratory operations). One hundred twenty-three respondents identified as a director/manager (ie, oversees all the clinical laboratory/a laboratory section's operational aspects). The remaining 66 respondents were the focus of the staff-level survey.<sup>11</sup>

### Demographics

The 2 survey respondent subsets (supervisor/lead, director/manager) represented males and females living in rural and urban communities with 1 to >30 years of experience.

Respondents held a wide range of professional certifications, worked in various laboratory settings, and their education levels ranged from associate to doctorate degree (Table 1).

### Managerial Tasks

The survey asked managers/directors about expected and perceived preparedness of newly hired/recently promoted

Table 1. Demographics

		Supervisors/ Leads	Directors/ Managers
Gender	Male	15%	31%
	Female	85%	69%
Community	Rural (<50,000 people)	27%	33%
	Urban (>50,000 people)	73%	67%
Length of experience, y	0-<1	0%	0%
	1-2	2%	0%
	3-5	6%	2%
	6-10	13%	2%
	11-15	7%	5%
	16-30	32%	28%
	>30	40%	63%
Highest level of education	Associate's degree	6%	3%
	Bachelor's degree	81%*	69%**
	Master's degree	13%	25%
	Doctorate degree	0%	3%
Professional certifications held	MLT (ASCP) or CLT (NCA)	9%	3%
	MT/MLS (ASCP) + MLT (ASCP) or CLT (NCA)	2%	4%
	MT/MLS (ASCP), MT (AMT) or CLS (NCA)	61%	67%
	2 or more – MT/MLS (ASCP), MT (AMT), and CLS (NCA)	9%	3%
	2 or more – MT/MLS (ASCP), MT (AMT), and CLS (NCA) and ASCPSpecialist (SBB, SC, SH, or SM)	17%	16%
	CQA (ASQ) or CQIA (ASQ)	2%	1%
	DLM (ASCP)	0%	1%
	Board-certified pathologist	0%	2%
	Not certified	0%	3%
	Laboratory setting employed in the longest	Physician's office	0%
Hospital		81%	64%
Hospital and reference		11%	4%
Reference		2%	21%
Other		6%	4%

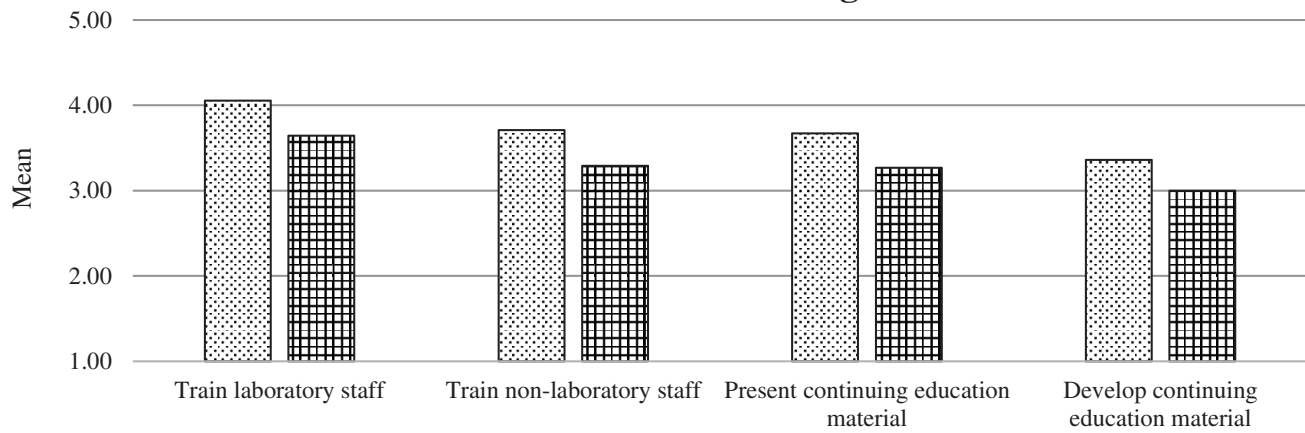
\*77% of these individuals earned their Bachelor's degree in CLS\*\*80% of these individuals earned their Bachelor's degree in CLS  
 AMT, American Medical Technologists; ASQ, American Society for Quality; CLT, Certified Logistics Technician; CQA, Certified Quality Auditor; CQIA, Certified Quality Improvement Auditor; DLM, Diplomate in Laboratory Management; MLT, Medical Laboratory Technician; MT, Medical Technologist; NCA, National Credentialing Agency; SBB, Specialist in Blood Banking Technology; SC, Specialist in Chemistry; SH, Specialist in Hematology; SM, Specialist in Microbiology

managers to perform managerial tasks (refer to the Methods section for respondent choices). For all task categories, managers'/directors' perceived preparedness of newly hired/recently promoted managers was lower than expected preparedness. The gap in the mean for all tasks was statistically significant ( $P < 0.05$ ). Hence, newly hired/recently promoted managers are not meeting administrative expectations (Figures 1 and 2).

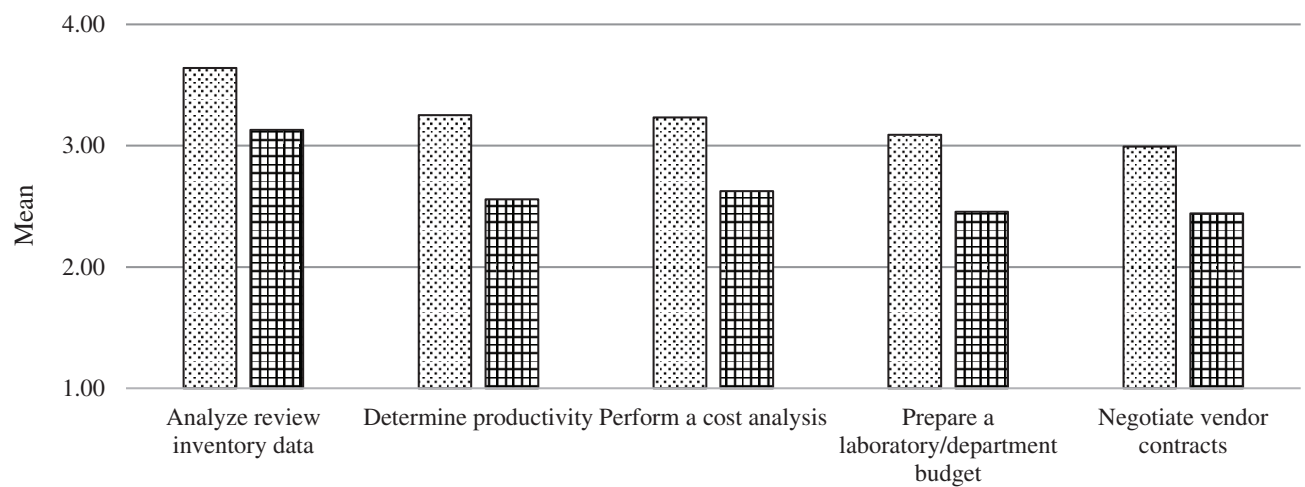
The survey asked managers/directors and supervisors/leads how well they felt their education prepared them to perform managerial tasks when they started their

first managerial position. Investigators sorted and analyzed by job category (ie, managers/directors and supervisors/leads) and level/category of education (ie, BS in Clinical Laboratory Science [CLS]; Bachelor of Art/BS or other/non-CLS Bachelor's degree; Master of Science in CLS/other Master's degree [nonbusiness]; Master's in Business/Management). Level/category of education data were neither further separated nor analyzed by job category. Associate and doctorate-level participants were excluded from analysis given very low respondent numbers and because degree specifics were not captured.

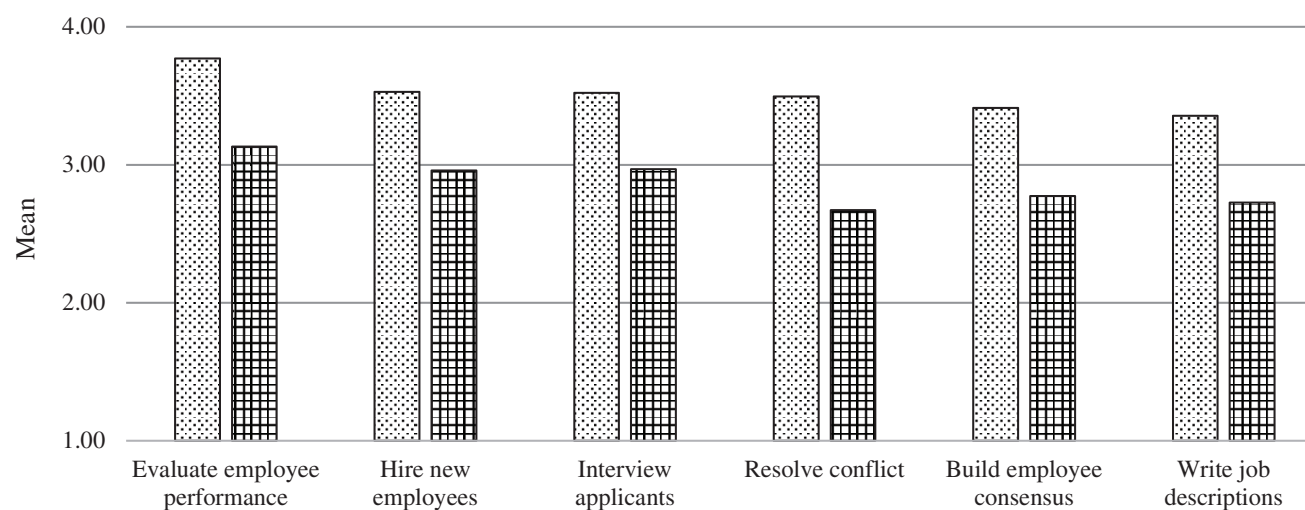
## Education and Training Tasks





## Finance Tasks

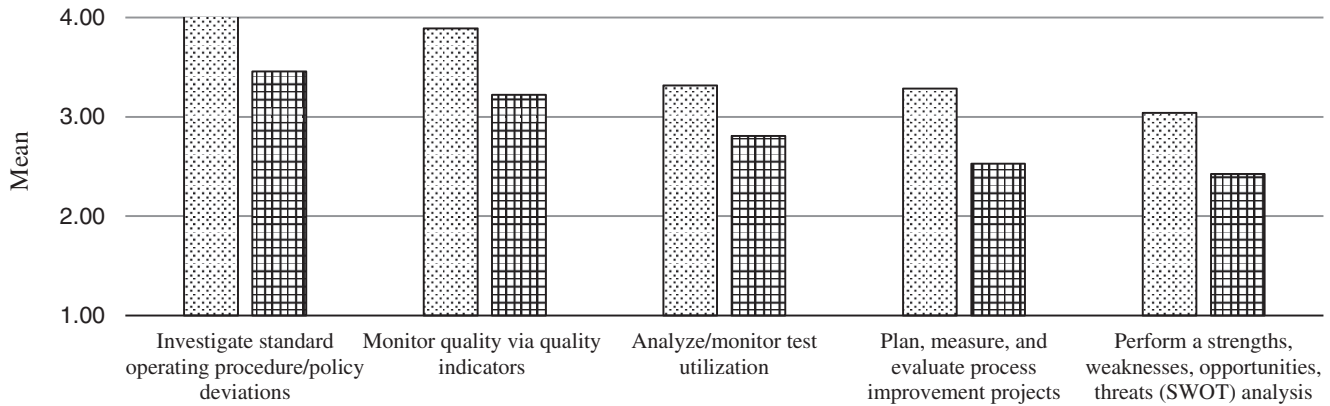


## Human Resource Tasks

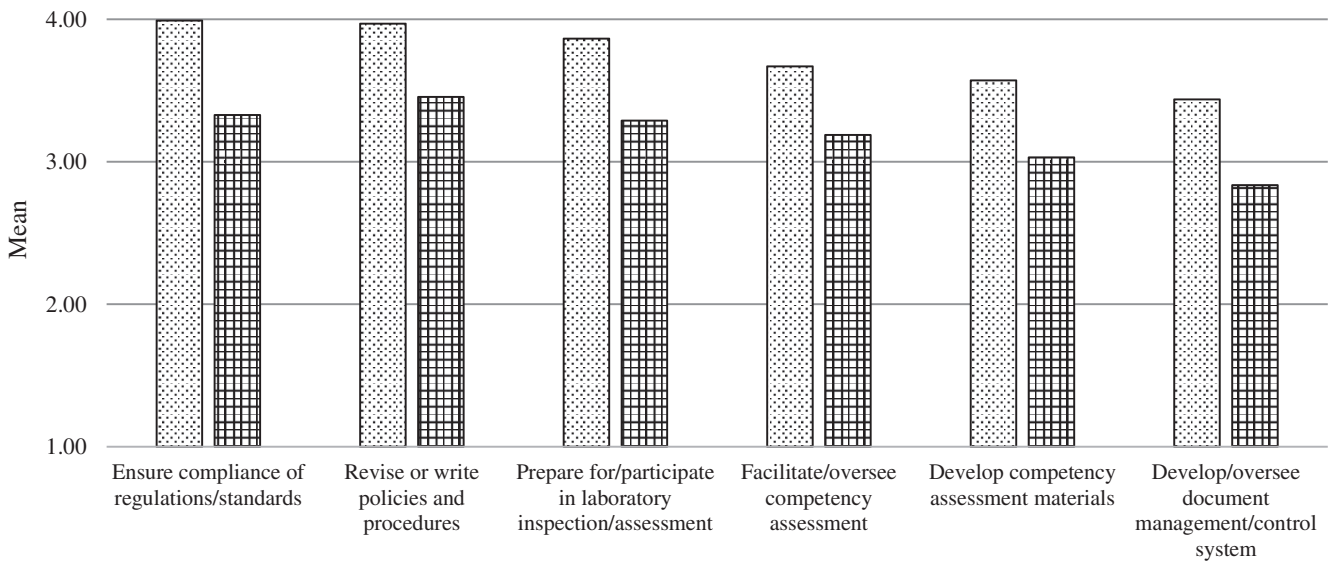


**Figure 1.** Managers'/directors' mean expected and perceived preparedness of newly hired/recently promoted managers to perform managerial tasks.  Mean Expected;  Mean Perceived.

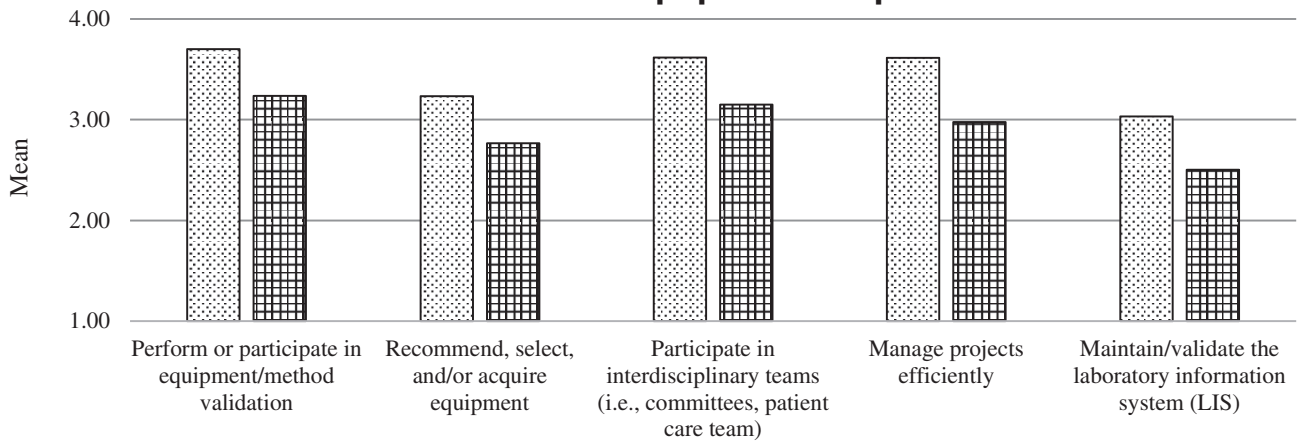
### Quality Tasks





### Regulatory Tasks



### Other Duties and Equipment Acquisition/Validation



**Figure 2.** Managers'/directors' mean expected and perceived preparedness of newly hired/recently promoted managers to perform quality, regulatory, other duties, and equipment tasks.  Mean Expected;  Mean Perceived.

## Education and Training Tasks

For the 4 education and training tasks, one-third to half of respondents in both categories felt at least not very well-prepared to develop continuing education (CE) material. For the laboratory and nonlaboratory staff training tasks, one-third to half of both categories of respondents felt at least very well-prepared to perform these tasks. When asked if they could present CE material, one-third to half of managers/directors felt at least very well-prepared to perform this task. Comparing the education levels/categories, respondents with a Master's degree in Business/Management felt the most prepared to perform these tasks (Table 2).

## Finance

Half or more of both respondent categories felt at least not very well-prepared to perform the 4 finance tasks (negotiate contracts, perform cost analyses, determine productivity, and prepare budgets). Comparing the education levels/categories, respondents with a Master's in Business/Management felt the most prepared to perform these tasks (Table 2).

## Human Resources

Half or more of both categories of respondents felt at least not very well-prepared to perform the 6 HR tasks (interview applicants, hire employees, write job descriptions, evaluate employee performance, build employee consensus, and resolve conflict). Comparing the education levels/categories, respondents with a Master's in Business/Management felt the most prepared to perform these tasks (Table 2).

## Quality

Of the 5 quality tasks, one-third to half of supervisors/leads felt at least not very well-prepared to investigate standard operating procedure (SOP)/policy deviations. In contrast, one-third to half of managers/directors felt at least very well-prepared to perform this task. For the task of monitoring quality via quality indicators (benchmarking), one-third to half of both categories of respondents felt at least very well-prepared to perform this task. For the remaining tasks (perform a strengths, weaknesses, opportunities, and threats (SWOT) analysis; analyze/monitor test use; and oversee process improvement), half or more respondents from both categories felt at least not very well-prepared to perform these tasks. Comparing the education levels/categories, respondents with a Master's degree in Business/Management felt the most prepared to perform these tasks (Table 2).

## Regulatory

Of the 6 regulatory tasks, one-third to half of supervisors/leads felt at least not very well-prepared to revise/write

policies/procedures. In contrast, one-third to half of managers/directors felt at least very well-prepared to perform this task. For the tasks of preparing for laboratory inspection/assessment and ensuring regulatory compliance, one-third to half of both categories of respondents felt at least not very well-prepared to perform these tasks. For the remaining tasks (develop competency assessment materials, facilitate competency assessments, and develop/oversee document management), half or more respondents from both categories felt at least not very well-prepared to perform these tasks. When comparing the education levels/categories, respondents with a Master's degree in Business/Management felt the most prepared to perform all regulatory tasks (Table 2).

## Equipment Acquisition/Validation and Other Duties

Equipment acquisition/validation tasks include selecting/acquiring equipment and performing equipment/method validation. Results showed that one-third to half of supervisors/leads and half or more of the managers/directors felt at least not very well-prepared to select/acquire equipment, and one-third to half of both categories of respondents felt at least not very well-prepared to perform this task. When comparing the education levels/categories, respondents with a Master's degree in Business/Management felt the most prepared to perform both equipment acquisition/validation tasks (Table 2).

Other duties include interdisciplinary team participation, managing projects, and maintaining/validating LIS. For the task interdisciplinary team participation, one-third to half of both categories of respondents felt at least not very well-prepared to perform this task. For the remaining tasks (manage projects and maintain/validate LISs), half or more of both categories of respondents felt at least not very well-prepared to perform either task. When comparing the education levels/categories, respondents with a Master's degree in Business/Management felt the most prepared to perform all 3 tasks (Table 2).

## DISCUSSION

### Initial Curriculum Development Considerations

When compared with the 3 other educational levels/categories, the Master's degree in Business/Management respondents self-reported being better prepared to perform finance, quality improvement/assurance and other administrative duty tasks ( $P < 0.05$ ). In addition, managers/directors' perceived preparedness of newly hired/recently promoted managers to perform all tasks was lower ( $P < 0.05$ ) than their expected preparedness. Therefore, newly hired/recently promoted managers are not meeting administrative expectations. As such, the

**Table 2.** Self-Reported Mean Preparedness to Perform Managerial Tasks Based on Education Level/Category

Master's in Business/ Management	MMLS +nonbusiness			Task	Category
	Master's degree	BA*/BS other	BS in CLS		
3.6	3.4	3.0	3.3	Train laboratory staff	Education and Training Tasks
3.5	3.1	2.8	2.9	Train nonlaboratory staff	
3.5	2.8	2.8	2.7	Develop CE material	
3.8	3.3	3.1	2.9	Present CE material	Finance Tasks
3.0	2.4	1.7	1.7	Negotiate vendor contracts	
4.0	2.9	2.1	2.1	Perform a cost analysis	
4.0	3.0	2.1	1.8	Prepare a laboratory or department budget	Human Resource Tasks
3.7	2.7	2.2	2.2	Determine productivity	
3.4	2.8	2.1	2.2	Interview applicants	
3.3	2.9	2.1	2.1	Hire new employees	Quality Tasks
3.5	2.6	2.3	2.2	Write job descriptions	
3.6	2.8	2.1	2.2	Evaluate employee performance	
3.5	2.5	2.2	2.1	Build employee consensus	Quality Tasks
3.2	2.5	2.1	2.2	Resolve conflict	
3.6	3.2	3.1	3.2	Monitor quality via quality indicators	
3.8	2.4	2.2	2.1	Plan, measure, and evaluate process improvement projects	Regulatory Tasks
3.8	3.0	2.8	3.2	Investigate standard operating procedure/ policy deviations	
3.2	2.6	2.4	2.4	Analyze/monitor test utilization	
4.2	2.7	2.0	1.9	Perform a SWOT analysis	Regulatory Tasks
3.4	2.5	2.5	2.5	Develop competency assessment materials	
3.5	2.7	2.6	2.4	Facilitate/oversee competency assessment	
3.6	2.9	2.7	2.8	Prepare for/participate in laboratory inspection/assessment	Other Duties and Equipment Acquisition/Validation
4.1	3.2	2.9	3.0	Revise or write policies and procedures	
3.5	2.3	2.5	2.5	Develop/oversee document management/ control system	
3.8	3.2	2.7	2.9	Ensure compliance of regulations/standards	Other Duties and Equipment Acquisition/Validation
3.2	2.5	2.7	2.4	Recommend, select, and/or acquire equipment	
3.4	2.7	2.8	2.8	Perform/participate in equipment/method validation	
4.2	3.0	2.8	2.7	Participate in interdisciplinary teams	Other Duties and Equipment Acquisition/Validation
3.0	2.2	2.0	1.9	Maintain/validate the LIS	
4.2	2.6	2.3	2.4	Manage projects efficiently	

\*BA, Bachelor of Arts.

30- credit MMLS program of study will include 15 hours of MLS program cross-listed courses (Table 3), 9 online graduate credits offered by the Business and Technology College at a sister institution, and 6 elective administration/education-focused graduate credits.

### Education and Training Tasks

Respondents' self-reported lack of preparedness to develop CE material indicates this topic should be included in the MMLS curriculum. The gap in the mean between managers'/directors' expected and perceived

**Table 3.** Proposed MMLS curriculum—draft student independent study plan**Completion of MLS Program = 28 undergraduate hours and 15 graduate hours**

<b>Course/Level</b>	<b>Credit (s)</b>	<b>Semester/Year</b>	<b>Example Graduate Application Project(s)</b>
Laboratory operations (U)	1	Summer/1	N/A
Introduction to chemistry/urinalysis (U)	1	Summer/1	N/A
Introduction to hematology (U)	2	Summer/1	N/A
Introduction to immunohematology (U)	2	Summer/1	N/A
Introduction to microbiology (U)	2	Fall/1	N/A
Clinical chemistry/urinalysis I (U)	2	Fall/1	N/A
Clinical hematology I (U)	2	Fall/1	N/A
Clinical microbiology I (U)	2	Fall/1	N/A
Clinical immunohematology I (U)	2	Fall/1	N/A
Clinical endocrinology & toxicology (U)	1	Fall/1	N/A
Clinical core laboratory practicum I (U)	1	Fall/1	N/A
Clinical microbiology practicum I (U)	1	Fall/1	N/A
Clinical immunohematology practicum I (U)	1	Fall/1	N/A
<b>Clinical immunology &amp; molecular diagnostics (G)</b>	2	Fall/1	Research paper w/molecular diagnostics focus
<b>Clinical laboratory management I (G)</b>	2	Fall/1	Case study paper w/ethics focus
<b>Clinical chemistry/urinalysis II (G)</b>	2	Spring/1	Poster project w/clinical chemistry focus
<b>Clinical hematology II (G)</b>	2	Spring/1	Case study paper w/hematology focus
<b>Clinical microbiology II (G)</b>	2	Spring/1	Educational e-learning module development w/microbiology focus
<b>Clinical immunohematology II (G)</b>	2	Spring/1	Evaluate immunohematology focused research paper
Clinical core laboratory practicum II (U)	1	Spring/1	N/A
Clinical microbiology practicum II (U)	1	Spring/1	N/A
Clinical immunohematology practicum II (U)	1	Spring/1	N/A
<b>Clinical laboratory management II (G)</b>	3	Spring/1	Write a clinical laboratory procedure
Clinical laboratory science theory, application, and correlation (U)	5	Spring/1	N/A
+			
<b>Required Graduate Courses Not Part of MLS Program</b>			
<b>Graduate Course</b>	<b>Credit (h)</b>	<b>Semester/Year</b>	<b>Example Graduate Application Project(s)</b>
<b>Health care management I: managing people effectively</b>	3	Fall/2	Semester project related to the clinical laboratory
<b>Fundamentals of funds management and financial decision making</b>	3	Fall/2	Semester project related to the clinical laboratory
<b>Health care management II: managing processes</b>	3	Spring/2	Semester project related to the clinical laboratory
<b>Elective (eg, management or education)</b>	3	Spring/2	
<b>Elective (eg, management or education)</b>	2	Spring or Fall/2	

G, graduate; U, undergraduate

preparedness to create CE material further supports inclusion of this topic. Preparedness data indicate respondents felt adequately prepared to train laboratory and nonlaboratory staff; hence, the MMLS curriculum does not need to

emphasize these tasks. Exclusion of training tasks is, however, debatable because the gap in the mean between managers'/directors' expected and perceived preparedness is statistically significant. Lastly, self-reported

preparedness data indicate managers/directors felt adequately prepared to present CE material; however, supervisors'/leads' data indicate inclusion of this task could be beneficial. The gap in the mean between managers/directors expected and perceived preparedness for this task further supports inclusion of this topic.

Based on the survey results, MMLS students should be exposed to the development and presentation of CE materials. These 2 topics will be included in the program's level-II theory courses. Students will develop a poster, a narrated slide presentation, and a case study with assessment questions. Because the BS-level curriculum already covers how to train staff, this topic will not be included in the MMLS curriculum. Ideally, students would develop an educational plan to train an individual at their clinical site. Unfortunately, given program time constraints and distance education logistical issues, inclusion is not feasible.

### Finance Tasks

Self-reported respondent preparedness to perform all 4 finance tasks and the gap in the mean between managers/directors expected and perceived preparedness indicate these topics should be included in the MMLS curriculum.

MMLS students will be required to complete a health care finance course offered through the College of Business and Technology at a sister campus. Covered topics include financial literacy, accounting and finance basics, financial diagnosis and problem solving, and financial operations/budgeting.

### Human Resources Tasks

Self-reported preparedness of respondents to perform all 6 HR tasks and the gap in the mean between managers/directors expected and perceived preparedness both indicate that these topics should be included in the MMLS curriculum. Therefore, MMLS students will be required to complete a health care management course that focuses on managing people; a sister campus currently offers this course. Covered topics include leadership, ethics, staffing, teamwork, communication, and performance management.

### Quality Tasks

Regarding performing a SWOT analysis, analyzing/monitoring test use, and overseeing process improvement, survey results and the gap in the mean between managers/directors expected and perceived preparedness for these tasks indicate that these topics should be included in the MMLS curriculum. The self-reported preparedness data also indicate that respondents felt adequately prepared to monitor quality via quality indicators. Although the curriculum does not need to emphasize this task, exclusion of this task is debatable because the gap in the mean between managers/directors expected and perceived preparedness for this task is statistically significant.

Similarly, inclusion of topics that describe how to investigate SOP/policy deviations in the curriculum could be beneficial even though the self-reported preparedness data indicate managers/directors felt adequately prepared to perform this task.

Based on the data analysis, MMLS students will be required to complete a health care management course that focuses on managing processes, which is offered through a sister campus. Covered topics include health services trends, health care operations strategy, problem solving and decision making, quality management, process improvement, and patient flow. Topics on scheduling and capacity management, supply chain management, health informatics, and improving financial performance with operations management will also be included.

### Regulatory Tasks

Management topics that would prepare managers/supervisors to perform regulatory tasks, such as how to prepare for laboratory inspection/assessment, ensure regulatory compliance, develop competency assessment materials, facilitate competency assessments, and develop/oversee document management, should be included in the MMLS curriculum based on the survey results. The self-reported preparedness data also indicate that managers/directors feel adequately prepared to revise or write policies/procedures; however, supervisors/leads data indicate inclusion of this topic could be beneficial.

At present, faculty are hesitant to include competency assessment material development for compliance purposes and facilitation of competency assessment in the MMLS curriculum because of program time constraints and curriculum focus. However, data analysis shows that MMLS students should be exposed to the development of competency assessment materials, facilitation of competency assessment, development/oversight of document management, laboratory inspection/assessment preparation, and regulations compliance. The MMLS curriculum will cover development/oversight in the previously mentioned health care management course that focuses on managing processes. In addition, the BS-level curriculum currently covers regulatory compliance and revising/writing policies/procedures. The MMLS-level curriculum will be supplemented with topics that cover writing laboratory procedures. The MMLS-level management II curriculum will also cover laboratory inspection/assessment preparation.

### Equipment Acquisition/Validation Tasks

Both the gap in the mean between managers/directors expected and perceived preparedness and self-reported preparedness by respondents indicate that selecting/acquiring equipment and performing equipment/method validation are topics that should be included in the MMLS curriculum.

Currently, the BS-level curriculum introduces these concepts and students complete a mock method evaluation; therefore, additional instruction/assessment over these topics will not be included in the MMLS curriculum at this time.

### Other Duties Tasks

Participation in interdisciplinary teams is one of the other tasks wherein data indicate that this topic should be included in the MMLS curriculum.

Whereas BS-level students are not formally taught about interdisciplinary team participation, they do participate in interprofessional (ie, pharmacy, nursing, medicine, or other allied health professions) education sessions. Additionally, MMLS students will learn to develop the skill of working in teams in the required health care management course that focuses on managing people. The required health care management course that focuses on managing processes will expose MMLS students to project management. Because LIS is facility-specific and a task that is considered beyond the scope of practice of an entry-level MMLS graduate, the topic on LIS maintenance/validation will not be included in the MMLS curriculum.

### Proposed MMLS Curriculum

The proposed Master's-level curriculum includes 15 undergraduate/graduate cross-listed MLS program credits and 15 graduate credits outside of the MLS program. For cross-listed courses, MMLS students will complete additional project-based/application assignments in addition to BS-level requirements. Application projects include a poster development/presentation, case study paper, review of research article, or other faculty approved projects (ie, developing an e-learning module, virtual microscopy). After completion of the NAACLS-approved curriculum that includes graduate-level, cross-listed courses, learners are eligible for certification. Learners can complete the remaining online, 15 graduate credits on a full- or part-time basis (Table 3).

### LIMITATIONS

The MLS program that performed this study will use this data as one resource for development of an MMLS program. The discussion neither includes consideration for 2 + 2 MMLS programs nor stand-alone MMLS programs. Also, respondents' geographic location is not included. In addition, the highest level of education attained of newly hired/recently promoted managers is not known.

### FUTURE RESEARCH

For graduate management curriculum development, a need exists to determine the frequency of managers' task performance. Lastly, at the national level, researchers recommend exploring the standardization of management-related terminology and content to help guide MLS educators in curriculum development at both the BS and MMLS levels.

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