ORIGINAL RESEARCH

Preparation for Clinical Laboratory Practice: A Practitioners' Point of View to Enhance Students' Experiences and Workforce Needs

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ABSTRACT

Effective communication is essential between clinical laboratory science (CLS) educators who prepare students for clinical practice experiences and clinical laboratory practitioners. The clinical practice experience is the primary pedagogy of CLS education. This study measured clinical laboratory practitioners' perceptions of student preparedness for the clinical practice setting. Participants (A-J)* were asked, "If you could suggest one thing to CLS educators to better prepare CLS students for clinical practice, what it would be?" Based on their feedback, brief pre- and post-surveys were administered to students in the CLS program at a Historically Black College/University (HBCU). Results were used to enhance student preparation for clinical practice by instituting curricular changes. Clinical Laboratory Science programs should consider continuous curricular changes based on ongoing assessments of changing workplace needs.

Keywords: clinical practice ▪ clinical laboratory science ▪ education ▪ communication ▪ Q methodology

*A-J are pseudonyms for participant responses

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INTRODUCTION

Clinical laboratory scientists are healthcare professionals who play an essential role in detection, diagnosis, and treatment of disease by performing laboratory tests on blood and other body fluids. They identify bacteria, parasites, fungi, and viruses; in dealing with such infectious and hazardous agents, they must work safely. They also analyze the chemical content of fluids, including blood glucose and cholesterol, type and cross-match blood for transfusions, and look for abnormal cells and clotting problems. They must pay close attention to specimens and sampling protocols to ensure high-quality results and evaluate those results to aid in their interpretation and correlation with disease states. Physicians depend on clinical laboratory scientists to determine and guide treatment for various ailments.

According to the US Department of Health & Human Services (2005), United States hospitals and other healthcare facilities face a critical shortage of clinical laboratory personnel. The shortage is nearly as severe as the well-publicized shortage of nurses (American Medical Technologists, 2003). Current trends indicate that 150,000 new clinical laboratory science professionals will be needed by 2016 of which 68,000 will be new positions (Coordinating Council on the Clinical Laboratory Workforce [CCCLW], 2009). To compound the escalating shortage, the average age of the laboratory workforce is around 50 (Bureau of Labor Statistics, n.d.; CCCLW, 2009). Approximately 100,000 clinical laboratory science professionals who entered the field in the 1970s and 1980s are approaching retirement age (Hecker, 2004). Some 40 percent of current laboratory professionals are project to retire in ten years (CCCLW, 2009).

Castillo (2002) identified the problem as the discrepency between the supply of new graduates and the number of vacant positions. Despite the near-crisis vacancy rates for clinical laboratory personnel over the past decade, the number of accredited programs has declined 71 percent since 1975, and many have closed (CCCLW, 2009). Everson (2004) reported that accredited CLS programs were graduating fewer than 5,000 a year, while over 9,000 were needed—a shortfall of 4,000 CLS graduates. Furthermore, minorities are not well represented in the profession (see Table 1).

Table 1. Race/ethnicity and sex of the laboratory science workforce and the US population in 2001

	Laboratory Workers		Population	
	Percent (%)	N	Percent (%)	N
Race/Ethnicity				
White, non-Hispanic	71%	372	74%	291,670
Hispanic/Latino	6%	30	10%	38,356
Black, non-Hispanic	15%	78	10%	41,348
Asian/Pacific Islander	7%	39	4%	16,213
Other	1%	3	2%	7,250

(continued)

Table 1. *(continued)*

	Laboratory Workers		Population	
	Percent (%)	N	Percent (%)	N
Sex				
Male	21%	110	48%	190,977
Female	79%	412	52%	203,860

Adapted from US DHHS (2005).

Communication between clinical laboratory professionals and clinical laboratory educators is vital in advancing the discipline. CLS students cannot complete their training without practical work experience to become effective and transition into the profession, and higher education institutions cannot offer an accredited program without clinical partners to provide student internships (Anderson, 2005). A decrease in clinical affiliate sites means fewer students are served; thus, fewer graduates are ready to enter the clinical laboratory workforce, causing a shortage of CLS professionals (Polansky, 2004).

How to structure the workplace to recruit and retain staff and how to transform educational programs to provide the workforce needed for the future must be addressed through a collaborative effort (American Hospital Association, 2002). Organizations that employ clinical laboratory professionals must communicate the competencies needed to address contemporary market needs to educators and educational policymakers (Davidson & Kimball, 2002).

Beck and Doig (2002) assessed laboratory managers and educators about the CLS work competencies expected at the entry and advanced levels. Both groups agree that clinical sites are essential for improving the quality of CLS education (Woeste, 2007), but they differed significantly in their perspectives on the adequacy of CLS programs in preparing students for careers in the laboratory. Managers did not agree that the content of current CLS curricula was adequate for the contemporary workplace, while educators thought it was. These conflicting viewpoints suggest continual communication between them is needed (Davidson & Kimball, 2002). To ensure that managers understand the scope and limits of the CLS curriculum and educators understand the real job expectations of CLS practitioners, research must be continually updated (Beck & Doig, 2002).

This study reports the results of these types of conversations, which are directly related to a presentation at the 2010 Clinical Laboratory Educators' Conference in Biloxi, Mississippi, The Wish List (McCauley, Ward, & White, 2010). This conference is the most important annual event for faculty, administrators, directors, and others in CLS education. We also assessed HBCU CLS students' perceptions to measure their attitude, enthusiasm, likelihood to ask questions, ability to think critically, and knowledge about the CLS profession before and after entering the CLS program.

METHODS

Q Methodology

Q methodology, a statistical approach to measure subjective feelings about a topic (Brown, 1992) was used to investigate and evaluate the viewpoints of CLS practitioners (n=52) about the preparedness of CLS students for clinical practice. In this case study, practitioners' perceptions of student preparedness for clinical practice were determined by asking them to rank on a scale from -3 (most disagree) to +3 (most agree) a group of work competencies (Q sample statements). Ideally, students are expected to have developed these competencies prior to entry-level practice as a CLS professional (see Table 2). Data were analyzed and interpreted using a statistical computer program for Q studies called PQMethod software, version 2.11 (Schmolck, 2002), and three distinct themes (affective, cognitive, and psychomotor) emerged.

Table 2. Q sample statements for CLS practitioners

1. Performs analytical tests accurately	15. Correlates clinical test result to the patient's
2. Describes principles and methodologies	16. Evaluates laboratory data to verify test results appropriately
3. Follows policies and procedures	17. Prepares reagents/media/blood products according to established procedures
4. Operates laboratory instrumentation condition	18. Identifies and distinguishes objects macroscopically and microscopically
5. Troubleshoots problems with test systems and instrumentation	19. Works safely with potential chemical, radiological, and biological hazards using standard precautions
6. Performs analytical tests in a timely manner	20. Evaluates data delta checks, technical limits, and critical values
7. Applies principles of current information systems	21. Demonstrates professional conduct and interpersonal skills with patients, laboratory personnel, other healthcare professionals, and the public
8. Calculates results from test data obtained from laboratory procedures	22. Applies knowledge to identify sources of error in laboratory testing
9. Performs collection, processing, and evaluation of appropriate specimens	23. Evaluates protocols, procedures, and critical pathways for laboratory
10. Troubleshoots quality control problems	
11. Follows procedures to maintain quality control and quality assurance	
12. Performs preventive maintenance	
13. Adheres to protocols for preventive maintenance	
14. Integrates data and recognizes discrepancies in of analytical tests patient results	

HBCU Student Survey Follow-up

Clinical laboratory scientists at an HBCU designed interventions from the practitioners' suggestions and implemented them for two semesters. Students were asked to answer the following questions about their experiences in the CLS professional program:

1. Rate your attitude before and after you entered the CLS professional program.
2. Rate your enthusiasm about clinical laboratory science before and after you entered the CLS professional program.
3. Rate your likelihood to ask questions before and after you entered the CLS professional program.
4. Rate your ability to think critically before and after entering the CLS professional program.
5. Rate your knowledge about what clinical laboratory scientists do before and after entering the professional program.

RESULTS

Three themes, categorized as affective, cognitive, and psychomotor competent, represented practitioners' distinct viewpoints on the entry-level workplace competencies that CLS student interns possessed. Their responses were gathered from open-ended questions asked in face-to-face interviews. Agreement with a certain theme indicated that CLS students demonstrated that learning domain and competencies. At the end of the interviews, practitioners were asked to share a suggestion, recommendation, or strategy with educators to help them better prepare students for the workplace. CLS educators can redesign program curricula based on the recommendations of clinical laboratory practitioners who directly train and observe the students during the clinical practical experience (internship). Redesigning the curriculum with a focus on areas in which practitioners expressed concerns will better prepare students with the affective, cognitive, and psychomotor skills needed for entry-level competency in the clinical laboratory workplace. Areas where practitioners unanimously agreed that students were strong should be maintained and/or improved (see Tables 3-5).

Table 3. Practitioners' consensus: Affective competence

No.	Statement	z-score	Rank Score
	Participants Agree		
19.	Works safely with hazardous material, uses std. precautions	1.836	+3
3.	Follows policies and procedures	1.716	+3
21.	Demonstrates professional conduct, interpersonal skills	1.544	+2
	Participant interview responses substantiating above statements:		
19.	Strongly emphasized in classroom and in general public		
3.	Students are accustomed to taking directions in the classroom		
21.	CLS educators instructed the students on professionalism		

(continued)

Table 3. *(continued)*

No. Statement	z-score	Rank Score
Participants Disagree		
10. Troubleshoots QC problems	-1.354	-2
14. Integrates data and recognizes discrepancies in results	-1.357	-3
5. Troubleshoots problems with test systems and instruments	-1.707	-3
Participant interview responses substantiating above statements:		
10. Students have theory of quality control but lack experience		
14. Students have book knowledge but can't correlate it with practical experience		
5. Troubleshooting instrumentation is acquired through practice, not an initial expectation		

$p<.01$

Table 4. Practitioners' specific concerns: Cognitive competence

No. Statement	z-score	Rank Score
Participants Agree		
15. Correlates clinical test results to the patient's condition	1.735	+3
2. Describes principles and methodologies of analytical tests	1.371	+3
16. Evaluates laboratory data to verify test results	1.270	+2
Participant interview responses substantiating above statements:		
15. Educators focused learning on correlating test results		
2. Students generally have good book knowledge		
16. Students use rote memory to learn test reference ranges and recognize deviations		
Participants Disagree		
13. Adheres to protocols for preventive maintenance	-1.292	-2
12. Performs preventive maintenance	-1.527	-3
14. Integrates data and recognizes discrepancies in patient results	-1.901	-3
Participant interview responses substantiating above statements:		
13. Practical experience necessary to develop skill for varied instrumentation		
12. Practical experience necessary to develop skill; however, educators must communicate importance of clean, well-maintained instruments		
14. Students have book knowledge but cannot correlate it with practical experience		

$p<.01$

Learning themes linked to clinical laboratory practitioners' feedback

Affective

Practitioners provided responses to the central questions related to the affective domain. Over all, they seemed to think that students' positive attitude and commitment to their work are

Table 5. Practitioners' specific concerns/sharply divided: Psychomotor competence

No.	Statement	z-score	Rank Score
	Participants Agree		
18.	IDs and distinguishes objects micro and macroscopically	2.446	+3
6.	Performs analytical tests in a timely manner (bipolar‡)	1.863	+3
4.	Operates laboratory instrumentation appropriately	1.188	+2
	Participant interview responses substantiating above statements:		
18.	Students learn in the didactic portion of school		
6.	Students can turn around tests in a reasonable time after initial training		
4.	High-tech laboratory instruments are user-friendly, operation learning curve short, younger students very proficient with computers		
	Participants Disagree		
17.	Prepares reagents, media, blood products correctly	-1.378	-2
21.	Demonstrates professional conduct, interpersonal skills (bipolar)	-1.411	-3
8.	Calculates results from test data from lab procedures	-1.421	-3
	Participant interview responses substantiating above statements:		
17.	Students do not know how to make dilutions or pipette		
21.	Students must develop work ethic, maintain a positive attitude, become a team player, and learn to accept constructive criticism		
8.	Students have trouble with lab math skills		

$p<.01$ except number 8, $p<0.5$ | ‡sharply divided viewpoints

essential. Some stated that students may be academically prepared but not eager to receive the necessary clinical instruction and experience. They felt that the students used proper safety protocols; were somewhat professional; but some students lacked the skills linked to trouble-shooting laboratory problems when encountered.

Wish 1: Adjust Attitudes

> "If there is one thing I would really like students to know when they come to a hospital setting is that attitude is everything. Most people that are training students have other work to do besides just training them. The laboratory is a very expensive place to be wasting time on students that are not interested or ready to learn" (Participant A). "They come in with this entire book portion, but too many times students will say, '... I know, I know.' They may have heard it, but they don't know it because they have no experience as a med tech [CLS]. This attitude turns off their instructor. Some students don't write any instructions down. They need to be ready to receive

instruction. The burden of learning is not on the technology training but on the students" (Participant B).

Wish 2: Inspire Motivation

"I especially want to see the younger students have enthusiasm for the profession, have excitement about their work. Part of it is to have a passion for what they are doing, and I am just not seeing that lately" (Participant C).

"[The] biggest change that I have seen over the last ten years is students just want to know how to do a job and get their grade, and they seem to not be interested or motivated by what they are doing. They do not ask enough questions. I don't mind if they do not know something; I really mind that they do not care to ask how or why. Write stuff down, bring a notebook, be curious, and drive me crazy with the why questions" (Participant D).

Cognitive

In relation to the cognitive domain, some practitioners replied that students may not have the necessary critical thinking skills or that these skills were not developed prior to the clinical experience. They provided some suggestions for improving students' critical thinking, which included activities and educator preparation. They stated that students should correlate test results to the patient's condition as opposed to displaying only "book" knowledge. They were particularly concerned that students had difficulty applying didactic information to clinical laboratory operations.

Wish 3: Improve Critical Thinking

"Students are used to there being one right answer, like on a test as opposed to other best alternatives. They think in black and white; [it is] hard for them to see the gray. Things in laboratory medicine are not always black and white" (Participant E).

"The critical thinking component is missing. Educators could use problem-based learning (PBL) techniques to sharpen critical thinking skills" (Participant F).

"Students need to visit a real laboratory to see what they signed up for before coming to their internship" (Participant G).

"Over time, educators lose sight of what the students really need to know before they come to clinical. It is important to have educators still working in the lab" (Participant H).

Psychomotor

In relation to the psychomotor domain, some practitioners replied that many students do not have the skills needed to perform some basic and specific daily operations in the laboratory, in-

cluding preparing reagents, media, and blood products. Some students were unable to calculate results when provided with the test data. A positive observation was that students were able to identify and distinguish objects microscopically and macroscopically. The students were able to perform analytical tests in a timely manner and operate laboratory instruments appropriately. Practitioners provided some suggestions for developing the students' psychomotor skills, which include practical skills and timing of these activities.

Wish 4: Enrich Practical Experiences

In evaluating students' psychomotor skills, practitioners thought that the didactic portion of the CLS program adequately taught students how to identify and distinguish clinical laboratory specimens using a microscope. Some believed that once students learned how to operate a particular instrument at the clinical site, they could perform analytical tests in a timely manner. The practitioners explained that most high-tech laboratory instruments are user-friendly, and students quickly learn how to run them appropriately.

Wish 5: Conduct a Preclinical Review

> "Too much time between learning a subject and coming to clinical. Students often say, 'I had that so long ago, I do not remember.' Need review of all departments with labs before getting here" (Participant I).

> "I suggest a refresher course before coming to clinical. It will put all of the pieces together for them. Good idea to focus on practical skills they will need, like pipetting, dilutions, differentials, urine microscopics, gram staining, among other lab tests" (Participant J).

HBCU Student Survey Findings

The data from the self-reported follow-up survey indicates an increase in attitude (15%), enthusiasm for the CLS program (17%), and likelihood to ask questions (27%). Notable percentage increases were observed for ability to think critically (125%) and knowledge about what CLS professionals do (250%) (see Figure 1).

DISCUSSION

Through their assessments of CLS student competencies, laboratory practitioners implied that educators must add practical applications, so students will be able to troubleshoot quality-control problems, integrate test data, and recognize discrepancies in test results. Some practitioners believe that the time between didactic coursework and practical training needed for the clinical practice experience is too long. Often students tell them that they do not remember vital course content. Practitioners recommended offering a refresher course before students come to the clinical practice site. Educators could focus on practical skills, such as pipetting, making dilutions, performing blood smear differentials and urine microscopic examinations, and evaluating gram-stained smears.

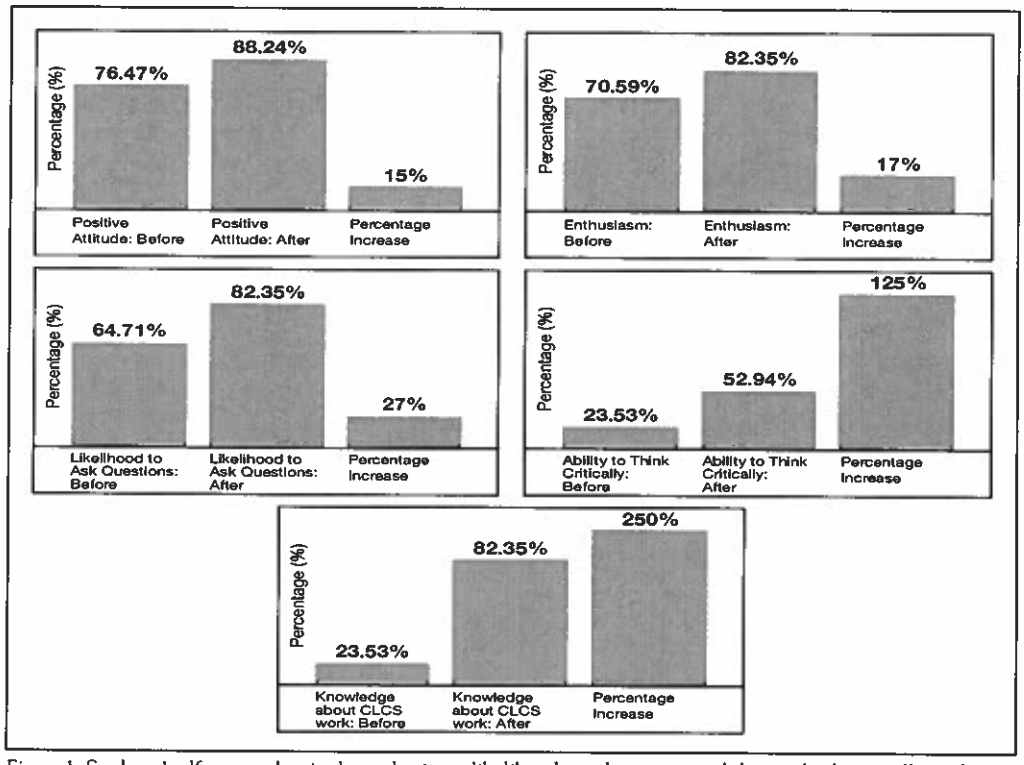

Figure 1. Students' self-reported attitude, enthusiasm, likelihood to ask questions, ability to think critically, and knowledge of what CLS professionals do, pre and post measures.

Practitioners indicated that students' critical thinking was deficient. They suggested that educators use problem-based learning (PBL) techniques, more case study experiences, and practical laboratory training in the academic setting to sharpen critical-thinking skills.

Practitioners felt that students were not expected to develop competence in troubleshooting problems with test systems and instrumentation until the practical workplace experience. Although practitioners agreed that students were competent in book knowledge, they expressed concern about the inability to apply that knowledge. They felt that, over time, educators can lose sight of what students really need to know in a contemporary clinical laboratory and suggested that some educators should still work in a clinical laboratory setting. According to practitioners, before they enter clinical internships, students are not expected to know how to perform preventive maintenance on laboratory instruments but are expected to understand the importance of preventive maintenance protocols to maintain the accuracy, precision, and reliability of laboratory results. Practitioners suggested that students visit a clinical laboratory before their clinical practice experience.

CONCLUSION

Educators in accredited CLS programs must adjust curricular paradigms to address new standards for the work environment; laboratory administrators must actively support the clinical practice component; and members of clinical laboratory professional organizations must promote and support the CLS profession. The recommendations from the clinical practitioners to improve student learning outcomes informed curricular changes in an HBCU CLS program beginning in fall 2008. Results from student surveys, CLS curriculum changes, enhanced clinical site supervision, and laboratory administrators' feedback indicate that these changes have improved student preparation in terms of positive attitudes, program enthusiasm, knowledge, likelihood of asking questions, and critical thinking in the field. However, continuous collaboration with clinical sites is needed for effective and complete CLS curricula that serve both CLS students and their employers.

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