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Evidence Based Practice in CLS Education

ELIZABETH KENIMER LEIBACH

Traditionally, CLS educators have filled a more supportive, rather than direct, role in the development of our practitioners. In this model, curriculum content was chosen for its relevance to practice, and the referent practice was considered primarily to be technical, that is, practice related to test analysis. With the advent of the evidence based practice (EBP) movement, attention is becoming increasingly focused on pre-analytic and post-analytic processes and the relevance of clinical laboratory information to medical effectiveness, cost-efficiency, utilization/interpretation, patient safety, and reduced numbers of errors. EBP has provided the theoretical and practical framework for praxis (i.e., acts which shape and change the world), in clinical laboratory science.¹

CLS educators now find themselves responsible for the development and evaluation of increasingly varied, complex, and crucial clinical skills directly related to consumer well-being and assurance of quality services delivered as interpreted and acted on not only by patients but by other healthcare professionals as well. Represented in this Supplement to Clinical Laboratory Science are timely theoretical and practical discussions of many foundational concepts in CLS practice and the evidence that supports the development and assessment of the “best” applications of these practices. Evidence supporting best practices in online and blended format course delivery, development and assessment of professionalism and teaching skills, and implementation of research in undergraduate and graduate curricula are just a few examples of practice concepts presented that will be of interest and practical use to CLS educators and practitioners alike. Another timely report examines the restructure and evaluation of baccalaureate curriculum presenting evidence that “good quality can cost less.”²

The evidence based practice of defining processes and assessing the efficacy, effectiveness, and efficiency of the outcomes of those processes defines CLS quality in all phases of clinical services delivery.³ And evidence based practice in CLS education defines and assesses quality of the processes related to teaching these “best practices.” CLS educators’ responsibilities, then, include identification, assessment, and application of these “best practices” through clinical and educational research. Following the communication of this and, hopefully, more works like it, expect to see incorporation of these best practices in program accreditation, quality improvement studies, practitioner certification, and regulatory requirements. Given the pivotal position of education in CLS, this inaugural Supplement is a long-awaited, welcomed addition to the body of knowledge. Contributing significantly in the EBP process and being aligned with its precepts, the ASCLS Education Scientific Assembly, sponsor of this edition, encourages your comments and feedback.

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Elizabeth Kenimer Leibach, Ed.D., MLS™, SBB
Education Editor, Clinical Laboratory Science
Preparing Clinical Laboratory Science Students with Teaching Skills

JEANNE M ISABEL

ABSTRACT
Training clinical laboratory science (CLS) students in techniques of preparation and delivery of an instructional unit is an important component of all CLS education programs and required by the national accrediting agency. Participants of this study included students admitted to the CLS program at Northern Illinois University and enrolled in the teaching course offered once a year between the years of 1997 and 2009. Courses on the topic of “teaching” may be regarded by CLS students as unnecessary. However, entry level practitioners are being recruited to serve as clinical instructors soon after entering the workforce. Evaluation of the data collected indicates that students are better prepared to complete tasks related to instruction of a topic after having an opportunity to study and practice skills of teaching. Mentoring CLS students toward the career role of clinical instructor or professor is important to maintaining the workforce.

INDEX TERMS: clinical instruction, clinical laboratory science curriculum, mentoring clinical instructors.

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INTRODUCTION
Training clinical laboratory science students in techniques of preparation and delivery of an instructional unit is an important component of all education programs and required by the national accrediting agency. In order to earn the title of Clinical Laboratory Scientist (CLS), one must master a background rich in the subjects of biology, chemistry and statistics to name a few, before engulfing in the more rigorous curriculum reserved for the major in CLS. Once on that path the CLS student encounters discipline specific courses along with more general subjects of research, management and teaching. Entry level practitioners must be able to perform not only technical procedures but to fulfill the role of clinical educator once in the workforce. Although the student may find the general subjects less interesting and perhaps unnecessary while in the academic environment, the value of this instruction becomes relevant in real practice.

The purpose of this paper is to evaluate CLS student preparation for teaching following a course in this subject. Participants of this study included students admitted to the CLS program at Northern Illinois University (NIU) and enrolled in the teaching course offered once a year between the years of 1997 and 2009. A cohort of data collected from groups of CLS course participants in the form of pre and post-course surveys were evaluated to provide insight to student perceived expectations of preparing an instructional unit for teaching.

The projected conclusion of this study is that CLS students are familiar with the tools and techniques of preparation and delivery of an instructional unit after completion of a course on teaching. Mastery of these skills develops with practice and mentoring of new educators requires directing potential candidates to resources available post academically.

Over the past few years, individuals seeking the profession of clinical laboratory science include both
those individuals eager to serve the public in a healthcare setting and those looking for adventure as a forensic scientist. Completion of both the baccalaureate and associate degrees for laboratory science attract student populations made up of adults of the traditional college age as well as nontraditional aged individuals looking for an alternative profession in this time of economic stress. All students are faced with juggling the role of academics versus personal life. Support from family and community, both emotionally and financially, help retain students in the academic environment. An interesting observation of today’s workforce in laboratory science is that the majority of practitioners continue to be women.

Clinical didactic material and basic laboratory skills are developed during the early phase of the CLS major with the honing of those academic and laboratory skills, along with practice towards competence, being accomplished during training in hospital laboratories. As cited in Harmening “Teaching hospitals are made up of a variety of personnel and many individuals are required to provide instruction as part of their job without any formal training in education.” In order to avoid the problem of unprepared clinical instructors, the CLS curriculum has been revised over time to include a course on developing an instructional unit. Undergraduate students may not realize that as little as one or two years after graduation, they may be teaching at the clinical site.

Accreditation requirements and implementation
College, university and hospital programs are encouraged to be accredited by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS). In order to maintain standards of excellence in CLS education the curricular standards of this accreditation body for the profession states that the CLS program must have “education techniques and terminology sufficient to train/educate users and providers of laboratory services.” In compliance with this standard, students in the CLS program at NIU are required to complete the course, AHCD 440 Introduction to Teaching in Allied Health Professions, for one hour of credit. The course content includes explanations of educational learning domains and taxonomy levels of difficulty. Discussions of different methods to match the level of instruction to the needs of the learner encourages the student to relate past academic experiences to new ideas related to instruction. Learning style inventories are used in the class to demonstrate the diversity in which adult learning is accomplished. Several intermediate assignments culminate in the final project of designing a presentation with accompanying objectives and multiple choice test questions to match the objectives. Students are encouraged to select a topic which interests them to prepare a presentation outline which contains objectives and assessment tools incorporating all three learning domains of cognitive, affective and psychomotor. In addition, levels of difficulty (taxonomy) help define the progress of learner from beginner to expert as described by Dr. Benjamin Bloom for the cognitive domain. In order to assist with management of the assignments, students select a class peer to review their drafts and offer suggestions for improvement. Finally the student prepares a learning activity suitable for delivery to an assortment of audiences, keeping in mind the media support needed for instruction in a variety of settings.

METHODS

Characteristics of Participants
The population for this study consisted of course enrollment of between 16 to 34 students per course over the twelve year period. The larger number of students per class section occurred in the last 5 years with more than 25 students in each section. Each group consisted of an average of 80% female and 20% male students. The age of students ranged from 21 years to about 40 years of age, the majority being traditional college aged students.

Description of procedure
In order to measure the student’s ability to accomplish the objectives of the teaching course, surveys were developed for participants to complete on the first day of class, and again on the last day. (Table 1 and 2). Survey questions were designed specifically for assessment of the student’s perception of abilities in educational tasks prior to instruction and at the completion of instruction. Both the pre and post-course surveys contain fifteen questions worded identically. In addition, there are eight questions on the
Table 1: Pre-Evaluation for AHCD 440 Introduction to Teaching in Allied Health Professions

The information you provide below will be used to improve the quality of instruction. Data from the survey may be compiled to use for presentations or publications related to CLS student’s perception of education in the curriculum. You are under no obligation to complete this form. Do not place your name on this form to protect your anonymity. Completion of this form will not impact your grade for this course. The questions below refer to class activities for AHCD 440 related to peer review, communication, preparation of necessary materials for instructing a unit. Thank you for your cooperation in completion of this survey. Circle the number that best applies.

At the present time I can effectively:

<table>
<thead>
<tr>
<th>Question</th>
<th>NA</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Select a presentation topic</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. Write educational objectives for the cognitive domain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. Write educational objectives for the psychomotor domain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. Write educational objectives for the affective domain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. Prepare a content outline for a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. Write level 1 multiple choice test questions (recall)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. Write level 2 multiple choice test questions (application)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. Write level 3 multiple choice test questions (problem-solving)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9. Select and use appropriate, recent references to prepare a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. Prepare handout materials for an oral presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11. Prepare an oral presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. Prepare graphics and visual aids for a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13. Select appropriate audio/visual equipment for a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. Use audio/visual equipment effectively</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15. Consult with peers to improve educational materials</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

*NA = Not applicable

Table 2: Post-Evaluation for AHCD 440 Introduction to Teaching in Allied Health Professions

At the present time I can effectively:

<table>
<thead>
<tr>
<th>Question</th>
<th>NA</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I expect to have teaching responsibilities in the first CLS job I have after graduation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. I expect to have teaching responsibilities at some time during my CLS career</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. The course will benefit me in the first job I will have after graduation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. The course has increased my understanding of education principles</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. This course has increased my ability to teach</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. The readings for this course were appropriate to my level of understanding</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. The work required for the course was appropriate for the time available</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. Select a presentation topic</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9. Write educational objectives for the cognitive domain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. Write educational objectives for the psychomotor domain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11. Write educational objectives for the affective domain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. Prepare a content outline for a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13. Write level 1 multiple choice test questions (recall)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. Write level 2 multiple choice test questions (application)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15. Write level 3 multiple choice test questions (problem-solving)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16. Select and use appropriate, recent references to prepare a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17. Prepare handout materials for an oral presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18. Prepare and oral presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19. Prepare graphics and visual aids for a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20. Select appropriate audio/visual equipment for a presentation</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21. Use audio/visual equipment effectively</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22. Consult with peers to improve educational materials</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23. Rate the overall value of this course</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What parts of the course do you feel will most benefit you in the future?
What parts of the course do you feel will least benefit you in the future?
If I could change this course I would:
post survey related to completion of the course and an area for comments.

Results of the surveys completed from 1997 to 2009 were evaluated with descriptive statistics. Students completed the survey anonymously and there is no record to match pre and post surveys to individuals for statistical analysis. However, summative data from the responses provide useful insight to student perceptions regarding the course designed to “teach them to teach.”

The pre and post-course survey established for this education course in the late 1990s was designed to assess the student’s perception of teaching concepts prior to, and at the completion of, a course covering the education process. Questions on the pre-course survey were numbered from 1-15 with a selection of 0-not applicable, 1- strongly disagree, 2- disagree, 3- agree, 4- strongly agree. The series of questions were prefaced by the statement “at the present time I can effectively.” A selection of “disagree” by the student on any item, indicates that he/she did not feel comfortable performing the tasks stated. Survey items ranged from selection of a topic and preparing an outline for presentation, to writing objectives in cognitive, affective and psychomotor domains. Other items relate to writing multiple choice test questions at three taxonomy levels while identifying the learning domain for each. Finally, statements referring to the student’s awareness of audio visual equipment needs and use were assessed. There were a total of 264 pre-course surveys analyzed with an average of 22 per year.

The post-course survey was given on the last day of class, after the student had completed all written assignments for the course and participated in class discussions. It included the same fifteen questions from the pre-survey. There are eight additional questions related to expectations of having teaching responsibilities once graduated, usefulness of the course in understanding education principles and ability to teach along with an assessment of the course overall. There were a total of 242 post-course surveys evaluated for an average of 20 per year. An opportunity for subjective comments on the post-course survey included describing the most and least beneficial components of the course and recommendations for change.

RESULTS
By looking at the surveys collected in the teaching class at NIU some distinctive observations and patterns are recognized. Figure 1 is a graphic illustration of three critical statements on the post course survey, namely expectation of teaching during the student’s career as a CLS, effective ability to teach after the course and overall course usefulness. The first bar in Figure 1 shows a comparison over the years of responses to the question of whether the student expects to have teaching responsibilities at some time during his/her CLS career. There appears to be a rather steady increase in the average for most years holding between 2.45 and 3.64 which is between “disagree” and “agree,” with a drop in 2002 and 2006. The response from the spring 2009 course is the highest average of all years with a 3.64 which places the response between “agree” and “strongly agree.” This is most likely due to emphasis in the class that there are many university and clinical instructors reaching retirement age and the need for instructors is constantly increasing.

The second bar of this graph indicates an average response to the question “this course has increased my ability to teach.” The averages vary between 2.50 and 3.23 which indicate responses between “disagree” to “agree” with only four of the yearly averages above 3.00 (agree). Because many CLS students equate teaching with standing in front of a classroom, they do not perceive themselves performing this task. In addition, the average numbers reflect the concept that actual practice in teaching is the best way to improve one’s self-confidence in the ability to teach.

The third column of the graph is an average of the responses to the question of “overall value of the course.” The number range of 2.78 (1997) - 3.56 (2009) reflects the student’s recognition of the value of the course.

Figure 2 is showing a comparison of the averages from the pre and post surveys in response to three questions referring to the student’s ability to write educational objectives using learning domains of cognitive, affective
and psychomotor. An average of all the pre course surveys for the years listed was 2.14, with five years having an average below this number. Certainly the concepts of learning domains and principles of writing good objectives for a lesson were unfamiliar territory. In contrast to the pre-surveys, the post surveys all indicate that on completion of the course the student can perform this task. The average difference in values given for the pre and post responses for these questions is 1.15 which indicates an improvement from disagreeing with the ability to write objectives, to more than agreeing on this ability.

Figure 3 is comparing the pre and post survey response averages to the three questions concerning writing multiple choice test questions for the recall, application and problem-solving levels. As seen in figure two for writing objectives, this graph also shows distinctive improvement of the post-course average to the pre-course response. It is interesting to note that the range between pre and post values is only 0.80 which is considerably less than that of the questions related to writing objectives. A possible interpretation may be that students think it rather easy to write good multiple choice test questions until they have to do it. Since the average on the post responses was only 3.38, there is agreement that improvement in ability occurred but students did not consider their ability to be very effective at the time of course completion. Most educators, especially those who have been teaching for many years, would agree that much practice is needed before mastering the task of expert exam question writer.

Figure 4 provides a visual representation of the pre and post survey averages in response to questions about preparing graphics and visual aids for a presentation, selection of audio-visual (AV) equipment and use of AV equipment effectively. The average difference of these pre and post responses was the smallest of all compari-
The open ended comments on the post survey asked for the most beneficial and least beneficial part of the course. Of 242 surveys completed, 159 students added comments (41%).

Many of the most beneficial comments were similar to the examples listed: “the test questions that we were to prepare. If you can teach a topic then you should be able to have a firm enough grasp to ask questions.”

“the objectives and test questions parts because I had no idea how to write objectives or test questions. I would just write random questions and hoped it worked”

“the ability to make presentations and write objectives”

At least 11% of the comments listed learning domains as a new concept and beneficial outcome.

As might be expected for each comment listing an activity as most beneficial is a matching least beneficial response. Note some responses:

“writing test questions”
“peer interaction”
“learning all the domains, they are interchangeable”
“since I don’t plan on going into the education major, this would not be useful, unless I plan on it later”

As noted by the last two comments, there is some disconnect between the objectives of the course and the student perceived outcome. The fact that considerably more students found the three main assignments as most beneficial instead of least beneficial was encouraging.
DISCUSSION

This study provides evidence that students in healthcare majors benefit from receiving instruction in subjects other than the sciences. By incorporating concepts that may be practiced once the student is a certified professional, the uncertainty of what to expect when asked to “provide an instructional unit” is not so frightening.

Other than stating accreditation requirements, justifying courses on education techniques, research and management as relevant to the student who plans to work “on the bench” for a few years may be a challenge. A report by Behan on teaching research design to CLS students describes opportunities that develop using different practice components in the curriculum. By emphasizing the developing roles of laboratory professionals and career opportunities, preparation in a variety of special skills is extremely important. The need for clinical laboratory science professors/instructors to be organized and able to present clear and concise objectives was emphasized throughout the course in this study.

During clinical practice students work hand in hand with preceptors or “bench instructors” and see the opportunity of utilizing the information delivered in the “teaching” course. Woeste and Barham have stated “professional practice experience offers an intense applied delivery where the student can begin to develop the skills and form the dispositions needed to become a successful entry-level professional when they graduate.” The student learns that it is not just the didactic and technical skills that were developed in the university setting that are needed in the workplace. The idea of transitioning from student on Friday to professional in the workplace on Monday is somewhat mind-boggling to some individuals. In reality, the development of professional skills takes place over a life time.

In order to groom young professionals for educational roles, there must be support for preceptors (also known as clinical instructors). New preceptors often lack confidence in the role. Once comfortable in the positions, they “gain a sense of contribution to the profession and recognize that they are shaping the next generation of practitioners.” Since there are several technologists in the workplace who have not had the advantage of a course in methods for constructing an instructional unit, the College of Health and Human Sciences at NIU has offered a workshop over the last three years to benefit clinical instructors in all health education specialties. The problems and issues confronting clinical education of students are not unique to CLS. Although there are different ways of delivering clinical instruction, there are many similarities and the workshop audience is very perceptive to adapting ideas presented by the speakers. In the most recent workshop, NIU alumni of the CLS program who are now clinical instructors commented on the benefit of the “teaching” course for their current role.

CONCLUSION

Filling the shortage of clinical laboratory science practitioners and mentoring professionals for the role of educator is a top priority of the laboratory science community. CLS programs strive to prepare students for all roles in their professional career. In some cases, the success of the learning and development of the individual depends on that person’s motivation, commitment and ability to be self-directed. The clinical laboratory scientist labors away analyzing specimens, identifying unknown organisms and providing data that enables physicians to make intelligent decisions regarding treatment and care of a patient. Recognition of the value of this profession continues to be an issue.

Evaluation of data from the research presented here indicates that CLS students typically are not exposed to learning theories and concepts related to teaching in adult education. After completion of an introductory course and practice with writing and presentation skills, most students will have more confidence to engage in teaching activities. Mentoring young professionals to become involved in professional societies and provide presentations at state and national meetings is an excellent way to promote competence in the skills being developed at the university or hospital setting.

Additional studies would be useful by charting the pre and post surveys for each group and recording some demographic data such as gender and age. The fact that
students came away from the course with recognition of new abilities in the area of teaching is encouraging. Many of the CLS students of today will find themselves utilizing these skills early in their careers.

REFERENCES
CLINICAL PRACTICE

Growing Our Own: Teaching and Doing Research in CLS

RODNEY E ROHDE, DAVID M FALLEUR, GERALD D REDWINE, THOMAS L PATTERSON

ABSTRACT
The shortage of clinical laboratory scientists (CLS) has been well-documented in the healthcare environment. This growing concern only becomes more critical as we enter the retiring baby boomer era in our society. Concomitantly, the problem of addressing how university CLS programs recruit and retain faculty to teach and satisfy research agendas is not being studied. These two problems, if allowed to collide, will provide a “perfect storm” with serious implications for an ongoing shortage of personnel and overall quality for the profession. CLS faculty, in the university setting, must typically satisfy the three tenets for tenure and promotion – teaching, scholarship, and service. While teaching and service will always be critical, scholarship (research) is an area of expertise that must be “taught” and mentored for future CLS faculty to be successful in the very real arena of “publish or perish”. This article provides a commentary with specific details associated with our experience in offering an evolving dedicated CLS clinical research course to purposively “grow our own” students in the art of conducting successful research. It offers a flexible template for adapting or incorporating a lecture and laboratory course to address theoretical and practical knowledge in the realm of clinical research. Additionally, a discussion of other research mentoring activities in our program will be outlined. The long term goal (and hope) of these program objectives is to build a culture of research for current faculty and for CLS graduates. This paper provides an approach to embedding these research ideals in all CLS graduates and, importantly, an intentional attempt to create a mindset for a possible career as a future CLS faculty member who can be successful in both the university and clinical environment.

ABBREVIATIONS: ASCLS = American Society for Clinical Laboratory Science; CITI = Collaborative Institutional Training Initiative; CLS = Clinical Laboratory Science; HIPAA = Health Insurance Portability and Accountability Act; HSP = Human Subjects Protection; IRB = Institutional Review Board; NAACLS = National Accrediting Agency for Clinical Laboratory Science.

INDEX TERMS: CLS faculty; CLS faculty recruitment and retention; education methods; teaching techniques; tenure track requirements; research informed teaching; research methods.

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According to the U.S. Bureau of Labor Statistics for the period of 2002 through 2010, 12,400 graduates will be needed annually to staff the nation’s clinical
laboratories. Nationwide, less than half the necessary laboratory personnel are graduating from accredited programs. Currently, with 4,200 graduates per year, there is a deficit of about 8,000 laboratory professionals per year. \(^1\) The clinical laboratory scientist (CLS) staffing shortage has been well-documented in a variety of sources. \(^2\)–\(^5\) While the issue of CLS shortages for the healthcare industry is critical, there is the additional often overlooked problem of recruiting and retaining successful CLS faculty in the “publish or perish” tenure-track environment.

There are numerous reasons that are related to attracting and retaining CLS faculty in a university system that can survive in the pressurized arena of satisfying the three tenets of responsibility – teaching, scholarship, and service. In the authors’ academic environment, these reasons are typically attributed but not limited to (1) the “type” of terminal degree relating to successful scholarship, (2) the research culture and perceptions of what can be feasibly done, (3) the amount of financial support and time, (4) the requirement of certification, and (5) the mentoring available. It has been the authors’ experience that while “good” teaching and experience are a given and expected by the administration, scholarship is the keystone in this three pronged tenure-track archway.

In 2004, Bamberg’s survey found many of the faculty in university CLS/MT programs are extending their preparation as scientists to the graduate level. The findings of this survey also found that the doctorate, as opposed to a master’s degree, can not be viewed as the ‘terminal degree’ as less than 50% of the reported faculty held a doctorate. Only 13% of the faculty held master’s degrees specifically in CLS. The author concludes that the wide variety of degrees reported and the lack of a substantial number of doctorates in CLS or in primary CLS curriculum areas does not support a doctorate in the teaching field as the standard for faculty teaching in baccalaureate CLS programs. \(^6\) In the authors’ experience, a graduate degree that required a thesis or dissertation is a critical part of the “toolset” needed to be successful in the area of research and overall scholarship. The Ph.D. is also being pushed for most academic units in our university.

In a very current and timely review, Mundt and Shanahan conducted a study of American Society for CLS (ASCLS) members to address the problem of how the professional society does not understand how their members perceive the importance of conducting research or their duty to the profession to do so. Briefly, the study found that the majority of participants agreed that the CLS environment offers important opportunities for information to be researched and published. However, the authors also found that a majority of participants felt that there are inadequate resources and time to do so. Finally, only a few (29.2%) are willing to publish research findings on their own. \(^7\) In a survey specifically of CLS faculty, Waller, Clutter, and Karni show an overall increase of faculty obtaining doctorates, promotions, presentations, publications, and grant funding from 1985 to 2008. However, teaching responsibility remains high and the average age of CLS faculty continues to increase. \(^8\) The expectation of scholarship is continually rising in the university setting which can impact faculty recruitment, retention and promotion.

It is within this context that the authors of this paper will discuss their experiences with building a research culture for their students (in a 2+2 university-based program). The following is a review of (1) an evolving dedicated CLS clinical research course to purposively “grow our own” students in the art of conducting successful research, and (2) a discussion of other research mentoring and activities in our program. The CLS course offers a flexible template for adapting or incorporating a lecture and laboratory course to address theoretical and practical knowledge in the realm of clinical research. The long term goal (and hope) of these intentional program objectives is to build a culture of research and a synergistic environment for current faculty and CLS students/graduates. This paper provides an approach for embedding these research ideals in all CLS graduates and, importantly, an intentional attempt to create a mindset in CLS students of a possible career as a future CLS faculty member who can be successful in both the university and clinical environment.
EVOLUTION OF RESEARCH IN THE CLS CURRICULUM

Current National Accrediting Agency for Clinical Laboratory Science (NAACLS) standards for accreditation includes research and development as a future responsibility of the CLS practitioner and knowledge of research design/practice sufficient to evaluate published studies as an informed consumer. The standards include principles and practices of applied study design, implementation and dissemination of results.9,10 With these standards in mind and the current reality of scholarship production in academia, the CLS program at Texas State University – San Marcos (www.txstate.edu/cls) has purposefully attempted to “grow our own” future CLS faculty while also continuing to maintain the high standards set for future CLS practitioners in the hospital and other laboratory areas.

Didactic lectures

While some institutions of higher education may only integrate research topics and laboratories in different CLS courses throughout the curriculum, a dedicated clinical research lecture/laboratory course (originally CLS 4261: Medical Technology Research, but currently CLS 4361: Clinical Research) was introduced at Texas State University in the 1977-78 catalog year. The faculty at Texas State University also take advantage of the opportunity to incorporate appropriate research-building skills (e.g. literature reviews, consent, Institutional Review Board (IRB)) in other courses; however, an immersion in a dedicated course is critical to allow for deeper learning, understanding and practice of the research experience. A variety of textbooks has been utilized for this course since its inception and is listed in Table 1. Regardless of the textbook, the topics selected in the lecture have remained fairly stable and are listed in Table 2.

The course begins with an introduction to research design and implementation in the clinical environment. The lecture topics follow with proposal writing, compliance issues in research (e.g. HIPAA, informed consent, IRB), literature searches (database tactics), manuscript writing (components of the manuscript), statistics (review and choosing the right statistical method), and illustration guidelines. The latter topics introduce professional journals, author instructions, manuscript submission troubleshooting and conclude with presentation guidelines. The lectures are supplemented with journal articles associated with clinical research and problem sets requiring student decision making with respect to choice of statistical tests. Additionally, the lectures are supplemented with special guest lectures from a variety of successful researchers from our university and other institutions.

Table 1. Textbook resources for clinical research course.

<table>
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<th>Textbook</th>
<th>Publisher and Edition</th>
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Table 2. Topics for clinical research lectures.

<table>
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<tr>
<th>Unit</th>
<th>Topics</th>
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<tr>
<td>1.</td>
<td>Research Design and implementation</td>
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<td>2.</td>
<td>How to write a winning proposal</td>
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<td>3.</td>
<td>HIPAA – IRB / Compliance with Research</td>
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<td>4.</td>
<td>Database searches</td>
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<td>5.</td>
<td>How to write a good research paper</td>
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<td>6.</td>
<td>Statistics Review</td>
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<td>7.</td>
<td>Illustration guidelines</td>
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<td>8.</td>
<td>Professional journals</td>
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<td>9.</td>
<td>Instructions to authors</td>
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<td>10.</td>
<td>Journal submission troubleshooting</td>
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<td>11.</td>
<td>Presentation guidelines</td>
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<tr>
<td>12.</td>
<td>Sharing your research / Grant process</td>
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Students are evaluated on the material based on written assignments including a proposal, IRB application, a final manuscript that must adhere to the guidelines of our professional journal, *Clinical Laboratory Science*, a final presentation of their research and a final comprehensive examination. The course is taken in the final semester in the CLS program (2nd year, summer semester); however, students are introduced to research project requirements for this course in the fall semester of the final year. In this way, the faculty can introduce content in other courses that will initiate the student towards a successful outcome in the subsequent clinical research course. For instance, the topic of compliance is discussed and modules are completed in a clinical seminar course in the final fall semester. Likewise, in the final spring semester, students begin clinical rotations at local hospitals and reference laboratories. The clinical rotations are accompanied by a clinical rotation course in which faculty assign journal article reviews while students are on campus. Each student is required to “dissect” CLS research journal articles that might be repeated in a research project. Students present journal findings to the entire class and faculty to augment the “research process” that occurs in the writing of a typical manuscript. The students are required to identify research projects at a clinical site that they will help design and conduct, such as a method comparison or validation of equipment or assays. Students may also design more elaborate research projects with a faculty advisor such as the recent publication of MRSA prevalence and characterization of a Texas university. The authors’ experience has been that a handful of CLS students become excited and motivated to work toward a possible publication and presentation of their research project in the clinical research course. The recent MRSA study by two of our students has received awards in our College of Health Professions Faculty-Student Research Forum, our University Undergraduate Research and Honors event, and the Texas Association for CLS state conference. It was also presented at the 2009 ASCLS national conference in Chicago, and ultimately, led to a publication in the journal, *Clinical Laboratory Science*. It is the authors’ belief that this type of mentoring will ultimately lead to potential future CLS faculty who will be successful in the realm of academic rigor with regards to tenure-track expectations.

The major limitation of the lecture format is that students are at different stages of understanding research concepts. Due to this concern, the Texas State University CLS program requires a prerequisite statistics course. However, students still can be at different “levels” of understanding due to the prerequisite being satisfied at different institutions and by different instructors. For example, some instructors focus on classic statistics and/or research design without including clinical or applied research. Other courses are lecture-based only without offering the student any laboratory experience. Another limitation is in the area of calculations and software such as SPSS that is often associated with clinical research. Some students struggle with calculations due to differences in their backgrounds and cognitive skills in math and statistics. This is especially noticeable with students who have not taken these types of courses recently. Texas State University, like others, has seen this issue with courses that require method validation and correlation cognitive skills. To help the students master the material, the instructor (and other CLS faculty) will meet with students independently or in small groups to review or practice these topics.

It should be noted that this type of research skill-building requires constant feedback, modeling, and examples of “how research is really done” in the university and in the clinical setting. The research course also has laboratory components and special guest “content area” lectures to review and build research skills.

**Laboratory component**

The laboratory component of the clinical research course is taught concurrently with the didactic component. Concurrent lecture and laboratory sessions allow the student to be involved in the actual generation of data using clinically relevant research tools and techniques. Senior students are also completing their clinical rotations in various community clinical laboratories during enrollment in the research course which permits possible observation and experience with clinical equipment and methods in the hospital and reference laboratory setting which apply to possible research projects. Finally, the concurrent clinical research laboratory helps reduce the problem of lecture
topics becoming abstract or distant before the student has an opportunity to “practice” what’s being covered in the didactic lecture.

During the initiation of the course in 1977, the laboratory component was a mixture of literature reviews, statistics applications, method comparison studies, and poster development and presentation by students. In 2002, an opportunity to revisit and revamp the course occurred due to the retirement of one faculty member and the subsequent employment of a new tenure-track faculty member. The laboratory experience for this course was adapted for the student(s) to successfully complete a “start to finish” research project. Students begin to identify possible research projects in the spring semester of their final year. Thus, when students enroll in the actual clinical research course for their final semester in the program they are ready to begin specific research “steps” that will result in the culmination of a final, polished manuscript ready for submission to Clinical Laboratory Science, if applicable.

Briefly, the students are required to complete the following steps chronologically in the course: (1) a proposal of their study which includes at a minimum the study title, problem description/hypothesis, clinical location, sample size, experimental design, IRB status, and clinical supervisor(s), (2) the completion of a Human Subjects Protection (HSP) course and subsequent electronic submission of an IRB application (exempt, expedited or full IRB), (3) attendance at an advanced database search and electronic bibliography software workshop with a research librarian at our institution, (4) attendance at a statistics review adapted by an institutional expert for an interactive session directed at “how to pick the right statistical method” for their clinical research projects, and examples of SPSS application of data, (5) completion of problem sets that have been “pulled” from published method validation articles (e.g. linear regression and correlation) and other types of research articles that include nominal data analysis (e.g. risk analysis via Chi Square and Odds ratio), (6) attendance at a “How to use SPSS” workshop adapted for our program by an institutional expert, (7) submission to the instructor of a “rough draft” at mid-semester to include the basic components of a manuscript for Clinical Laboratory Science and the subsequent “mock reviewers” comments from the instructor or other faculty in our program, (8) practice presentation of research projects with instructor and peer feedback, (9) attendance at a “How to submit a grant” workshop with a member from Texas State University Office of Sponsored Projects, (10) electronic submission of the final manuscript to the mock editor (instructor) including all accompanying paperwork (e.g. author checklist, financial conflicts, etc. found at http://www.ascls.org/leadership/cls/index.asp#Authors), and (11) a final presentation before student peers, CLS faculty, and guest clinical faculty.

It is important to mention that Texas State University’s Assurance with the federal Office of Human Research Protections requires that the University provide an education program in HSP. Completion of the basic HSP course is required for Texas State faculty and students submitting an application to the IRB, and for faculty supervising student applicants. Beginning November 17, 2006, the nationally recognized training program by Collaborative Institutional Training Initiative (CITI) was implemented at Texas State to fulfill the federal training mandate. More than 600 other institutions utilize this web-based program. Curriculum content is provided by well-known experts and is updated regularly. For more information, please see: (http://www.txstate.edu/research/orc/humans-in-research/training.html).

This laboratory component is critical to the students’ overall understanding of “how research is conducted” in a real world approach and clinical setting. The step by step process augments the ability of a student to integrate all pieces of the research puzzle, builds critical thinking skills, and improves writing skills with respect to peer-reviewed manuscript production. The individual assignments also improve understanding of mathematical operations and interpretation of data. Students are evaluated during the entire semester and are given a comprehensive final exam. The final exam includes theory of basic research concepts and synthesis/critical problem solving of data interpretation (Table 3).
Research Activities
A variety of other research intensive experiences and assignments are provided by the Texas State CLS program. Students in their first year of the program are required to complete Health Insurance Portability and Accountability Act (HIPAA) training at the university’s student health center. Students review HIPAA and related confidentiality issues (informed consent, electronic health records, CLS related law suits, and IRB) in their final year during a seminar course. Instructors integrate literature reviews, case studies, and writing intensive coursework in most of the CLS curriculum/coursework.

Table 3. Topics for clinical research laboratory.

1. Proposal design: An overview
   - Identifying topic / Framing research problem
   - Literature review
   - Common elements
   - Example proposals
2. Principles for protecting human subjects
   - Disclosure / Confidentiality / Participation
   - Belmont Report / Institutional Review Board
   - Informed consent process / Developing documents
3. Advanced database searches / Electronic bibliography building software
4. Statistics
   - Research design approaches
   - General review
   - Advanced data analysis / SPSS
5. Preparing and organizing data
   - Text
   - Tables / Figures
6. Manuscript preparation and submission
   - Instructions to authors
   - Publishing your manuscript
   - Research sharing
7. Formal presentation of research
   - Guidelines for components of research

In the clinical immunology course (first year) and molecular diagnostics course (final year),13 students are required to complete a literature review for a class grade to include submission to the Texas State College of Health Professions Faculty-Student Research Forum. The Research Forum introduces the students to the process of abstract writing, synthesis and integration of literature as it applies to an advanced course content area (e.g. flow cytometry in cancer diagnosis, microarrays in genetic disorders), and the peer-review method for abstract acceptance to present findings at a scientific meeting. Tours of specific research laboratories (e.g. The Virginia Harris Cockrell Cancer Research Center at The University of Texas M. D. Anderson Cancer Center, Science Park – Research Division) are conducted specifically in the research course to identify research in clinical and related disciplines and to introduce students to graduate school opportunities. The Science Park - Research Division is located in the Lost Pines region near Smithville, Texas. The mission of Science Park is to investigate the molecular biology of cancer and to develop means for cancer prevention and detection (see http://sciencepark.mdanderson.org/). Students are also encouraged to attend the annual state TACLS conference (see http://www.tacls.org/) and, if possible, the national ASCLS conference (see http://www.ascls.org/). These efforts have led to recent increased attendance and posters at the state level and submission of research papers for student award opportunities at the national level.11

The CLS faculty at Texas State University attempt to incorporate their students into various research projects that they are conducting throughout the academic year. For example, two recent projects incorporated student immersion into a MRSA prevalence, risk analysis, and genetic characterization study in a Texas correctional facility14 and in a Texas university.11 Student cohorts were involved at various stages of the projects as the research progressed. For instance, some students performed the actual bench level microbiological testing while others were involved in data analysis and other post-analytical steps. Participation with a faculty research project is strictly voluntary; however, the students that do participate usually become “hooked” on the research experience and offer a mechanism for peer-to-peer sharing of their efforts. These types of student initiated research opportunities are far more powerful than a top-down approach from a faculty member.15-16

SUMMARY
As many CLS programs in the U.S. can attest to, it is often difficult if not impossible to fill CLS tenure-track positions with “research-prepared” faculty that can succeed in this environment. Many CLS programs are
faced with the very real problem of needing competent and qualified “teachers” to prepare future CLS for the workforce. Historically, these faculty have a master’s degree (46%) or a BS in CLS (11%), with the remainder being doctorates (43%) and usually all of these are most likely recruited from the clinical environment. All of these degree holders are probably outstanding teachers of the CLS curriculum. However, the profession should not overlook the equally important issue of ensuring that faculty can be successful in the 21st century academic environment of scholarship production. Universities are continually raising the bar for faculty, including CLS faculty, in the realm of research and publish/perish viewpoints. As Mundt and Shanahan recently reported, “though the percentage of the reported faculty holding a doctorate was not higher than previous assessments of such faculty, these data indicate that almost half of the reported CLS faculty in the U.S. universities are preparing themselves as scientists for their roles in teaching and, increasingly, in research.”

By including a dedicated clinical research course in the CLS curriculum alongside other intentional research activities, the CLS program at Texas State is attempting to prepare students with the knowledge and background they need to be competent in applying this skill set in the clinical workforce and academic arenas. The course has strengthened our student’s “job attractiveness” in clinical, reference, research, and public health laboratories. Importantly, the course also has had the added effect of stimulating student’s interest in research and the likelihood of pursuing a graduate degree, and ultimately, attracting future CLS faculty that will be better equipped to be successful in the academic research world. These activities have also enhanced a synergistic relationship between the scholarship activities of our current CLS program with students and increased the collaboration across other allied health programs in our college.

Expectations on how and where to publish research offers an opportunity for faculty to become comfortable with the journals in CLS while also showing venues for published writing to the student. This approach can be quite effective for programs with limited time and schedules available for expanding coursework because research standards could be added to existing courses. It could also be effective for a CLS designated research course. Critical components for faculty would be knowledge of principles of basic research design for successful integration of research skills into curricula. Universities and the healthcare arena have research personnel who can help faculty with the design of course related research exercises if faculty are not accomplished in research.

It is important to mention the challenges associated with the endeavor of pursuing this type of course in the CLS curriculum. The major obstacles that the Texas State CLS program encountered were (1) faculty expertise, (2) time of placement within CLS curriculum, and (3) student preparation for course rigor (e.g. prerequisites and advanced research skills).

These obstacles were addressed in a variety of ways. Faculty expertise is continually being met by a renewed commitment to a research culture within our program, college and university. The faculty spends time in special workshops and informal mentoring with experts in the areas of statistical methodology, proposal development, grant development, and peer-reviewed publication. Additionally, one current CLS faculty member has successfully defended his Ph.D. dissertation and one other recently hired faculty has been accepted into a Ph.D. program. The placement of the research course in the curriculum and student preparation will be different for each CLS program. In the authors’ experience, the course was best placed in the final year so that students would have the opportunity to finish prerequisites and build their skills in critical areas (e.g. statistics, software, and writing). Finally, students can become frustrated with the challenge that research courses and projects present in an undergraduate program. This challenge is being met by consistent mentoring, feedback, tutoring, and “modeling the research environment” for a clinical laboratory scientist.

A dedicated course in clinical research provides CLS programs with the unique opportunity to become flexible in the face of growing clinical shortages in the workforce and in the continuing decline of finding research-prepared faculty for the tenure-track environment in academia. Furthermore, CLS programs
must begin to build a synergistic research environment between faculty and students to encourage the future possibility of a career in academia. While research is taught and practiced in a variety of university and college departments at the master’s and doctoral degree level, CLS programs can begin to develop future academicians at the undergraduate level by preparing clinically competent and research-oriented CLS professionals.

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ACKNOWLEDGEMENTS
The authors would like to thank the various guest lecturers, subject area experts, and affiliate clinical faculty that have helped build and enhance the clinical research course and environment in our CLS program. We would also like to acknowledge the past, present, and future students of the Texas State University-San Marcos CLS Program who have participated and helped conduct the various research projects in our program. Finally, we thank retired faculty members Associate Professor Emeritus Philip Kostroun and Professor Emeritus Dr. Lou Caruana. Each of these individuals was instrumental in the early development of research objectives in this program.
Preparing CLS Professionals to be Consumers and Producers of Research

SUHA M SALEH, KASTRO M HAMED

ABSTRACT: Research proficiency is part of the curriculum in all NAACLS accredited CLS programs. Learning the basic research tools enables students to understand and interpret published research as informed consumers of research. This paper describes an improved and innovative approach to prepare future CLS professionals to be both analytical consumers and active producers of pertinent research.

ABBREVIATIONS: CLS: Clinical Laboratory Science, NAACLS: National Accrediting Agency for Clinical Laboratory Science, UTEP: University of Texas-El Paso, TACLS: Texas Association for Clinical Laboratory Science

INDEX TERMS: Clinical Laboratory Science, Research methods, Teaching methods, Research instruction

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INTRODUCTION

The Clinical Laboratory Science (CLS) curriculum is rich in scientific content as well as in hands-on applications of laboratory procedures. While Clinical Laboratory Scientists are exposed to a broad spectrum of clinical and basic knowledge experience, they also need to keep up with new advances and innovations in research. Advances and improvements have been implemented to improve CLS students’ critical thinking, transitions to the clinical environment and employment opportunities, but the research curriculum is still primarily taught to fulfill the basic educational requirement in most CLS programs.

The need for training CLS students in searching, reading, and understanding published clinical/medical research has been addressed by the National Accrediting Agency for Clinical Laboratory Science (NAACLS) as an important educational requirement for all accredited CLS programs. Standard 22 of the NAACLS requirements for accreditation of CLS educational programs discusses the curricular requirements, where teaching about research is included as an integral part of the instructional areas. Section B # 8 of the NAACLS curricular requirements (standard 22) states that “the curriculum must include knowledge of research design/practice sufficient to evaluate published studies as an informed consumer.” Based on this research educational requirement, Clinical Laboratory Scientists graduating from accredited CLS programs should be able to read and evaluate published research. This implementation of the CLS research requirement would passively deliver the research educational content without active student involvement. It falls short of expecting the students to create research ideas, collect their research data and participate in scholarly presentations to share their research findings with other professionals. If this educational requirement were to be actively implemented to engage the students in the research process, it would not only achieve the basic knowledge as stated by NACCLS, but it would also increase the students’ interest in, and comprehension of, the processes of clinical/medical research. It would also open new avenues and future opportunities for the CLS
graduates. Some of these opportunities would include career opportunities in research laboratories and pharmaceutical companies. Greater access to opportunities in higher education can result by stimulating student interest in pursuing graduate education and participation in research projects.

In this paper, a course design based on an active learning model for clinical/medical research (Clinical Investigation) is described. This class is designed with an innovative approach that combines both the knowledge requirement by NAACLS for preparing CLS students as informed consumers of research, and the active learning component for engaging the students in designing, completing, and presenting their own research projects. The main objective of this Clinical Investigation class is to graduate CLS students who are both consumers and producers of research.

Students at the University of Texas-El Paso’s (UTEP) CLS program are accepted in their junior year after they have finished their pre-professional course pre-requisites. The students then progress as a cohort. A typical cohort is about 22 students. During the junior year the students take core CLS courses such as clinical chemistry, hematology and infectious diseases. In their senior year they take professional courses such as clinical education, laboratory management, preceptorship (clinical rotation) and the research class (clinical investigation).

Course Description
Clinical Investigation is a senior level class offered every Fall semester, which is also the semester when senior CLS students start their clinical rotations. At that time the students are exposed to clinical practice that complements the basic knowledge that they acquired during their junior year in the CLS program. This course is intended to introduce CLS students to the fundamental processes of conducting research in the health sciences. The course is designed to have two complementary learning components: the first component includes the basic research knowledge and the second component includes the active application of research. The course objectives are arranged accordingly, where objectives 1-5 are aligned with the first learning component and objectives 6-8 are aligned with the second learning component (Table 1).

### Table 1. Course Objectives

Upon completion of this course the students are expected to be able to:

1. Evaluate analytical, descriptive and experimental research.
2. Summarize and critique published research studies.
3. Discuss basic measurement concepts such as validity, reliability and objectivity, scales of measurements, field tests and laboratory tests.
4. Interpret data, tables and summaries typically presented in research studies.
5. Interpret analytical, descriptive and experimental research.
6. Plan for and design research projects, which includes selecting a problem, selecting an appropriate research method, locating and using appropriate referencing format.
7. Plan and implement both descriptive and inferential statistical data analysis.
8. Use written and verbal forms for communicating results of research.

### Table 2. Basic Research Knowledge Component

(A) **Instructions Units:**

1. Introduction to Research
2. The Scientific Method
3. Types of Research in Health Sciences
4. Research Planning
5. Research Design
6. Data Collection
7. Descriptive Statistics
8. Inferential Statistics
9. Dissemination and Critical Evaluation of Research

(B) **Textbooks:**

1. *Title:* Introduction to Research in the Health Sciences  
   *Authors:* Stephen Polgar and Shane A. Thomas  
   *Publisher:* Churchill, Livingston
2. *Title:* Exploring Research  
   *Author:* Salkind, N.  
   *Publisher:* Pearson Prentice Hall

The basic research knowledge component in this class consists of instructional units that cover various aspects and steps of the research process. Table 2(A) includes a list of instructional topics that are taught as part of this component. These educational units are delivered to the students in a combination of lecture and discussion formats. For each research educational topic, the basic information is presented to the students, and then the
students are engaged in an active discussion on the applications of the research topic. Various assignments are also provided to broaden the students’ understanding of the application of each educational component. Two textbooks (Table 2(B)) are used in this class, and they are available to the students to complement the instructional units.

The active application of the research component consists of working on individual students’ research projects. Students apply the knowledge they gain and the tools they learn from the first component of the class to plan, design, carry out and present their own research projects. Early in the semester the students select a researchable health related topic that is of interest to them and has benefits to the local and/or global research community. Keeping in mind that the students’ research projects should be completed during one academic semester, the students plan research projects that can be finished within 15 weeks. A general class schedule with timelines is described in Table 3. As part of the research design, the students comply with UTEP’s research requirement by submitting their research studies to the Internal Review Board (IRB) for approval. Students also learn the skills and benefits of teamwork. Each group of two students works together on one research project with continuous consultation with the course instructor. The students plan their research topic and decide on the type of research approach they will use to collect and analyze their data. They then write their research study plan and submit it for IRB approval. Students who conduct their research in conjunction with other agencies such as local hospitals or schools need to submit their studies for approval from these organizations also. The students present their completed research projects in three formats. First, the projects are presented orally in a PowerPoint format to an audience from the CLS and other programs in the College of Health Sciences at UTEP. The presentation must include a clear hypothesis, data collection, data analysis, discussion and conclusion. Then, every group of students submits their research project in the format of a research paper. This is an active writing experience where students apply the scientific method in documenting their research project from start to finish. To enhance the students’ ability to disseminate and discuss their research findings to other students and faculty, the students also present their projects in research poster format at UTEP’s annual Research Expo. Several groups of students also presented their research posters at the annual Texas Association for Clinical Laboratory Sciences (TACLS) conference.

Assessment
The assessment in this class evaluates the students’ proficiency in the course’s two components. Both the students’ knowledge and understanding of the research process as well as their application of research through their research projects are evaluated.

Table 3. General Schedule and Timelines for Class Activities

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Topic / Activity</th>
<th>Deadlines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Research; The Scientific Method</td>
<td>Research Topic Selection</td>
</tr>
<tr>
<td>2</td>
<td>Research in Health Sciences, IRB</td>
<td>Assignment-1</td>
</tr>
<tr>
<td>3</td>
<td>Research Planning</td>
<td>Test - 1</td>
</tr>
<tr>
<td>4</td>
<td>Test - 1</td>
<td>Research Study</td>
</tr>
<tr>
<td>5</td>
<td>Research Design Submission to IRB</td>
<td>Assignment-2</td>
</tr>
<tr>
<td>6</td>
<td>Data Collection</td>
<td>Test - 2</td>
</tr>
<tr>
<td>7</td>
<td>Descriptive Statistics; Inferential Statistics</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Dissemination and Critical Evaluation of Research</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Test - 2</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Student Projects in Progress</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Student Projects in Progress</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Student Projects in Progress</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Student Oral Presentations</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Student Oral Presentations</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Student Oral Presentations</td>
<td>1. Research Paper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Research Poster: electronic submission accepted, to be evaluated by the instructor. Students present the posters in the Spring semester</td>
</tr>
</tbody>
</table>

Evaluating the students’ comprehension and knowledge of the research process is essential to ensure their success in applying research and completing their projects. Therefore, assignments are designed to complement the instructional units and to strengthen the connection.
between abstract instruction and application of research. Exams are also given to the students on the topics covered in class. The assignments and exams are designed to be aligned with objectives 1-5 (Table 1).

In evaluating the students’ research projects, the assessment goals are to ensure that the students learned and applied the scientific method in their writing and presentation, and to evaluate their ability to communicate new information and research data to other students and professionals. These activities assess the student’s performance on objectives 6-8 (Table 1). Students are given guidelines and requirements for writing the research paper, preparing the poster and the oral presentation. The students’ research papers are graded and corrected, then returned to the students with grading sheets that contain comments for improvement and/or corrections. As the students present their research orally in a seminar format to the audience from the College of Health Sciences, the students learn self-confidence by being able to present data that they collected and analyzed. This presentation is often their first experience in presenting and providing new information to an audience; information that is not completely collected from published papers and textbooks. The students’ participation in the Research Expo at UTEP is an excellent learning experience for sharing their findings and research with other students and faculty in the research and professional community. This experience motivates some students to attend the Texas State CLS conference (TACLS) and present their posters.

**Synopsis of two years experience of teaching Clinical Investigation**

Teaching Clinical Investigation using the design described in this paper for the past two years has emphasized the benefits, value and importance of actively engaging the CLS students in designing and carrying out research projects. Students have been enthusiastic and excited about the new experience. Most of the students selected research topics that could benefit our local community or that focused on understanding a phenomenon that they observed during their clinical rotations in the laboratories. A sample of the topics of the students’ research projects is summarized in Table 4.

<table>
<thead>
<tr>
<th>Table 4. Sample Topics of Students’ Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prevalence of Risk Factors for Diabetes Among Students at the College of Health Sciences</td>
</tr>
<tr>
<td>2. Identification of Segmented versus Band Cells Among Medical Technologists</td>
</tr>
<tr>
<td>3. Do Dialysis Centers in El Paso Have Sufficient Capacity to Meet the Needs of the City’s Diabetic Patients?</td>
</tr>
<tr>
<td>4. Attitudes of Parents and Students Towards HPV Vaccine in Middle School</td>
</tr>
<tr>
<td>5. Posttraumatic Stress Syndrome Among Soldiers Returning from Iraq</td>
</tr>
<tr>
<td>6. CLS Workforce in El Paso, TX</td>
</tr>
<tr>
<td>7. CLS Workforce in Tucson, AZ</td>
</tr>
<tr>
<td>8. Hereditary Abnormal Red Blood Indices: A family Study</td>
</tr>
<tr>
<td>9. Comparison Between Professional Attitudes Among Health Science Major Students and Students in Other Majors at UTEP</td>
</tr>
<tr>
<td>10. Workload and Binge Drinking: Comparison Between CLS and Social Work Students</td>
</tr>
<tr>
<td>11. Comparing the Quality Control Between Coulter LH 750 and Coulter LH 755</td>
</tr>
<tr>
<td>12. UTEP CLS Program-an Intra Study</td>
</tr>
<tr>
<td>14. MRSA Awareness Among CLS Students Versus The General Public</td>
</tr>
<tr>
<td>15. Factors Affecting the Preference for Automation versus Manual Methods in the Clinical Laboratories</td>
</tr>
<tr>
<td>16. Obsessive Compulsive Disorder Among Laboratory Personnel</td>
</tr>
<tr>
<td>17. Incidence of Bacterial Meningitis in El Paso Local Hospitals</td>
</tr>
<tr>
<td>18. Incidence of AIDS in El Paso versus Austin</td>
</tr>
<tr>
<td>19. Incidence of Vancomycin Resistant Enterococcus in El Paso Local Hospitals</td>
</tr>
</tbody>
</table>

Students learned through practice to plan and complete projects. Students were inspired and participated in professional conferences locally at the UTEP level and at the state level at TACLS. One group presented a research poster at the 2008 TACLS conference and two groups at the 2009 TACLS conference. The benefits of engaging students in research extended beyond their graduation. The fear of applying and conducting research projects was alleviated and replaced with curiosity and interest in most students. Approximately 15% of the students are pursuing degrees in higher education after graduating from the CLS program.

Even though the outcomes of using this approach in teaching Clinical Investigation are excellent, there are a few points that are worth keeping in mind before
adopting this approach. Since this approach requires continuous communication between the students and their instructor, the instructor should always be available to the students and provide continuous advice as the students progress in their projects. Students should also update the instructor frequently so as to overcome obstacles and prevent delays in their projects. Careful time management is an important tool that the students need to develop as part of this approach. Students need to plan for many deadlines, including some major deadlines such as IRB study submission, research paper and oral presentation due dates, and the poster presentation schedule. Minor deadlines are also important but are easier to keep because these deadlines take place at the same time for the entire class and the students are used to them. They include exams and assignments’ deadlines as well as regular updates and communications with the instructor. However, despite these challenges, this approach in teaching research is a great experience for both the instructor and the students; it allows the students to interact with local health agencies and organizations and improves the students’ communication skills.

REFERENCES

2011 CLEC Abstract Deadline
The deadline for abstracts for oral presentation at the 2011 ASCLS Clinical Laboratory Educators’ Conference (CLEC) is October 1, 2010. Submission instructions and the proposal form may be found at www.ascls.org/conferences. The completed proposal form and abstract must be submitted electronically by the deadline. There will be no poster presentations or technology demonstrations at CLEC 2011. Presentations acceptable for submission include research studies, teaching tools or education/curriculum projects.

The 2011 CLEC will be held February 17-21 in Fort Lauderdale, FL. Additional meeting information will be available at the ASCLS Conferences website.
Professionalism – A Required CLS/CLT Curricular Component

SANDRA LATSHAW, KAREN HONEYCUTT

OBJECTIVE: Determine the impact of requiring Clinical Laboratory Science (CLS) students to participate in approved professionalism activities as part of a mandatory management course.

DESIGN: Quasi-experimental, case study reporting qualitative results of 25 CLS students. During the admission interview, students complete a written response to questions about their perceptions related to professionalism. During the clinical educational year, students are required to complete approved professionalism activities as part of a management course. At the end of the course, students write a reflective paper focusing on their professional activities and how these experiences will influence their future professional practice. Overall themes of student reflections are provided.

SETTING: University of Nebraska Medical Center (UNMC) CLS Program in Omaha

CONCLUSION: After participating in a mandatory professionalism curricular component requiring active student participation in professional activities, student reflective writings provide evidence this is one successful approach to nurture professional identity within future Clinical Laboratory Science/Clinical Laboratory Technician (CLS/CLT) practitioners.

ABREVIATIONS: ASCLS = American Society for Clinical Laboratory Science, ASCP = American Society for Clinical Pathology, CLS = Clinical Laboratory Science, CLS/CLT = Clinical Laboratory Scientist/ Clinical Laboratory Technician, DCLS = Clinical Laboratory Science Doctorate, NAACLS = National Accrediting Agency for Clinical Laboratory Scientists, UNMC = University of Nebraska Medical Center

INDEX TERMS: Clinical Laboratory Science, Education, Professional Role

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INTRODUCTION
Cultivating professionalism in students is a goal of all CLS/CLT National Accrediting Agency for Clinical Laboratory Scientists (NAACLS) accredited programs since affective domain assessment is required. Yet many technically competent graduates choose not to become actively involved in their profession after entering the work force. The American Society for Clinical Laboratory Science (ASCLS) Code of Ethics\(^1\) clearly indicates a duty to the patient, colleagues/profession and the society. Why do so many laboratorians fail to progress past their duty to the patient?

No one disputes that professional behaviors such as ethics, integrity, dependability, initiative, responsibility, and effective communication are essential in students. However, if educators wish to encourage all students to become active professionals after graduation, deliberate planning and evaluation of curricular content is necessary. Opportunities must be provided to nurture
professional growth in CLS/CLT students for the laboratory profession to realize its potential.

Professionalism has been included in UNMC’s management course for several years, emphasizing professional development, community service and scholarly activities. A desire to determine if these activity requirements influence students’ views of professionalism throughout their 11-month program led to this study.

LITERATURE SEARCH
Literature searches on professionalism in CLS and other allied health fields uncovered minimal peer-reviewed articles. One health science text focused on professional behaviors, but did not move beyond day-to-day expectations. Correiro reviewed the importance of assessing professional competency skills valued most by hospital employers. Being a professional laboratorian as opposed to being a “9-5 tech” (a clinician skilled in performing lab testing not espousing the demeanor and attitude of a true professional) was discussed by Golyski.

“Professionalism 101” was a wake-up call, addressing the perceived lack of recognition of laboratory professionals compared to other Allied Health fields. Davis states, “whether clinical laboratory scientists are successful (or not) in our professional lives depends not only on our competence in the laboratory, but also on whether or not we demonstrate true professional status.” Characteristics she proposes include not only a unique body of knowledge and skills and sense of altruistic commitment to patients, but also control over the profession and establishment of a professional culture/organization. “The difference between professionals and those who are expert at what they do, is how they view their own responsibility and accountability.”

Epner succinctly stated the problem: “The curriculum for teaching students about the technology in the lab is relatively uniform, while professionalism advocacy, and leadership training is not.” He suggests cultivating these skills could potentially increase the visibility of the laboratory’s importance to healthcare peers and hospital administrators, and would better prepare students for consultative roles. “The laboratorians of the future will require soft skills in leadership, advocacy and professionalism as well as technical competency.” Educators are encouraged to incorporate standardized curricula to address this issue.

The importance of teaching CLS/CLT students about professionalism, encouraging students’ involvement in ASCLS, and providing opportunities to incorporate professionalism into curricula were presented by the ASCLS Leadership Academy at the 2009 Clinical Laboratory Educator’s Conference. Laboratorians perceiving CLS to be a profession, rather than just a technical field are more likely to progress and remain in their career.

CLS/CLT educators can learn from medical schools experienced in establishing and assessing professional growth in students. Professionalism must be taught and assessed as a separate topic; role modeling is not sufficient to ensure learning transfer. Learning should occur in authentic contexts that meld cognitive base and experiential learning to “transform knowledge from the abstract and theoretical to the useable and useful.” Allowing time for student reflection is vital. Reflection supports, “integration of theoretical concepts into practice; increased learning through experience; enhanced critical thinking and judgment in complex situations; and the encouragement of student-centered learning.” The reflective process should encompass three stages: recollection of the experience, identifying positive or negative feelings, and re-evaluating the experience.

Using reflection to gauge professional growth provides “insight into students’ attitudes about the medical profession and their sense of developing identity in relation to their new community and its expectations.” Reflections will “expose their patterns of reasoning as they approach challenging professional dilemmas. Exploring the reasoning behind behaviors is important because the choices made by an individual are not necessarily evident in the outcome we observe.”

A program to teach professionalism must expand beyond the cognitive domain; learning is minimized when students do not reflect upon the experience.
opportunity is lost to incorporate new attitudes or integrate professional behavior changes into one’s daily life. Institutional administrative support creating an appropriate environment is essential for success. A formal curriculum that includes professionalism sends the message that faculty believe in what they are teaching. Curriculum should include, “structured teaching, clinical exposure, and organized activities designed to promote self-reflection.”13 Structured teaching of professionalism should be introduced to students early in the course of training and reinforced throughout the educational program. Students must be given “real-life situations taking place in clinical rotations or practice, in community service, or during activities specifically designed for the purpose. The key is to promote reflection upon these experiences.”13

BACKGROUND
UNMC’s CLS Program is an 11-month, 3+1 program with approximately 50 students in four states at 12 different clinical sites. Each student is assigned to complete clinical rotations at one location: a rural hospital, urban hospital, or reference laboratory. The program also includes 25 working MLT degree advancement students. Approximately 80% complete the majority of their education at a distance.

Professionalism goals (Table 1) are introduced early in the program. The first management session provides the cognitive base: a lecture and independent unit on the CLS scope of practice and profession. The ASCLS code of ethics; overview of the history of the profession since its inception; NAACLS standards; Board of Certification; CLS/CLT practice levels; and ASCLS and American Society for Clinical Pathology (ASCP) comparisons are addressed.

Professional activity opportunities are then explained to students. UNMC has created three categories of professional activities: professional development, community service and scholarly activity (Table 2). Each student is expected to earn a minimum of seven professional activity points throughout the year, with the goal being at least ten. No more than five points may be earned from a single category; the intent is to expose students to many different activities. Some point values are clearly established, while others are awarded based on the time the student spends planning and/or completing an activity, or on the number of visits of a continuing service.

Table 1. UNMC Professionalism Unit Goals
In this unit, the Clinical Laboratory Science student will participate in activities designed to:

1. Build professional pride within the student.
2. Advance the Clinical Laboratory Science profession.
3. Promote the Clinical Laboratory Scientist’s role as a key member of the healthcare team.
4. Increase the visibility of Clinical Laboratory Scientists to community members, as well as other healthcare professionals.
5. Encourage lifelong involvement in professional activities.
6. Collaborate with other healthcare professionals

Table 2. Examples of approved professional activities students can complete to earn professionalism points. Activities used to achieve these points CANNOT be required educational experiences or monetarily compensated; all must be lab related.

<table>
<thead>
<tr>
<th>Professional Development Activities</th>
<th>Suggested Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Join a professional society (ASCLS or ASCP)</td>
<td>1 for each</td>
</tr>
<tr>
<td>Advisory board representative</td>
<td>1-2</td>
</tr>
<tr>
<td>Planning a lab related activity (e.g., lab week)</td>
<td>1-2</td>
</tr>
<tr>
<td>High school/college career recruitment</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Community Service Activities</th>
<th>Suggested Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary or middle school laboratory educational activity</td>
<td>1-2</td>
</tr>
<tr>
<td>Health/wellness/career fair (single event, 1-4 hours)</td>
<td>1</td>
</tr>
<tr>
<td>Community clinic continuing series (e.g., Sharing Clinic) ≥10 visits</td>
<td>5</td>
</tr>
<tr>
<td>Community clinic continuing series (e.g., Sharing Clinic) 8-9 visits</td>
<td>4</td>
</tr>
<tr>
<td>Community clinic continuing series (e.g., Sharing Clinic) 1-2 visits</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scholarly Activities</th>
<th>Suggested Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poster presentation</td>
<td>2-5</td>
</tr>
<tr>
<td>In-service or case study presentation</td>
<td>2-5</td>
</tr>
<tr>
<td>Teaching other healthcare professionals</td>
<td>1-2</td>
</tr>
</tbody>
</table>

Professional development activities fall into three categories: personal development; leadership development; and service for the profession. Personal development includes joining a professional society, or creating a curriculum vitae. Serving as a student representative to advisory boards, student senates,
student councils, student clinic boards or state professional societies are examples of leadership development opportunities. To qualify for points the student must take an active leadership role that involves regular meetings, sharing reports with peers, and fulfilling project responsibilities. Service for the profession includes volunteering at state professional society meetings; serving on career panels; and planning or assisting with recruitment, National Medical Laboratory Week, or other lab-related activities.

Community service opportunities encompass service for those outside the laboratory profession, such as planning and/or conducting an educational activity at an elementary or middle school; volunteering at a health fair; and volunteering at a student-run community clinic. UNMC has three student-run evening clinics providing numerous leadership and volunteer opportunities. These clinics allow students to gain real-world laboratory experience with minimal supervision and provide healthcare to underserved populations in an interprofessional environment. CLS student leaders schedule peers to ensure all shifts are covered throughout the year and may develop testing protocols. Five hours of training are required to volunteer at these clinics. All UNMC’s CLS students for the past two years have voluntarily completed this training shortly upon entering the program.

Poster presentations are the most common scholarly activity. Students work individually or in pairs to author and present a scientific poster. Scholarly activity points are also earned by presenting a case study or in-service to faculty/peers; teaching other healthcare professionals a laboratory skill; publishing an article at the local, state or national level; or completing a quality performance improvement project.

Career development is a management unit that students complete near the end of the program. The focus is on continued professional involvement and life-long learning. Students study licensure, certification, credentialing, registration and accreditation followed by an exploratory/opinion paper on CLS/CLT personnel licensure. Students investigate positions held by ASCLS, ASCP and the College of American Pathologists; determine their personal stance for or against state licensure; and write a persuasive paper, justifying their choice.

METHODS
Student perceptions regarding professionalism were obtained by asking CLS applicants to write a response to these two questions at their face-to-face admission interview:

What does the concept of professionalism in healthcare careers mean to you?  
What impact do you anticipate professionalism will have on your development as a Clinical Laboratory Scientist?

Throughout the educational year students document their participation in faculty approved professional activities as previously discussed. At the end of the year students are required to write a reflective paper using the following guidelines:

You may choose to write about a single professional activity/experience or an entire professional category (community service, scholarly activity or professional development). The focus of the paper is to reflect on how or if these professional activities/experiences will influence your future professional practice and why.

End-of-the-year student reflective responses were compared to admission question responses.

RESULTS
Pre-admission responses were qualitatively categorized into like themes based on similar student perceptions (Table 3). Major themes revealed an emphasis on patient care, teamwork and character traits. Students were able to successfully complete course requirements at all locations with 87% percent earning 10 or more professionalism points. Excerpts of several end-of-the-year student reflective paper responses follow.

Personal professional development #1: “The ASCLS and ASCP professional society websites are great and something I will bring with me to keep up-to-date within the career.”
Table 3. Major themes from pre-admission student responses to:

<table>
<thead>
<tr>
<th>Overall Theme</th>
<th>Number of Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsibility, respect, compassion to the patient</td>
<td>16</td>
</tr>
<tr>
<td>Teamwork and respect to co-workers</td>
<td>14</td>
</tr>
<tr>
<td>High standards, honesty, integrity, confidentiality, trustworthiness</td>
<td>11</td>
</tr>
<tr>
<td>Knowledge and skills regarding the profession</td>
<td>7</td>
</tr>
<tr>
<td>Motivation to continually improve knowledge/skills</td>
<td>5</td>
</tr>
<tr>
<td>Appropriate dress and appearance</td>
<td>3</td>
</tr>
<tr>
<td>Work is focused, organized and efficient</td>
<td>3</td>
</tr>
</tbody>
</table>

Community service — educational activity:

“When being a professional finally hit me: We were boasting about our profession to these kids who probably had no idea that we even existed. It was great to see them actually pay attention to us. I hope that we planted a little seed into even a few of those kids and that they will keep our profession in mind when they attend college.”

Community service at a student-run clinic:

“While volunteering my services at the Respect and Sharing Clinics, I would feel very proud of the fact that I was going to become a CLS. When medical students are coming to myself and my working partner to ask questions about tests that need to be done and actually knowing the answer is a great feeling. If medical students would ask questions we were unsure of answering, it motivated us to look up the answer and retain that information.”

Overall professionalism #1: “At the ASCLS state meeting this year I was able to listen to a great speech about current topics that affect clinical laboratory scientists. The speech focused on topics such as professional licensure, competitive bidding, and the introduction of the DCLS (Clinical Laboratory Science Doctorate). These are all topics that will affect the laboratory and the people working in the laboratory in a significant way. One thing that surprised me is that I have been working in the lab for almost eleven months now and until about one month ago I hadn’t heard anything about these topics. I found out about the licensure situation because we had an assignment about it. I knew about the DCLS because there was an issue of ASCLS magazine that focused on the DCLS, but I didn’t know anything about competitive bidding until I listened to the speech. The reason that I was surprised is because I would have thought these would have been topics that I would have heard people around the lab talking about.

Personal professional development #2:

“Through questions asked and answered during the professional conference, I saw that healthcare is indeed a collaborative field. No matter the topic, questions and answers came from clinical laboratory scientists, physicians, researchers, and others involved in patient health. This degree of professionalism demonstrated the need to continue to have a community of healthcare providers, not act as discrete entities without communication between one another in order to give patients the best possible outcomes.”

Leadership development from a student-led clinic board member: “This allowed me the opportunity to experience firsthand the difficulties, and challenges to staffing, and communicating problems at the clinic to all volunteers in a clear and understandable method. As an employee, I will be aware of these situations, and understand how these interactions can affect the employees in the clinical laboratory.”

Service for the profession – recruitment: “I was amazed to see how many people don’t know or know very little about professions in medical laboratory science.”
I think that it is very important that medical technologists stay well informed about these topics and get involved in the ones that they feel strongly about. These are changes that will affect the way the laboratory works and these decisions should be made by the people who they will affect the most. Medical technologists should not just ignore these issues and allow someone higher up the ladder to make the decisions. The more people who get involved and challenge each other’s ideas the better the outcome will be.”

Overall professionalism #2 from a currently employed MLT: “Of the activities I did to satisfy the requirements of this project I found, to my surprise, the volunteer efforts to be the most satisfying. Before this project I had never done any volunteer work for any number of reasons. Either I was too busy or I didn’t have time or I needed to spend the time I did have doing something to make money. While my need to make money to support my family has only increased, I do think that after my experience with this assignment I will in the future find the time to do more volunteer work. It may not help to pay the bills, but it does make one feel good about what they are doing.”

Overall professionalism #3: I was able to step outside my box and learn things that I hadn’t gotten the opportunity to learn previously. Had I not been required to partake in these activities I may not have chosen to do so. I have learned to stay involved in my field, which will help me to develop professionally and become a valued member of the healthcare team.

End-of-the-year reflective papers were qualitatively categorized for common themes, in a manner similar to the pre-admission responses. Reflective responses expanded in scope from the egocentric themes of the pre-admission paper, evolving to include other health care professionals, community and professional societies (Table 4). In addition, the pre-admission themes of compassion for the patient, high personal standards, knowledge of core CLS competencies and the desire for lifelong learning were reiterated in these reflective papers. Expanded overall themes of professionalism were provided in 88% of these reflective papers, while 12% remained focused on the pre-admission themes of self and the patient.

Table 4. Major themes from end-of-the-year student papers reflecting on their personal community service, scholarly activity or professional development activities and the potential influence of these experiences on their future professional practice.

<table>
<thead>
<tr>
<th>Overall Theme</th>
<th>Number of Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognize the collaborative nature of healthcare</td>
<td>17</td>
</tr>
<tr>
<td>Educate the community/other professionals</td>
<td>12</td>
</tr>
<tr>
<td>Exhibit pride in CLS' contribution to overall healthcare</td>
<td>12</td>
</tr>
<tr>
<td>Promote the laboratory profession</td>
<td>9</td>
</tr>
<tr>
<td>Recognize cultural competency issues</td>
<td>6</td>
</tr>
<tr>
<td>Volunteer their CLS practitioner skills</td>
<td>5</td>
</tr>
<tr>
<td>Recognize the challenges of leadership</td>
<td>3</td>
</tr>
<tr>
<td>Recognize the value of professional societies</td>
<td>3</td>
</tr>
<tr>
<td>Accept leadership roles</td>
<td>2</td>
</tr>
<tr>
<td>Themes repeated from pre-admission responses:</td>
<td></td>
</tr>
<tr>
<td>Responsibility, respect, compassion to the patient</td>
<td>13</td>
</tr>
<tr>
<td>Teamwork and respect to co-workers</td>
<td>1</td>
</tr>
<tr>
<td>High standards, honesty, integrity, confidentiality, trustworthiness</td>
<td>13</td>
</tr>
<tr>
<td>Knowledge and skills regarding the profession</td>
<td>6</td>
</tr>
<tr>
<td>Motivation to continually improve knowledge/skills</td>
<td>5</td>
</tr>
<tr>
<td>Appropriate dress and appearance</td>
<td>2</td>
</tr>
<tr>
<td>Work is focused, organized and efficient</td>
<td>0</td>
</tr>
</tbody>
</table>

Comparisons of individual students' pre-admission perceptions to their end-of-the-year reflections on professionalism follow:

Student 1

Preadmission themes: Putting patient needs first, appropriate dress, doing the best job possible, working well with others, motivation to improve myself.

End-of-the-year reflections: “When I first entered the program, professionalism often seemed like a distant and undesirable concept. As a recent college graduate, I often associated the word with a set of meaningless behaviors that had to be followed in order to please my
superiors. During my time in the CLS Program, I have obtained a new respect for professionalism. Professionalism was a necessary tool for my work as a representative of the Sharing Clinic Board. This position required continuous discussions with other healthcare professionals about issues involving the clinic. I had to explain how the clinic laboratories worked to other health care disciplines and have a basic understanding of how other healthcare disciplines operated in the clinic. At its core, professionalism is about being competent enough in one’s job so as to inspire confidence in both the customer and fellow workers. As a CLS, it is about effectively communicating with other healthcare professionals and doing everything necessary to serve the patient.”

Student 2

Preadmission themes: Healthcare professional that many people trust and respect, trying my hardest, responsibility to patient.

End-of-the-year reflections regarding professionalism assignments: “The first thing to enter my mind was that this would be another thing I had to add to my already seemingly overwhelming year ahead. What I didn’t think about was the experience I would have throughout the year while participating in these activities. I didn’t realize that they would change my opinions and open my eyes to issues I would have hardly considered relevant in my life.”

End-of-the-year reflections regarding student-led clinic: “I knew it was for low income people who I thought should have taken the initiative in their own lives in obtaining a good job and better insurance so our tax dollars wouldn’t have to pay for their medical bills. When I thought of poor people my mind went to the people suffering in Africa from AIDS, malaria and starvation. It didn’t dawn on me that there were so many people in Nebraska that had to decide between having medical insurance and putting food on the table.”

DISCUSSION

Prior to performing professional activities in authentic environments, student perceptions focused on the patient and self with no comments related to duty to profession and society. After service learning participation, students’ professional perceptions expanded. Evidence of this growth was demonstrated through reflections indicating that CLS professionals should take personal responsibility to collaborate with other healthcare practitioners, educate the community and other professionals and promote the CLS career, as well as exhibit pride in the CLS’ contribution to overall healthcare. The desire to continue volunteer activities was noted by multiple students. Recognition of cultural competency issues, leadership challenges and the advantages of professional society membership were additional themes mentioned. These reflections reveal students’ awareness that a CLS professional’s responsibility and accountability extends outside the walls of the laboratory.

This reflective paper analysis supports the belief that providing structured educational opportunities that require CLS/CLT students to become actively involved in professional activities, followed by reflection on those experiences, positively influences the professional attitude of most students. However, not all students embraced the course’s service learning component, failing to expand their professionalism insight beyond the patient and self. Current data collection methods will continue, as well as documentation of the professional involvement of UNMC CLS program graduates.

Including professionalism as an essential part of CLS/CLT curricula is one successful educational approach to nurturing professional identity within future laboratory practitioners. Requiring students to become involved in professional development, community service and scholarly activities throughout their professional educational year encourages a more encompassing view of professionalism from the relatively egocentric view evidenced prior to beginning coursework. In completing service learning require-
ments, most CLS graduates recognize that working with the community, other healthcare professionals, and professional societies are important components of professionalism, as are maintaining a focus on patient concerns, desirable character traits, and competent laboratory skills.

REFERENCES
7. ASCLS Leadership Academy. What should we teach our students about our profession? Proceedings of the 25th Annual Clinical Laboratory Educator’s Conference; 2009 Feb 19-21; Denver, Colorado.
Research and Scholarship of Clinical Laboratory Science Faculty Members

KATHY V WALLER, JILL E CLUTTER, KAREN R KARNI

OBJECTIVES: To describe the research and scholarly productivity of faculty in four-year college and university clinical laboratory science (CLS) programs. To identify hours spent in research, numbers of presentations and publications, and external funding.

DESIGN: In 2008, a national study involving 106 college and university CLS programs was conducted to determine whether faculty were participating in research. A questionnaire, in electronic format, was distributed to 448 faculty members. Data from 2001 to 2008, and from 275 respondents (61% response) representing 93 of 106 (88%) CLS programs were analyzed.

SETTING: The study took place at The Ohio State University with collaboration from the University of Minnesota.

PARTICIPANTS: All CLS faculty within a four-year university or college sponsoring a NAACLS-accredited CLS program were invited to participate.

MAIN OUTCOME MEASURES: To determine whether CLS faculty scholarly activities have been strengthened in the past decade. To quantitate scholarship productivity. To assess faculty perceptions of their employment environments.

RESULTS: Data indicate that faculty who possess earned doctorates have higher levels of research productivity. While 52% of CLS faculty hold doctorates and 45% are tenured, 36% of all CLS faculty members have not published a research paper or abstract since 2001. On the other hand, 19% have published 11 or more times. CLS faculty were also awarded a total of $62 million in external funding, 83% from government sources. Teaching remains a primary responsibility of many faculty members.

CONCLUSIONS: In the past decade, and generally speaking, CLS faculty have made some progress in scholarship including highest degree obtained, publications, presentations, and grantsmanship.

INDEX TERMS: Clinical laboratory science, research, faculty, scholarship.

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INTRODUCTION

Since 1985, the first author of this study, together with colleagues, has investigated the research and scholarly activities of faculty in baccalaureate level programs in clinical laboratory science. As we stated in 1999, research and scholarly activities are often considered hallmarks of the establishment of a true profession. These activities validate professional practice standards and promote advancement of knowledge in the field. In academia, research is often an expectation of faculty and may be the major determinant in tenure and promotion decisions.
RESEARCH AND REPORTS

Hu and Gill, reporting on the research productivity of information specialists, further state that “it has become increasingly important for academicians to be more productive in their research fields. Being classified as a ‘research university’ is often perceived as an indication of quality programs, faculty and students. Very often such classification is based on the research productivity of faculty members or specific programs of a university.”

This study addresses similar issues, with particular emphasis on: demographic characteristics of CLS faculty members; time allocated to research by faculty degree, rank, kind of employing institution, and tenure status; scholarly productivity of CLS faculty; external funding awarded to CLS faculty; hours spent each week in teaching; and perceptions of the research environment.

MATERIALS AND METHODS

The survey questionnaire used in the 1996 study of clinical laboratory science faculty was slightly modified in 2008 and adapted to an electronic format via SurveyMonkey.

The questionnaire was divided into three sections. The first section sought individual demographic information, such as highest degree earned, current academic rank, tenure status, and type of employing institution. The second part identified each participant’s involvement in various research activities to include time spent in research, numbers of publications, presentations, and grants awarded as well as hours spent in teaching. The final portion focused on perceptions of the research environment within each faculty member’s employing institution.

The population surveyed included all faculty in National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) accredited college and university based baccalaureate level CLS programs. Names and email addresses of all regular salaried faculty members were obtained, either by using an internet search, or by contacting the program director. In May of 2008, e-mail cover letters together with an electronic link were mailed to 448 individuals from 106 programs, an average of 4.2 faculty per institution. Follow-up requests were sent to non-respondents in June and July. Responses were received from 275 of 448 (61%) CLS faculty, representing 93 of 106 (88%) programs.

Data were analyzed using SPSS 16.0 for Windows. For the purposes of this study, descriptive statistics and one-way ANOVA analyses are reported. The Scheffe post hoc test for multiple comparisons determined differences between groups. Consent to perform the investigation was obtained through the Institutional Review Board of The Ohio State University.

RESULTS

Demographic Characteristics

Demographic characteristics of the group are listed in Table 1. In 2008, 52 percent of CLS faculty held a doctorate degree and 54 percent were senior faculty (associate or full professors). Forty-five percent of the respondents were tenured, with 16 percent on a tenure-track line, and for 39%, tenure did not apply. The majority of respondents (55%) were from 4-year colleges/universities, while 42% were employed by research universities. Most faculty (66%) were on a 12 month full-time status. Fifty-three percent held a faculty position for 16 or more years and over three-quarters were women. Seventy-two percent of respondents were 50 years of age and older, and 26% were 60 or older.

Figure 1 shows the importance of research, teaching and service as perceived by faculty within their employing institutions. Two-thirds ranked teaching as most important, while 31 percent ranked research as most important.

Involvement in Research Activities

This section identified participants’ involvement in scholarly activities between 2001 and mid-2008. It included the number of hours per week spent in research, numbers of research publications (articles and abstracts), and presentations, together with grants awarded.

When queried as to the number of hours spent in research each week, and in 2008, 29% of faculty spent no time in research; 41% spent one to eight hours; 22% indicated nine to twenty hours; and 7% performed 21...
or more hours of research. Hours per week spent in research factored by degree, faculty rank, type of institution, and tenure status were measured. Faculty holding doctorates spent significantly more time in research than BS and MS degree individuals. Professors spent significantly more time in research than instructors/lecturers. Tenure track individuals spent significantly more time in research than tenured faculty as well as “tenure not applicable” individuals. However, tenured individuals spent significantly more time in research than “tenure not applicable” faculty. There was no significant difference for number of hours of research by type of institution.

Table 1. Demographic Characteristics of CLS Faculty Respondents – 2008

<table>
<thead>
<tr>
<th>Highest Level of Education</th>
<th>Frequency (</th>
<th>%</th>
<th>)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baccalaureate</td>
<td>14</td>
<td>(5.1)</td>
<td></td>
</tr>
<tr>
<td>Masters</td>
<td>118</td>
<td>(42.9)</td>
<td></td>
</tr>
<tr>
<td>Doctorate</td>
<td>143</td>
<td>(52.0)</td>
<td></td>
</tr>
<tr>
<td>Academic Rank</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructor/Lecturer</td>
<td>41</td>
<td>(14.9)</td>
<td></td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>85</td>
<td>(30.9)</td>
<td></td>
</tr>
<tr>
<td>Associate Professor</td>
<td>91</td>
<td>(33.1)</td>
<td></td>
</tr>
<tr>
<td>Professor</td>
<td>58</td>
<td>(21.1)</td>
<td></td>
</tr>
<tr>
<td>Tenure Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenured</td>
<td>124</td>
<td>(45.1)</td>
<td></td>
</tr>
<tr>
<td>Tenure Track</td>
<td>44</td>
<td>(16.0)</td>
<td></td>
</tr>
<tr>
<td>Tenure does not apply</td>
<td>107</td>
<td>(38.9)</td>
<td></td>
</tr>
<tr>
<td>Type of Employing Institution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-year major research university</td>
<td>114</td>
<td>(41.6)</td>
<td></td>
</tr>
<tr>
<td>4-year college/university</td>
<td>150</td>
<td>(54.7)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
<td>(3.6)</td>
<td></td>
</tr>
<tr>
<td>Current Employment Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time, 9 months</td>
<td>77</td>
<td>(28.0)</td>
<td></td>
</tr>
<tr>
<td>Full-time, 12 months</td>
<td>182</td>
<td>(66.2)</td>
<td></td>
</tr>
<tr>
<td>Part-time</td>
<td>16</td>
<td>(5.8)</td>
<td></td>
</tr>
<tr>
<td>Years in Faculty Position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 to 7</td>
<td>75</td>
<td>(27.6)</td>
<td></td>
</tr>
<tr>
<td>8 to 15</td>
<td>52</td>
<td>(19.1)</td>
<td></td>
</tr>
<tr>
<td>16 to 23</td>
<td>70</td>
<td>(25.7)</td>
<td></td>
</tr>
<tr>
<td>&gt;24</td>
<td>75</td>
<td>(27.6)</td>
<td></td>
</tr>
<tr>
<td>Level of students taught</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baccalaureate</td>
<td>271</td>
<td>(100)</td>
<td></td>
</tr>
<tr>
<td>Masters</td>
<td>104</td>
<td>(37.8)</td>
<td></td>
</tr>
<tr>
<td>Doctorate</td>
<td>37</td>
<td>(13.5)</td>
<td></td>
</tr>
<tr>
<td>Academic Role</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>161</td>
<td>(58.5)</td>
<td></td>
</tr>
<tr>
<td>Director or Chair</td>
<td>90</td>
<td>(32.7)</td>
<td></td>
</tr>
<tr>
<td>Education Coordinator</td>
<td>10</td>
<td>(3.6)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
<td>(5.1)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>213</td>
<td>(77.5)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>62</td>
<td>(22.5)</td>
<td></td>
</tr>
<tr>
<td>Age - years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 40</td>
<td>28</td>
<td>(10.4)</td>
<td></td>
</tr>
<tr>
<td>40 – 49</td>
<td>47</td>
<td>(17.4)</td>
<td></td>
</tr>
<tr>
<td>50 – 59</td>
<td>126</td>
<td>(46.6)</td>
<td></td>
</tr>
<tr>
<td>60 – 65</td>
<td>57</td>
<td>(21.2)</td>
<td></td>
</tr>
<tr>
<td>&gt;66</td>
<td>12</td>
<td>(4.4)</td>
<td></td>
</tr>
</tbody>
</table>

For research articles and abstracts in refereed journals as first or co-author, 36% of the respondents had never published a research article or abstract; 31% had published one to five; 14% published six to ten; and 19% (n = 53) had published 11 or more times. The numbers of research publications were significantly higher for doctoral faculty than faculty holding a BS or MS degree. Professors published significantly more than assistant professors and instructors/lecturers, but not statistically more than associate professors. Tenured and tenure track individuals published significantly more than “tenure does not apply” faculty members. There were no significant differences between tenured and tenure track faculty for numbers of research publications, nor between types of institutions.

For presentations, 24% of the respondents had never given a presentation; 26% had presented one to five times; 16% six to ten times; and 34% (n = 93) had given 11 or more presentations. Data for total presentations depicts scientific and research papers, poster sessions, case studies, brief presentations, panel discussions, and non-research symposia given at state,
national, and international levels. Tenured, doctoral faculty at the level of professor provided significantly more presentations. There were no statistically significant differences between type of institution and number of presentations.

Time spent in teaching was not significantly different by degree, rank, institution type, nor tenure status. On average, all CLS faculty spent 22 hours each week teaching.

Data on the number of CLS faculty awarded external funding, together with sources of such funding were collected and totaled $62 million. Between 2001 and 2008, the majority (83%) of funding originated from government sources. Forty-seven percent of faculty received some kind of external funding and 9.5% (n=26) garnered grants in excess of $500,000, with 20% (n=55) awarded from $100,000 to one million dollars or more. Doctoral faculty received significantly more funding than MS faculty. Professors were awarded significantly more grant monies than instructor/lecturers. There was no significant difference for total grant monies by type of institution nor tenure status.

Perceptions of the Research Environment
Table 2 shows the faculty members’ perceptions of their own research environments. Computer accessibility and the importance of research for promotion and tenure decisions ranked first and second as characteristics of the environment. Resources (including finances and time) were seen by faculty as being least present in their environments.

DISCUSSION
Our data show that CLS faculty members holding a doctorate make up 52% of all faculty in 4-year NAACLS accredited institutions. This percentage is smaller than faculty members in such allied health programs as health administration (80%), speech language pathology and audiology (70%), or physical therapy (67%). But, CLS faculty with doctorates are considerably more than those in dental hygiene (12%), radiography (12%), or physician assistant (18%), while somewhat similar to faculty in dietetics (59%) or occupational therapy (54%).

In clinical laboratory science, 53% of faculty have been in their positions for more than 16 years, and 72% are 50 years old or more. These findings are of concern, and the graying of the professoriate has grown in size. Our studies confirm anecdotal reports that suggest we may lose at least one quarter of our CLS faculty in the next five years.

Figure 1 depicts faculty members’ perceptions of the importance of research, teaching, and service in their own institutions. While 42% of respondents were employed in a research institution, only 31% of all respondents thought that research was most important. In contrast, two-thirds believed that teaching to be most important. This may indicate that some faculty in research institutions (e.g. academic health centers) have not been provided clear expectations of their duties, or that their roles are, indeed, primarily in teaching. This finding also supports CLS faculty members’ extensive involvement in teaching – an average of 22 hours each week, regardless of degree, rank, type of employing institution or tenure status. It also reinforces perceptions of their own research environments, in which “time available for research” ranked lowest with “research supported financially,” ranking next to lowest (Table 2).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer is accessible</td>
<td>6.1</td>
<td>1</td>
</tr>
<tr>
<td>Research is important for promotion/tenure</td>
<td>5.9</td>
<td>2</td>
</tr>
<tr>
<td>Research is a priority</td>
<td>5.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Research is rewarded</td>
<td>5.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Research is supported by department/division</td>
<td>4.9</td>
<td>5.5</td>
</tr>
<tr>
<td>Importance of research, teaching, and service well defined</td>
<td>4.9</td>
<td>5.5</td>
</tr>
<tr>
<td>Personally interested in research</td>
<td>4.8</td>
<td>7</td>
</tr>
<tr>
<td>Statistical services available</td>
<td>4.6</td>
<td>8</td>
</tr>
<tr>
<td>Research supported administratively</td>
<td>4.4</td>
<td>9</td>
</tr>
<tr>
<td>Institutional resources available</td>
<td>4.1</td>
<td>10</td>
</tr>
<tr>
<td>Research opportunities numerous</td>
<td>3.8</td>
<td>11</td>
</tr>
<tr>
<td>Research supported financially</td>
<td>3.5</td>
<td>12</td>
</tr>
<tr>
<td>Research time available</td>
<td>2.6</td>
<td>13</td>
</tr>
</tbody>
</table>

*Scale = 1(Low) to 7 (High)
Time spent in research was greatest for those holding doctorates (averaging 10.5 hours each week), and at the rank of professor. These findings suggest that these persons are more experienced in performing research and have achieved their rank by previously successful research productivity. However, by tenure status, those on a tenure track spent the most time in research, implying that to achieve tenure they needed to perform research.

For research publications again, those with doctorates and who held the rank of professor produced the most articles and abstracts in refereed journals as first or co-author. Again, these results are not surprising, indicating that individuals with doctorates and highest rank, are producing the most publications.

Presentations are correlated with publications, and again, those faculty with doctorates, highest rank, and tenured status had the greatest numbers of presentations.

It appears noteworthy, that once again, as in 1996, CLS faculty spent an average of 22 hours each week in teaching. This is a heavy teaching load. Hours spent in teaching did not differ significantly for type of employing institution, earned degree, or tenure status. These data may indicate, perhaps, that teaching is an essential component of most employment settings in higher education, whether located in research universities or in four-year colleges and universities. It may also reflect the small numbers of faculty in CLS baccalaureate programs, averaging only 4.2 faculty members per program.

Being awarded external funding is important, not only to faculty members, and their reputations, but also to their employing institutions. Here, we find that 55 faculty (20%) received $100,000 or more from 2001 to mid-2008. Sixteen (5.8%) received $1,000,000 or more during this time frame. Total numbers funded, at some level, were $62 million by 131 individuals (48%). These figures indicate that more CLS faculty are being awarded more monies than before ($23 million in 1996). The major source of funding in 2008 was the government ($51 million), at 83%. As might be expected, those holding doctorates and with the rank of professor garnered the most funding. However, neither tenure status nor type of institution was significant.

Faculty perceptions of the characteristics of their research environments reinforce the importance of research in their institutions. While computer accessibility ranked first in their work places in 2008, the statements “research is important for promotion and tenure, research is a priority, and research is rewarded” ranked 2 through 4. Here we may have a disconnection – while teaching was ranked first in importance by two-thirds of faculty participants, many of these same individuals ranked the importance of research very highly. Perhaps this may show an awareness that in their overall collegiate/university environment, research is considered important, but in their own programs, teaching is more important. Or, funding and/or time for research are lacking.

A 2001 study by Akroyd et al. investigated the differences in attitudes of allied health faculty and deans regarding the importance and rewards of teaching and research. Faculty perceived teaching as more important than did deans. The authors concluded that faculty roles, expectations, and the appropriate reward and support system should be clearly delineated for both teaching and research.

A relatively new finding in this study was a lack of difference in research activities (time spent, publications, presentations, or funding) between faculty in research universities and those in non-research four-year colleges and universities. This has recently been an observation with commentaries in The Chronicle of Higher Education. For example, Ghodsee wrote a compelling piece regarding her accepting a position at a liberal arts college in Maine. She states, “in my own case, as a result of a lower teaching load, generous internal grants, and two years of junior leave to take advantage of external fellowships, I was able to do the research and writing for a second book and several peer-reviewed journal articles. I successfully came up for tenure in my sixth year.”

Her article prompted a number of letters to the editor including Raybeck’s comments, “I have spent my entire professional life in a liberal-arts setting, where I
found research support, travel funds for meetings, and a personal – not bureaucratic – relationship with administrative officers. The result was a number of books, scores of articles, and an active engagement with my profession of anthropology."

Still, Taub11, a biologist, writes. . ."college professors in some disciplines appear better able than professors in other fields to approximate the research output of their colleagues at doctoral institutions. Faculty members in history did best, nearly matching the rate of their doctoral colleagues’ scholarly publications: college professors of political science, communications, English and literature, philosophy and religion, and fine arts published more than two-thirds as much as did their peers at doctoral institutions. In contrast, faculty members in business, foreign languages, biology, physical sciences, and computer sciences published less than a third as many scholarly works as did their doctoral colleagues."

Our colleagues in clinical laboratory science may appear to have somewhat “bridged a gap” in research activities and productivity, concerning their own sites of employment. A number have been successful, regardless of setting.

Finally, attention must be paid to the Association of Schools of Allied Health Professions (ASAHP) for its ongoing advocacy and oversight of research activities among many allied health disciplines, including clinical laboratory science. More recently, ASAHP published a special article on the NAPRAH Symposium: Enhancing Faculty Research Career Development: Infrastructure and Mentoring Models.12 The National Alliance Promoting Research in Allied Health (NAPRAH) was formed in 2003 to assist the research capacity among the allied health professoriate.

Finally, Wise, Brotherton and Mitcham have offered an opinion in which teaching and service can enhance scholarship among faculty members.13 They state:

With heavy teaching loads and service expectations, many allied health faculty members find themselves in situations that limit their ability to engage in traditional research and scholarship of sufficient magnitude to meet institutional standards for promotion and tenure. Strategies that link teaching or service activities to scholarly productivity increase the potential for allied health faculty to build credible forms of scholarship and find their niche in the academy.

Thus, good teaching and good service can lead to good scholarship.

CONCLUSION
Clinical laboratory science faculty from both research institutions and four-year colleges and universities, have made progress in earning doctorates, and in their own research activities including time spent in research, publications, presentations and grantsmanship. Those holding doctorates and senior faculty have been most successful in scholarly activities.

All faculty members, regardless of their employment setting, spend an average of 22 hours per week in teaching, perhaps precluding some from a more active involvement in scholarly pursuits. The CLS professoriate is also graying, and possibly one-quarter may retire within the next five years. These circumstances call for our advocating and nurturing potential faculty – particularly in research, to join our ranks.

REFERENCES
An Exploratory Study of Live vs. Web-Based Delivery of a Phlebotomy Program

NADINE A FYDRYSZEWSKI, CRAIG SCANLAN, H JESSE GUILLES, ANN TUCKER

ABSTRACT: Changes in student population and increased Web-based education offerings provided the impetus to assess pedagogy, cognitive outcomes and perceptions of course quality.

OBJECTIVE: This study explored cognitive outcomes and students’ perception of course quality related to the Seven Principles for Good Practice in Undergraduate Education between live classroom delivery, compared to a Web-based delivery of a phlebotomy program.

DESIGN: Quasi-experimental; students self-selected to enroll in live or Web-based program.

RESULTS: For cognitive outcomes, no significant difference was found between the groups. Student perception of course quality differed only for Principle One (student-instructor contact). Students in the live classroom rated Principle One higher for the Part I course compared to the Web-based group. For the Part II course, there was no significant difference in perception of course quality related to any of the Seven Principles.

CONCLUSIONS: The more constructivist pedagogy in the Part II course did not improve cognitive outcomes however, it may have contributed to knowledge retention. The live group rated Principle One in the Part II course evaluation relatively the same as they did for the Part I course evaluation. However, the Web-based group rated Principle One considerable higher for the Part II course than for Part I course. Future studies with a larger sample could explore improved course quality assessment instruments.

INDEX TERMS: Web-based education, cognitive outcomes, course quality, Seven Principles

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INTRODUCTION
The 21st century has introduced unique challenges to higher education. A changing student population with increased non-traditional students, women, adult learners, rapid technological advances, and increased competition and challenges in resource allocation have compelled higher education institutions to become more responsive to the needs of adult learners. An analysis of trends revealed that there is a growing market for distance education courses both academic and non-academic as well as certificate programs. In the clinical laboratory science profession, an increasing number of programs are offering Web-based education, but a paucity of literature exists regarding the evaluation of clinical laboratory science Web-based programs and courses.
The purpose of this study was to compare two types of educational delivery methods for a post-secondary phlebotomy certificate program, Web-based distance learning, and traditional live classroom delivery. The phlebotomy program consisted of theoretical courses and a clinical practicum. The instructional design was a mixed pedagogical design based on the Continuum of Knowledge Acquisition Model (CKAM).

Pedagogy - CKAM
The CKAM advocates a mixed pedagogical approached based upon the level of the learner and the pedagogical strategies change as the student moves along the continuum of learning. This approach supports the concept of matching learning theories with the content and the level of the learner, blending objectivist and constructivist learning theory, and is divided into three phases. In the first phase (introductory), the learner has very little or no prior knowledge of the subject matter. In this initial stage of learning an objectivist approach is used to learning strategies. Objectivist pedagogy is instructor-centered, using clearly defined measurable goals and mainly utilizing testing, reinforcement, re-testing strategies to assess learning. In the second phase (advanced), the learner has acquired some knowledge and is capable of solving more complex problems. In this phase, constructivist pedagogy is introduced. Constructivist strategies are learner-centered, with the instructor involved as a facilitator and utilizes problem solving approaches as well as strategies where the student helps create their learning environment. By the third phase (expert), learners should have extensive knowledge and experience that has been transferred from the previous learning phases. In the CKAM Model, as a student moves through the phases of learning they gain more control over their learning and the learning environment.

The mixed model has application in health professions education, particularly phlebotomy education. Students entering the health professions usually have minimal to no prior knowledge of the discipline-specific content and skills. The educational process begins with building a foundation of knowledge using the objectivist approach, and progresses toward higher-level knowledge acquisition, skill building, and experiential learning in advanced theory courses and the clinical practicum using a constructivist approach.

This research focused on student learning outcomes measured by final exam performance and perceptions of course quality measured by a Course Quality Survey. The research addressed several shortcomings and gaps cited by Phipps and Merisotis as key deficiencies in past studies: 1) the theoretical/conceptual framework of distance education courses, 2) program outcomes versus single course outcomes, 3) instrument validation, and 4) sample selection. In addition, this study identified and evaluated strategies developed for both the Web-based and traditional live classroom phlebotomy program that implemented the Seven Principles for Good Practice in Undergraduate Education. Table 1 lists the Seven Principles.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
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<tbody>
<tr>
<td>One</td>
<td>Encourages contact between students and instructor</td>
</tr>
<tr>
<td>Two</td>
<td>Develops reciprocity and cooperation among students</td>
</tr>
<tr>
<td>Three</td>
<td>Uses active learning techniques</td>
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<tr>
<td>Four</td>
<td>Gives prompt feedback</td>
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<tr>
<td>Five</td>
<td>Emphasizes time on task</td>
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<tr>
<td>Six</td>
<td>Communicates high expectations</td>
</tr>
<tr>
<td>Seven</td>
<td>Respects diverse talents and ways of learning</td>
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</tbody>
</table>

Adapted from “Seven Principles for Good Practice in Undergraduate Education”, by Chickering A, Gamson Z. 1987, AAHE Bulletin, March, p.1

The hypotheses explored were: 1) is there a difference in cognitive outcomes between students learning theoretical content in a traditional synchronous live classroom format compared to those learning the same content in an asynchronous Web-based delivery format? 2) is there a difference in student perception of the course quality related to the Seven Principles in a traditional synchronous live classroom format compared to an asynchronous Web-based delivery format? 3) is there a difference in student cognitive outcomes versus student perception of course quality in a traditional synchronous live classroom format compared to an asynchronous Web-based delivery format?

The Course Quality Survey was developed using items from the Flashlight Current Student Inventory (CSI). CSI
is an evaluation tool kit consisting of 481 survey items and interview questions indexed by technology and educational issues based on 14 themes. The 14 themes incorporate and expand on the Seven Principles. IRB approval was obtained from the institution and data from only those students who signed the consent form were used in the study.

METHODS
The Phlebotomy Program used in this study consists of multiple courses: Part I Basic Theory, Part II Advanced Theory, and a Clinical Practicum. The research was conducted in three phases. Curriculum design was the focus in phase one. In this phase, the CKAM was operationalized, and the Seven Principles (Table 1) were implemented into the courses. Pilot testing of the curriculum and the validation of instruments was conducted in phase two, and phase three was implementation of the research study.

Sample size was determined by an a priori power analysis (0.8) indicating a minimum of 17 in each group. Due to attrition this was not achieved in the 2005-2006 offering of the program. Data were pooled to include the 2006-2007 class. A pre-course survey was administered to assess key sample demographics and to gather data on the potential covariates. The characteristics assessed were: age, gender, ethnicity, English as a second language, work status, highest level of education, length of time since took a formal education course, reasons for taking this program, residence (urban vs suburban), and prior phlebotomy training/experience. Analysis of the demographics between the 05/06 and 06/07 groups indicated no significant difference. Post hoc power analysis was 0.72.

DATA ANALYSIS & RESULTS
Data analysis consisted of descriptive statistics, chi-square, independent t-test, correlation analysis. All methodological assumptions were met except random samples, which could limit the generalization of the study. For the t-test, homogeneity of variances was confirmed by the Levene’s Test for Equality of Error Variances. For the Pearson product-moment correlation analysis, all distributions were confirmed to be normal by the Shapiro-Wilk Test.

Sample
A total of 62 students enrolled: 33 in the live program; 29 in the Web-based program; 58 signed the consent form to participate in the study. The final study sample, those completing the phlebotomy program, was 30, with 19 in the live and 11 in the Web-based program. For demographic characteristics, there was no significant difference between the program completers vs. the non-completers, except for ethnicity. A slightly higher rate (50%) of African-American/Blacks did not complete the program. For the program completers
there was no significant difference between the two groups for any of the demographic characteristics explored except for education level. There was a significant relationship between the type of education delivery and the highest education level of the student. In the Web-based group 64% indicated more than a high school education, while only 16% of those enrolled in the live classroom program achieved more than a high school education. An independent sample t-test was performed to assess computers skills between the two groups. There was no significant difference between the live classroom setting and the Web-based setting for computer skills (t= .796, df=25, p= .43).

Cognitive Scores
Independent samples t-test was used to compare cognitive outcomes between the live and Web-based groups (Table 2).

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>M</th>
<th>SD</th>
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<tbody>
<tr>
<td><strong>Part I Exam Scores</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live Classroom</td>
<td>19</td>
<td>88.79</td>
<td>7.40</td>
</tr>
<tr>
<td>Web-based</td>
<td>11</td>
<td>87.27</td>
<td>5.73</td>
</tr>
<tr>
<td><strong>Part II Exam Scores</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live Classroom</td>
<td>19</td>
<td>85.32</td>
<td>8.45</td>
</tr>
<tr>
<td>Web-based</td>
<td>11</td>
<td>87.09</td>
<td>9.98</td>
</tr>
</tbody>
</table>

The same final exam was administrated at the end of the Part I and Part II course. There was no significant difference between the live classroom group and the Web-based group for the first administration at the end of the Part I course (t= -.57, df=28, p= .57), and no significant difference between the two groups for the second administration at the end of the Part II course (t= -.52, df=28, p= .61).

Student Perception of Course Quality Ratings
Independent samples t-test was used to compare students’ perception of course quality between the live and Web-based groups. The same Course Quality Survey was administered at the end of the Part I and Part II course. There was no significant difference between the live classroom and the Web-based groups for the overall Course Quality Survey rating for the first administration at the end of the Part I course (t= 78, df=28, p= .44) and no significant difference for the second administration at the end of the Part II course (t= .58, df=28, p= .57). For the survey results from the Part I course, there was no significant difference for Principles Two through Principle Seven. However, there was a significant difference between the live classroom setting and the Web-based classroom setting for Principle One, student/instructor contact. (t=2.34, df=28, p= .03). Those in the live classroom setting had significantly higher Principle One ratings than those in the Web-based classroom setting. For the survey results from the Part II course there was no significant difference between the Web-based classroom setting and the live classroom setting for any of the Seven Principles subscales.

A paired sample t-test was conducted to evaluate the Part I and Part II Course Quality Survey Principle One (student/instructor contact) subscale rating differences between the live classroom group and the Web-based group. There was no significant difference between Part I and Part II course rating of Principle One (student/instructor contact) for the live setting (t=1.42, df=18, p= .17), and no significant difference between Part I and Part II course rating of Principle One (student/instructor contact) for the Web-based group (t=2.08, df=10, p= .06). Evaluating the mean difference for Principle One (student/instructor contact) for the Part I and the Part II course revealed the live classroom group rated Principle One (student/instructor contact) slightly higher for the Part II course than the rating for the Part I course (mean difference= -1.37, SD=4.20). This is a difference of approximately one point and of little significance. For the Web-based group, the mean difference for Principle One (student/instructor contact) was -4.27, SD=6.82. The Web-based group demonstrated a four point increase in the rating of Principle One (student/instructor contact) between the Part I course (M=41.90) and the Part II course (M=46.18). Although the difference is statistically not significant, a wide 95% confidence interval of difference (-8.86) and the small sample for the Web-based group (n=11) suggests the need to collect additional data before making any conclusive observations.

Pearson’s correlation coefficients were calculated to determine whether there was a correlation between the
Course Quality Survey scores and the cognitive Examination scores. For the Part I course, all of the correlations between the Course Quality Survey ratings and the cognitive measurement, the final exam score were significant and negative. These results reveal that, in general, the higher a students’ cognitive score the lower their overall course quality and principle subscale scores. When examining the correlations from the Part II course, all of the correlations between the Course Quality Survey ratings and the cognitive measurement, the final exam scores were not significant.

**DISCUSSION**

Analysis revealed there was no significant difference between the two groups for age, gender, ethnicity, English language, work status, reasons for taking the course, residence, prior phlebotomy training and computer skills. However, there was a significant relationship between the type of education delivery and the education level of the student. Although the groups differed in highest level of education, statistical analysis failed to show that this difference affected students’ cognitive examination scores. Since there was no effect on this outcome measure, there was no justification to incorporate education level as a covariate.

There was no significant difference in scores between the live classroom and the Web-based classroom setting for the first administration of the final exam in the Part I course and the second administration in the Part II course. These findings were consistent with the numerous studies that have reported Web-based student cognitive outcomes to be comparable to traditional live classroom delivery.\(^{18,19,20}\) Because the study’s planned minimum power was not achieved, a Type II error due to inadequate sample size may be a factor in the no significant difference findings for cognitive outcomes. However, the difference between the groups on the final exam scores was extremely small, on average less than two points. This difference is not seen as particularly important, and an adequately powered study still may not have found this difference statistically significant. Based on the results of this study it is apparent that the mixed pedagogical approach implemented, particularly the more constructivist approach in the Part II course, did not improve cognitive examination scores. Students performed relatively the same, with no significant increase or decrease in final exam scores between the Part I and Part II course.

There was no significant difference between the live classroom and Web-based groups for the overall course quality ratings for the Course Quality Survey in Part I and Part II courses. However, the findings revealed a significant difference for subscale Principle One (student-instructor contact). The results of the Course Quality Survey administered in the Part I course revealed students in the live classroom rated their experience significantly higher on Principle One subscale (student-instructor contact) when compared to students in the Web-based classroom. This was not the case for the rating results of the second administration of the Course Quality Survey for the Part II course. For the Part II course, there was no significant difference between the live classroom setting and the Web-based setting for the overall Course Quality rating and all the subscales. Even after controlling for differences in final exam grades, the students in the live setting vs. the Web-based groups still differed significantly \((F=5.25, df=1.27, p=0.30)\) in their perception of Principle One (student-instructor contact). This means that two students with the same grades still rated Principle One (student-instructor contact) differently. Possible explanations for this finding may be the physical/emotional presence in live vs Web delivery, instructor attributes and role in communication, and the student’s role in communication. Further studies are needed to explore these potential variables and their impact on perception of course quality. In the assessment of the sample characteristics, there was a difference between the live and Web-based groups in level of education. The results revealed that a higher portion of students with post-high school education were in the Web-based group. In general, for the first administration of the Course Quality Survey in the Part I course, the results indicated that those students with only a high school education rated the course higher than those with more than high school education. This suggests that the education level may be a third variable influencing the correlation analysis.

For the Part II course, there was no significant difference between the live classroom setting and the Web-based setting for overall Course Quality Survey.
ratings and all the subscales. It appeared that the difference in the rating of Principle One (student-instructor contact) between the first administration in the Part I course and the second administration in the Part II course were related to the Web-based group rating Principle One (student-instructor contact) higher for Part II course. In contrast, the traditional live classroom group provided comparable ratings on Principle One (student-instructor contact) between the first and second survey administration. This increase in the Web-based group rating of Principle One (student-instructor contact) may have been due to the clinical rotation experience. The Web-based group experienced live student-instructor/preceptor interaction for the first time during the program of study.

For the Part I course, all correlations between the Course Quality Survey’s seven subscales and the students’ examination scores were significant and negative. Contrary to expectations, this finding indicated that the best performing students tended to assign lower ratings to all dimensions of course quality. In contrast the weaker students, although still passing the course, tended to rate the course higher. Complicating this unexpected finding was that the same relationships did not pertain when comparing these measures for the Part II course. For the Part II course, the correlations between the Course Quality Survey and the cognitive measurement, although negative, were relatively low. In the Part II course, although all students began with didactic sessions and lab sessions, they were then placed in different clinical sites for the clinical practicum. There is clinical site rotation variability (i.e. site size, preceptor, patient population). These variables may have accounted for the changes in course perception observed in this study.

CONCLUSIONS & FUTURE DIRECTIONS
Limitations applied to this study were: 1) small sample size which limits generalization; 2) quasi-experimental vs. true experimental design; 3) construction of the Course Quality Survey may not have included all measures associated with good practice and self-perception of course quality and as applied in this analysis, several of the survey’s Principle sub-scales had marginal reliability; 4) the effect of student learning styles on outcomes which was beyond the scope of this study. Notwithstanding these limitations, the results of this study have both theoretical and practical implications. From a practical standpoint, the study revealed potential improvements that could be implemented in curriculum design, particularly related to the Part II course. The curriculum modifications could lead to an improved research design and potentially more meaningful findings. The comparison of outcomes in an entry-level allied health profession provided administrators and instructors with information to develop and evaluate similar programs that could be delivered in an on-line environment using a mixed pedagogical model.

The findings of this study provide several new lines of inquiry with future phlebotomy classes: 1) implementing modifications to improve measurement tools, 2) restructuring the program into three courses, Part I Theoretical, Part II Advanced Theoretical, and Part III Clinical Practicum, 3) evaluating the instructor-student interaction in the Web-based courses and potential impact on perception of course quality, 4) assessment of student attributes, such as motivation and perseverance in relation to cognitive outcomes and perceptions of course quality and instructor effectiveness, 5) assessment of the applicability of the Seven Principles in a predominately objectivist pedagogical model versus a constructivist model, and 6) explore the role of education level on perceptions of course quality. Research can focus on the effectiveness of a mixed pedagogical approach such as the CKAM Model.

REFERENCES


ABSTRACT: A typology of EBP research heuristics was defined relative to clinical laboratory science levels of practice. Research skills requisite for CLS baccalaureate level are associated mainly with quality control of analytic processes. Research skills at master’s level are associated with pre- and post-analytic investigations, as well. Doctoral level CLS practice portends to utilize research skills facilitating quality investigations at the systems level.

ABBREVIATIONS: ASCLS = American Society for Clinical Laboratory Science; CTR = clinical and translational research; CLS = clinical laboratory science/clinical laboratory scientists; DCLS = doctorate in clinical laboratory science; EBM = evidence based medicine; EBP = evidence based practice

INDEX TERMS: clinical and translational research; clinical and translational science; clinical doctorate; clinical laboratory science; clinical outcomes; critical thinking; epidemiology; evidence based practice; expert practice; professional doctorate; research methods.

INTRODUCTION
The emerging view of evidence based practice in clinical laboratory science is one with patient-centered focus and interaction. In venues in which the impact of laboratory information is determined to impact patients’ well-being, clinical laboratory scientists, functioning at levels of practice appropriate to their education in clinical research, will collate, interpret, and summarize clinical laboratory information and consult with patients and other healthcare providers to optimize services delivery and desirable health outcomes.1

Working backward from this prototype practice to CLS educational programs, didactic coursework and internships must be designed to inform practice and expose students to clinical experiences providing the greatest opportunity to develop the research skills necessary not only to utilize evidence in clinical decision-making but also to generate and communicate data-supported practice guidelines, to monitor patients’ critical paths, to evaluate and introduce new technology, to develop quality indicators, and to create and analyze testing algorithms. Not only will this CLS evidence be used in clinical decision-making, but these ordering and utilization data can be analyzed to support development of best practices to decrease errors, increase patient safety, and communicate CLS evidence for practice improvement across all healthcare delivery systems, public and private. Though the need for this CLS-specific clinical and translational research (CTR) has been clearly articulated, educational strategies for teaching the tenets of EBP appropriate for each level of CLS practice have not been previously defined.2

RESEARCH AIMS
Literature related to the theoretical underpinnings of CLS EBP was explored. In 2002, critical thinking behaviors, emerging from CLS practice, were reported...
from a large national survey of CLS practitioners. Common themes, or CT factors, were then distilled from the CT behaviors identified. These CT factors have been shown to be exhibited in expert practice in the healthcare professions, and can be considered categories of observable expert practice behaviors emanating from the critical thinking process. Further, the epidemiologically-based methodologies of CTR can be shown to serve as an important applied platform for the exercise of critical thinking behaviors comprising expert practice. These CT-expert practice-EBP connections are discussed in more detail elsewhere.

EBP heuristics needed to effectively apply methodology of CTR in CLS practice can be identified and ordered according to extent of CT behaviors involved. The aim of this study was to develop a research skills typology defining component constructs of EBP to be taught at CLS baccalaureate, master’s, and doctoral practice levels.

EVIDENCE BASED PRACTICE OVERVIEW

The larger Evidence Based Medicine (EBM) movement, from which DCLS practice tenets are derived, is driven by computerization (and information overload), the need for cost-efficiency, and public demand for best treatment options. EBM is commonly described using the definition of the author of the movement, David Lawrence Sackett, Canadian-born, American-educated physician:

“The conscientious, explicit, and judicious use of the best evidence in making decisions about the care of individual patients.”

Since the inception, however, much literature and many processes have been developed to support the generation and interpretation of “best evidence” and “making decisions about the care of individual patients.” A quick search will reveal a plethora of options for EBM study. Indeed, most health professions have adapted Sackett’s concepts to their own disciplines, and after this adaptation, the concept and practice strategy becomes “Evidence Based Practice” (EBP). Regardless of the adapted professional specificity, EBP shares with EBM a process for generating, evaluating, and utilizing best evidence in professional decision-making. This process denoted as “EBM Fundamentals” is provided in Figure 1.

The emerging view of CLS EBP is one with patient-centered focus and interaction. In venues in which the impact of laboratory information is determined to impact patients’ well-being, CLS practitioners collate, interpret, and summarize clinical laboratory information and consult with patients and other healthcare providers to optimize services delivery and desirable health outcomes. This focus of quality assurance is shared with traditional EBM practice, i.e., effectiveness, as defined below, and encompasses patient diagnoses, therapy monitoring, and assessing clinical outcomes. In addition, CLS EBP must include the traditional measures of quality (quality control) as well as quality evaluation, assurance, and improvement at the systems level, where the EBP of other disciplines supported by laboratory information integrate with CLS EBP. An axiom borrowed from the manufacturing sector figures prominently in the measurement of quality of clinical laboratory information: “Good quality costs less than poor quality.” Thus, EBP for CLS should incorporate clinical studies resulting in, for example, diagnostic testing descriptive studies, practice guidelines development, and cost-efficiency analysis as well as conventional effectiveness assessments like clinical trials and observational studies. These additional areas of practice are defined, in quality terms, as efficacy, e.g., diagnostic testing studies, practice guidelines development, and efficiency, e.g., cost-efficiency analysis. These quality definitions meaningful in CLS EBP are as follows:

- **Efficacy** measures how well a treatment works in clinical trials or laboratory studies, while
- **Effectiveness** relates to how well a treatment works in practice.
- **Efficiency** is broadly defined as “the mix of health care resource inputs that produce optimal quantity and quality of health and health care outputs… among individual, institutional, and groups of providers.”

The goal of the CLS EBP effort is to provide quality healthcare in the most cost-effective way. And it follows that quality healthcare delivery protocols, guidelines, and processes should be supported by evidence from rigorously constructed clinical studies that are experimental or observational in design. CLS practice must address all areas of quality services delivery:
efficacy, effectiveness, and efficiency. In other words, CLS EBP must address the entirety of the diagnostic and therapeutic processes that are supported by CLS information: quality in pre-analytic and post-analytic aspects of services delivery, as well as assuring quality of analytic processes.

EBP, then, can be succinctly stated as:

“The conscientious, explicit, and judicious use of the best evidence from CLS in making decisions about the care of individual patients.”

EBP RESEARCH HUERISTICS TYPOLGY FOR CLS EDUCATION

EBP is clinical in nature with roots in epidemiological methodology. As such, these clinical and translational approaches are not typically addressed to any significant degree in CLS curricula. Certainly, the application of EBP research methodologies in CLS practice has never been acknowledged nor have EBP research skills been indexed to CLS practice levels. Common components of EBP research are listed in Table 1. Figure 2 summarizes an instructional typology suggesting an ordered presentation of clinical research constructs from more basic (baccalaureate) to complex (doctorate) in CLS education. EBP constructs appropriate for the CLS baccalaureate level are those statistical concepts underlying quality control assessment and concepts related to critical appraisal of the literature. Appropriate for the CLS master’s level are instruction in human and non-human research policy, design, and methodology as well as practice in identification and utilization of evidence to evaluate analytic testing phase questions. At the doctoral level, EBP instruction should focus on clinical and translational research concepts employed in effectiveness studies for evaluation of pre- and post-analytic testing phase questions.

Practice responsibilities at all practice levels should capitalize on these expanded scopes of knowledge. Evaluation of the analytic phase of the diagnostic testing process, i.e., quality control, is appropriate for the baccalaureate-prepared practitioner. Additional EBP knowledge at the master’s level prepares these post-baccalaureate practitioners to identify and address clinical questions related to testing process efficacy and clinical effectiveness. These types of analyses can be categorized under the rubric of quality assurance.12 Doctorate-prepared practitioners should focus on clinical questions involving the appropriateness and utilization of CLS information. These doctoral-level analyses represent system-wide approaches to the assessment of clinical quality improvement questions involving the interpretation and utilization of laboratory information by multiple disciplines.1,8

EBP RESEARCH MODELS IN CLS EDUCATION

Much literature has been devoted to theoretical and practical aspects of statistical analysis of quality in laboratory testing.9 Further, statistical underpinnings as well as clinical applications of quality control are taught and modeled during associate and baccalaureate pre-service CLS education. These elements of practice and quality management are the foundations of EBP in master’s and doctoral level CLS education and practice. Types of research designs appropriate for master’s level CLS education and practice and examples of completed master’s level projects are listed in Table 2.
At the CLS doctoral level (DCLS), the complexity of EBP research and commensurate requisite education increases due to the systems approach required in clinical investigations as well as the interactive nature of CLS EBP and the EBP of other healthcare disciplines. As an example of this increasing complexity, suppose the results of the master’s level project correlating the five-part white cell differential to total white count in leukemia patients suggested a substantive change in ordering patterns for that diagnosis group. First, an EBP study testing this hypothesis would have to be designed, using the EBP process, to identify and assess patient outcomes with the potential for variance relative to these hematological parameters. After the study was implemented and evaluated and if the hypothesis were accepted, practice guidelines could be altered and new guidelines constructed and proposed. Acceptance of these new practice guidelines by the medical staff would not only alter CLS EBP but would also impact EBP of physicians, nurses, and other healthcare providers involved in the critical path of patients in this diagnosis group.

### Table 1. EBP Research Component Constructs

- **Statistical Analyses**
  - Bayes’ Theorium; Causation; Hypothesis Testing
  - Sensitivity/Specificity; ROC
  - Predictive Value
- **Experimental Research Design**
  - Diagnostic Testing (Screening vs. Specific; Incremental Gain; Bias)
  - Strength of Evidence
  - Randomized Clinical Trials (RCT)
- **Observational Studies**
  - Outcomes / Cost-effectiveness Analyses / Cohort / Cross-sectional
  - Practice Guidelines Development / Clinical Prediction Rules
  - Meta-analysis

Like the EBP process itself, the choice of DCLS EBP projects to pursue should be data-driven. Given that the roots of CLS EBP are embedded in quality, projects should be considered that offer the greatest potential impact on quality services delivery. Among that population would be diagnoses impacting laboratory operations because of their frequency, increased risk of errors in ordering or interpreting test results, or high per unit laboratory direct costs. The following steps should guide the development and utilization of evidence for performance improvement at the systems level:

1. **Identify collaborating healthcare subspecialties and services utilizing and monitoring significant clinical laboratory information for medical decision-making, e.g., pharmacy, quality improvement, therapeutics/transfusion service, infectious disease, risk management, utilization review, internal medicine, elective surgery, family medicine, emergency medicine, pediatrics, geriatrics, oncology, hospital medicine.**
2. **Identify high risk, high frequency, and high cost procedures and diagnoses as well as quality indicators in each of the subspecialties and services.** The procedures and diagnoses identified as well as quality indicators chosen to be monitored for institutional quality assessment will provide the criteria for determining study type and focus, i.e., outcome/diagnosis study, cost-effectiveness analysis, practice guideline development/comparison.
3. **Identify high risk, high frequency, and high cost clinical laboratory tests, procedures, and/or diagnoses in the clinical laboratory as well as related quality indicators for each of the subspecialties.**
4. **Compare high risk, high frequency, and high cost tests, procedures, diagnoses, and quality indicators.**
in the subspecialties to those in CLS. Apply evidence based techniques to investigate patient cases related to procedures, diagnoses, and quality indicators common to both. Comparison of clinical laboratory quality indicators to those diagnoses/procedures with high clinical laboratory resources impact will provide criteria for determining diagnoses/procedures for study focus.

- Analyze utilization data from focused clinical study(ies) to propose common steps and strategies in design and development of representative evidence based study models that can be implemented in DCLS internship experiences and, afterwards, in practice.

The role of the CLS practitioner would be to apply EBM process steps to their appropriate level of CLS practice by: (1) evaluating projects with potential for quality impact, i.e., those related to assessment of quality indicators, efficacy, effectiveness, and/or efficiency, (2) identifying projects related to diagnoses and/or procedures (tests) with greatest impact on quality services delivery, (3) searching the literature for practice guidelines and standards relevant to these projects, (4) comparing existing internal critical paths associated with these projects to relevant published guidelines and standards, and (5) evaluating the downstream effects of differences in internal practices and relevant published protocols. The CLS EBP process and its relationship to the EBM process model are summarized in Figure 1.

SUMMARY AND CONCLUSION
In preparation for their advanced practice roles, CLS students will perform clinical internship duties that will prepare them for practice upon program completion. Baccalaureate students, and baccalaureate-prepared CLS practitioners later, will control laboratory analytic processes in all venues where testing is performed. Master’s students, and master’s-prepared CLS practitioners, will address issues of quality related to assessment of effectiveness of laboratory processes and information. DCLS students, and DCLS practitioners, will collate, summarize, and present laboratory information related to patients and intervention groups representing significant clinical laboratory resource utilization. The typology of research skills presented here provides the epistemological frame for defining, teaching, and applying this EBP process in CLS.

REFERENCES
Focus: Online Education and Technology

Introduction

VICKI S FREEMAN

Medical Laboratory Science (MLS) educators continue to look for new and better ways to teach students the knowledge and skills that they will need when they graduate and become employed in the laboratory field. Educators are also challenged by administration to increase the size of their classes (but with fewer resources), make their programs more cost-effective, and meet workforce needs. In recent years, to meet these demands, distance and online learning opportunities have substantially increased in MLS programs. Currently, nineteen MLS and twenty-five Clinical Laboratory Technology programs are listed as having components of online education.¹

Originally, this focus series was planned to discuss distance education and technology. However, as the articles evolved, it became evident that using the narrower term of online education was more precise when coupled with the term technology. The Focus section has been divided among two Clinical Laboratory Science journal issues with the summer issue focusing specifically on technology (Using Technology in Resource Limited Countries for Competency Based Education and Training and Moving from Face-to-Face to Online Teaching) and the education supplement discussing effective online education techniques (Staying Connected: Online Education Engagement and Retention using Educational Technology Tools and Preparing Online Students for Comprehensive Examinations). A few definitions are important, as many different terms are employed when discussing these topics.

Distance learning is an educational situation where “the instructor and students are separated by time, location, or both”² and can be either synchronous (real-time, instructor-led event in which all participants are virtually “in class” at the same time) or asynchronous (interaction between instructors and students occurs intermittently with a time delay) using a variety of distribution methods including technology.² Online education is also a separation of the teacher and learner, but it uses a computer network to present or distribute educational content with two-way communication via the network so that students may communicate with instructors and each other.³ As you can see, the definition of distance education is broader and inclusive of the definition of online education. Distance education does not have to use technology in order for education to be distributed. However, online education does not necessarily need to be completely “distance,” but can include a combination of modalities, including on-campus sessions. Two other terms that fit into online education are blended learning and web-enhanced courses. In blended learning, instructors “combine face-to-face instruction with online learning and reduced classroom contact hours,” while web-enhanced courses are face-to-face courses that make use of the web through a course management system but do not reduce classroom time. Online resources may be used, but do not replace classroom time.⁴

Interestingly, students not only expect, but actually demand, that some coursework be available online. As some of the articles in this series will discuss, even students attending face-to-face classes expect to be able to access online resources including downloading previously delivered classroom lectures. But, it is also important to realize that not every student wants to take their education online nor are successful at online learning. Therefore, although faculty members need to find ways to respond to student expectations and enhance the learning of the students, they need to make sure that a variety of learning strategies are available to match the learning styles and needs of their students.

“Good teachers have always used a mix of strategies, methods and media to reach their objectives—that’s not new. What is new is that today’s internet-based tools...
can facilitate communication, interaction, and collaborative learning in ways that were not possible before.\(^5\)

The challenge to faculty is to keep up-to-date on the new tools that are available and find ways to use them in an appropriate and effective manner in their classes. Questions such as whether to allow students to have computers or even cell phones in the classroom have arisen. If e-tools are being used for learning purposes in place of classroom exercises, how does an instructor measure competency? Overseas, MLS programs are moving to more competency-based curricula. Face-to-face contact does not ensure competency any more than online teaching. Also, what techniques can an instructor use to keep in contact with and develop a “presence” in the online classroom if the student is totally online? And, finally, as is necessary with all programs, how can programs assess and evaluate the learning outcomes?

The purpose of this focus series is to provide information on the different tools available to an instructor when delivering online education and to show how instructors are using these tools in their courses. Four articles were selected to highlight:

- the e-tools that are available and how these tools help to engage and retain online learners;
- competency-based education in resource-limited countries and how technology, including online resources, are used to facilitate the skills development;
- how faculty adjust their teaching and their courses to effectively facilitate learning online; and
- an assessment of learning outcomes using comprehensive exam scores.

I hope that these articles encourage clinical laboratory educators to at least try some of the online tools that are available on most campuses or at least incorporate some web-based educational resources in their courses.

REFERENCES

Staying Connected: Online Education Engagement and Retention using Educational Technology Tools

JOSE SALAZAR

ABSTRACT
The objective of this article is to inform educators about the use of currently available educational technology tools to promote student retention, engagement and interaction in online courses. Educational technology tools include content management systems, podcasts, video lecture capture technology and electronic discussion boards. Successful use of educational technology tools requires planning, organization and use of effective learning strategies.

KEYWORDS: online education; educational technology; engagement; retention

LEARNING OBJECTIVES
1. Define educational technology.
2. List 4 educational technology tools used to enhance the delivery of interactive online education.
3. Discuss the overall impact of educational technology tools on online education.
4. Describe 2 major causes for high attrition in online education.
5. Identify and describe 2 interactive methods that result in increased engagement and retention of online students.

INTRODUCTION
The rapid evolution of computer technology has promoted the expansion of educational borders, both physical and mental, by allowing today’s students to virtually join the classroom via online education. More recently, online education has increasingly been delivered in electronic forms, such as web-conferencing, course management systems and wireless mobile devices. The internet has spawned a new generation of users who depend on computers for daily tasks ranging from paying bills to keeping up with friends via social networks. As students become more accustomed to the internet and the interaction it has brought to their online experience, they expect their online education to use similar applications for their learning experiences. There are major differences in an online teaching environment when compared to a face-to-face class. It is important to differentiate between the competency of web surfing to that of completing actual coursework online. The additional options of the internet can enhance the learning experience and be used to teach to a variety of learning styles, but it also requires faculty to rethink how they teach and how they engage online students.

The use of educational technology, combined with a pedagogically sound curriculum, can be a powerful combination to engage and successfully graduate online students. Educational technology is defined as addressing educational needs using networked computers and mobile devices. Online learning outcomes and retention rates at least equal or exceed traditional classroom learning environments when instructors use a systematic design process to develop online courses. Dziuban et al. compared success and withdraw rates using an instructional design model and found that environments that support faculty development, promote organizational skills, and provide course
development assistance have a direct positive impact on student learning.³

Additionally, identifying the needs and expectations of the students in an online class plays an important role in creating a working relationship between the instructor and the students and results in increased student engagement and the establishment of an online virtual community. According to Ezarik, the majority of distance learners are older than 27, first-generation college students and enrolled part-time. They spend more time working and caring for dependents than on-campus students. Students who have the ability to be consistent, structured, and organized are more successful in an online course. By understanding the dynamics of online students an instructor can create a learning environment that allows the students to learn effectively, while interacting at their own pace and time.

Implementing Educational Technology
Educational technology has revolutionized the way education can be delivered and how it can be customized for maximal impact in an online environment. The measurable impact on students’ learning depends on the way educational technology is used and the conditions under which it is implemented.⁴ The implementation of online educational technology requires administration support, technical staff guidance and ample course development time. Educational technology does not replace effective learning strategies, but requires that the strategies be implemented in a manner that makes the best use of the technology. For example, discussions that take place in face to face classrooms can be mimicked to provide a similar learning experience by using discussion boards or chat rooms. Using this technology, the learning experience is enhanced because discussions are captured and can be reviewed later by students and instructors.

Student Engagement and Retention
Online education works best when it is not treated as a self-serve package. Creating meaningful interactions is of paramount importance to engage an online student. The following steps outline a series of recommendations that an online instructor should follow to successfully deliver an online course.

1. Distribute information on how to access the course online in an efficient and timely manner. For example, the instructor can host an orientation session so that online students will know where general course information is located and whom to contact if they have course content issues or technical problems with technology. To prevent procrastination, instructors should mandate orientation within the first week of class.

2. The online instructor must develop the course with a structured online platform. All course content should be well thought-out so that it is intuitive for the student to locate basic information such as the course syllabus, schedule, learning objectives, content, and assignments. The majority of universities are now adopting course management systems (CMS) such as Moodle®, Sakai®, Blackboard®, Angel® or WebCT®. These systems allow instructors to distribute and manage course materials in a password-secured central location.

3. Instructors should introduce themselves early in the course to establish an online presence. For example, instructors can create a self-introduction video clip or an interactive bio. Online students perform well when they experience a sense of community between their instructor and fellow peers.⁵ Group function well through online interactions between instructor-student and student-student that create an environment similar to a classroom. Educational tools such as podcasts, chat or discussion boards can be used to initiate contact.

4. Get the students involved early in the course. Ask students to utilize the educational tools to introduce themselves. Discussion forums, internal student web pages, and student groups are applications that allow both instructors and students to share information quickly and to specific groups. For example, at the beginning of the course, ask students to post a short biography with a picture. A more interactive approach involves students posting a short video clip showcasing themselves as they share parameters indicated by the course instructor.

5. Provide timely feedback. Maintain consistent contact with students regarding progress, graded assessments and student ideas. According to Hannum, students in
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successful programs were well-supported by strong orientation sessions, a single point of contact for students, and frequent instructor feedback.7

The same study found the most common reasons for attrition were students realization that the medium did not fit their learning style, minimal instructor interaction and lack of course information.7 Reducing attrition rates among online education programs is a major concern. Online courses require just as much planning, organization and use of effective learning strategies as traditional face to face courses. For instance, virtual simulations and web chats mimic elements of traditional classroom experience.7 Instructors can design their courses to include group activities and assessments that support writing, viewing, listening, comprehension, and synthesis. These activities pull in the student in a collaborative effort thus promoting student-student learning interactions and address the wide variety of learning styles. Further, if online courses are designed to incorporate educational technology in a student/instructor friendly manner, and if students are oriented to the tools, there is an increased possibility that reflective learning can be achieved and that the learning is adaptive, communicative, productive, narrative, and interactive.8 By using educational technology to its full potential, student learning can be improved and factors that contribute to online student attrition are minimized.

A number of educational technology tools that enhance online course learning have been introduced in the past decade. Podcasts, wikis, course management systems, and videoconferencing via internet protocol (IP) are just a few of the tools now available. These educational technology tools can be used to increase the amount of interactivity in an online course, thus resulting in a higher degree of student engagement and retention.

Educational Technology Tools
Synchronous audio and video delivery can be delivered live. One method available to accomplish synchronous video and audio delivery is called web-conferencing or Webinars. Several web-conferencing services and software downloads are available at no cost along with media license packages that education institutions may purchase and maintain. Web-conferencing allows synchronous connections among multiple locations. High-speed broad-band internet connections are required. The hardware requirements include a computer, web camera and microphone. Web conferencing allows for the creation of a sense of community and serves as an ice breaker between the instructor and the enrolled students.

Asynchronous online course interaction can be achieved by recording the session using the same technology as is used in web conferencing. Instead of delivering the content live, it is stored on a server with video streaming capabilities. Students are then able to stream or download the recorded content at a time that aligns with their schedule. Video lecture capture technology (VLCT) is very similar to web-conferencing except that it is set up for continuous video capture of classroom lectures. VLCT supports student retention by engaging students, increasing student satisfaction, and promoting student achievement.9 Every class is captured in a combination of both audio and video format using computers and the internet for capture, processing and delivery. There is no need to process tapes or hire a film crew. The VLCT is distributed to students through an online course management system. Students are then able to review the captured materials anytime, anywhere. VLCT provides instructors with a teaching strategy that resonates with students accustomed to multimedia. Instructors initiate recording software before beginning their class lecture. The software records the lecture and provides video feeds of the instructor and the presentation (PowerPoint, for example). The captured content is uploaded to a server that makes the content available to students within an hour. Students who have logins are able to view the lectures from any computer device connected to the internet. Further, students may also download the audio/video content as podcasts and vodcasts to off-line computers and mobile devices thus allowing them to access the content without an internet connection. VLCT is also used to engage students in the class environment, particularly if they are joining asynchronously. A student can record content that is to be shared with classmates. For example as an interactive case study assignment, students can use the VLCT to record a case study at home, upload the presentation.
and easily distribute it to fellow classmates and instructors for peer review or grading.

Course management systems (CMS) are web-based platforms that allow instructors and students to securely access course materials, multi-media files, assessment tools, email, chats and discussions from a central site. Students utilize the CMS as the hub for their course interactions. CMS provides a rich environment an instructor can use to engage students by way of synchronous and asynchronous communication in an organized structure. Course information and content are organized and accessible. Good CMS programs are designed to be intuitive and consistent. A benefit of using CMS is its flexibility. CMS are easily customizable to provide a canvas for instructors to deliver a course. Some CMS structures are too flexible, providing more than one way to organize materials. This can be confusing.

An organizational plan must be developed before course materials are added to the CMS. When a user enters the course, a concise menu should appear. Too many menu choices will confuse and distract the user. Design the CMS so that the most basic and important pieces of information make up the course appear first. Menu items such as Announcements, Course Syllabus, Course Materials, Assignments, and Resources are deemed concise and appropriate for a course welcome page. Announcements should contain time-dependent information. Content changes, schedule updates, deadlines, and other timely information are appropriate under the announcement menu item.

Under the Course Syllabus heading, general course policies and the course schedule should be housed. Course Materials can be used to organize the course content, consisting of outlines, learning modules, slide shows and PowerPoint lectures notes. The Assignments area can include quizzes, exams, and individual assignment units. Under Resources, post internal and external links. Other menu items may be added as necessary.

Another area which is useful in CMS is the submission of assignments. Not only can the assignments be made available, but students can also submit them via assignment boxes that deliver files directly into the CMS instead of the instructor’s email. The process is a well-orchestrated exchange between instructor and student. To implement online submissions the instructor creates an assignment module within the CMS. Pedagogically-based models of online modules in the CMS involve the use of assignment learning objectives, grading criteria, and instructions for successful completion within the module. During this process the CMS automatically creates a “digital drop box” area for the student to electronically submit their completed assignment. The CMS grade center automatically creates a column in the grade center (grade book) that is accessible only to the instructor. The instructor then has the option of sending an announcement to students via the CMS email system indicating that an assignment has been posted and is ready for the student to download. The student retrieves the assignment via download from the CMS. The assignment is completed and uploaded to the respective “digital drop box” and is stored in the grade center ready to be reviewed by the instructor. The instructor now has the opportunity to download all submitted assignments from one location. A tremendous benefit is the ability to provide immediate feedback to graded work in the form of written comments along with the earned grade. The student can track and review submissions, instructor comments, and earned grades as the course progresses. This mechanism facilitates the interaction between the instructor and student regarding the exchange of work that is assigned and submitted for assessment. Further, the feedback opportunity aligns with the goal of consistent and frequent communication with students.

Through CMS tracking mechanisms an instructor can identify and reach students who are at risk for attrition or failure. By recording and storing grades in a CMS, the tracking feature allows the instructor to non-intrusively mine and analyze student data. Once high risk students are identified, the instructor can contact the student to initiate remediation that increases retention and successful completion of the course.

Communication tools found in CMS, such as discussion forums, blogs, and chat rooms, play an important role in enhancing the interactivity between instructor and
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students as well as student to student communications. An interactive discussion board can include consistent and meaningful posts from both the instructor and student. In some instances, it is appropriate for the instructor to begin a thread and only moderate the discussion as needed. Blogs (web logs) are online diaries that can be hosted securely. Blogs can be used by students to express their opinions on issues related to the course of study. Peers have access to each other’s blogs and are able to review other classmates’ perception of the material. Only the owner of the blog can contribute commentaries, images or videos to the blog.

A wiki, also known as collaborative software, is a great tool to stimulate group work. Wikis allow a group of students to post documents within the CMS and render it available to any member for updates and editing. The wiki monitors and organizes the activity.

Podcasting is an audio/video medium (video is also known as vodcast) in which information is delivered via real simple syndication (RSS) feeds. The producer needs a computer, microphone and webcam if video is to be recorded. The author records content with a sound capture program that uploads the audio files to a server that hosts RSS feeds. Users can then program their MP3 player client to download RSS feeds. Educators can reach online students by creating podcasts that are informative and related to course progress. Supplemental podcasts are a very popular source of quick up-to-date information that can engage students as they progress through their course work.

Learning objects (LOs) are tools that captivate the attention of learners of all learning styles. LOs are instructional material broken down into pieces that can be used independently or in conjunction with other materials. Concepts that are difficult to teach are prime candidates for creation of LOs. LOs allow the instructor to spread abstract topics into elementary teaching pieces using technology that incorporates visual and audio cues. LOs can be images, animations, or text modules that are transportable and reusable. The creation of LOs begins with the idea of identifying specific topics students have difficulty understanding. Once an area is identified, work begins with a computer programmer or multi-media specialists along with the instructor as the subject matter expert. LOs can be disseminated online via a CMS or an LO repository such as http://webcls.utmb.edu/lo. Students are able to download LOs and use them to enhance their learning experience.

CONCLUSION

Students now expect to use technology in all aspects of their lives, including education. Why not engage them by providing an interactive learning environment that will enhance their skills? Educational technology tools convert the online learning environment into a canvas ideal for interaction. Taking the classroom to the virtual world is the wave of the future. Let us embrace technology and harness its power to engage and stimulate students of today and the future.

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Preparing Online Students for Comprehensive Examinations

MICHELLE S KANUTH, E CAMELLIA ST JOHN

OBJECTIVE: Identify and remedy difficulties in the preparation of online students for certification examination success.

DESIGN: The final examination scores for the CLS Seminar course for the 2008 class of 27 on-campus and 10 online students were compared for statistical differences in seven examination areas. Problem areas were identified and changes in the CLS Seminar course were made in 2009 to improve the scores of the online students. The examination scores for the 2009 class of 33 on-campus and 10 online students were studied to determine improvement. Student’s two-tailed t-test was used to determine statistical significance of differences between scores of on-campus and online students.

INTERVENTIONS: Interactive video over the web; used to answer online student questions, review games, more class time, and more recorded review sessions; were added to the Seminar. The study guides provided during preceptorships were tied to the objectives of the seminar course and the questions on examinations. Specific objectives for each question missed on the final examinations were provided to the student.

RESULTS: In 2008, examination scores for online students were lower in two of seven areas by a statistically significant amount than on-campus students. The difference approached significance in a third area. After interventions in 2009, the examinations scores had equalized with the exception of one area, Immunology.

CONCLUSION: Increasing the amount and method of review in areas deemed important to online education was successful in improving examination scores.

ABBREVIATIONS: Chem= chemistry, hemat = hematology, immuno= immunology, micro= microbiology, urine= urinalysis, CLS=clinical laboratory science

INDEX TERMS: Certification, Clinical Laboratory Techniques, Education, Online/methods, Laboratory Personnel/education, Technology, Medical/education

LEARNING OBJECTIVES:
Upon completion of this article, the learner will be able to:
1. Identify two interventions that decreased the gap in examination scores for online students.
2. Correlate interventions with the problem area they were designed to improve.
3. Discuss the limitations of online reviewing.
4. Provide two reasons that immunology material may be more difficult to reinforce than other areas.
5. List the areas in which statistically significant differences were seen in the 2009 scores between on-campus and online students.

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Online education is the current trend in Clinical Laboratory Sciences (CLS) education for many reasons. Among these are the shortage of laboratory personnel, especially in rural areas with place-bound students, the need for larger class sizes to ensure program survival, and limited clinical affiliates near large CLS programs. Both Freeman, et al. and Russell, et al. studied outcomes in online education students and found that GPA and certification examination scores were not significantly different between online students and those in the traditional classroom setting. The same findings have been seen in online education of other health science professionals. Online interactivity, whether delivered by email, case studies, discussion board, interactive videoconferencing, or recorded audio and video, is thought by many authors to be the key to success in content assimilation. One of the challenges, when students are not on-site, is preparing them for certification and licensure examinations. When preparing to take these exams, online students are expected to set their own study schedule and take initiative to do their own preparation.

Faculty noticed that many of the online education students enrolled in the CLS Seminar class seemed to have difficulty preparing for the final examination and passing the course. This course is designed to assess the culmination of the knowledge they have acquired during the CLS program and to prepare the student to take the certification exam. The final examination in the seminar course is an approximation of the certification examination offered by the Board of Certification of the American Society for Clinical Pathology (ASCP) and includes sections covering blood banking, chemistry, hematology, immunology, laboratory operations, microbiology, and urinalysis. In the past, on-campus reviews and question and answer (Q&A) sessions were provided. The course instructors were also available during their office hours to explain to the students those concepts either forgotten or never learned. The course materials were available to both on-campus and online students on the course BlackBoard site, with video/audio recordings of the on-campus sessions, online quizzes, and extra exam questions available to all students, as well as advice on purchasing review books. Comprehensive objectives for each of the seven areas were also on BlackBoard. A question pool for the final examination, tied to the objectives, was maintained. Students were given a “dry-run” examination (for which they were specifically encouraged not to study) immediately prior to enrollment in the CLS Seminar course in order to show them the deficits present in their body of knowledge.

All the materials were available to the online students, including the videotaped sessions; however, blackboard interactions were difficult to capture clearly and in some cases PowerPoints with voiceover were added. Even with the availability of these materials the online students participated more passively in the class. They received feedback on the exam questions they missed either by email or over the telephone, where drawing diagrams and sketches were difficult. Areas identified as particularly problematic for online learners included convincing students to begin studying prior to enrolling in the CLS Seminar and engaging learners in autopsying their knowledge to determine what they actually have internalized versus what information they recognize when reading through their materials. Equally challenging was convincing them that knowledge is not retained when it is not being used or actively studied and reviewed. Additionally, limited face-to-face interaction with online learners inhibited their ability to ask questions as they thought of them and for instructors to fully explain the answer. When an instructor visually determines whether or not the learner is engaged and understanding, he or she can alter the explanation to fit the particular learner. This was impossible when the instructor could not see the learner as they could not tell if they were lost, bored, struggling, or had given up mid-explanation.

The aim of this study was to determine what changes could be made to the course that would enhance the learning of both the online and on-campus students and to improve their scores on the CLS Seminar final examination.

METHODS
Comprehensive examination scores from all students attempting these examinations during 2008 and 2009 were noted. Scores for each of seven areas (blood banking, chemistry, hematology, immunology, laboratory operations, microbiology, and urinalysis) were
averaged for the on-campus group and for the online group. Student's two-tailed t-test was performed to determine the significance of the results. Significance was defined as p<0.05. The 2008 students were the control group and the 2009 students were the intervention group.

INTERVENTION
The following changes were made to the course and took effect in the Summer Semester 2009 course offering. In order to aid both online and on-campus students, previously recorded review sessions and a new review session for each area of the examination were made available, starting with the summer semester 2009 course offering. The previously recorded sessions were either on videotape for streaming video or narrated PowerPoint, whereas the new review sessions were done on Tegrity®. The Tegrity® recordings are much clearer to view than videotape that is streamed online and the instructor can be visible at the same time as the PowerPoint or other visual aid being used. The interaction with online students was enhanced by the availability of interactive videoconferencing over the web for answering questions. The instructors could draw and sketch on the screen while the students viewed the results on their computer screen. The amount of time provided every week for review and Q&A was doubled from one hour to two hours. Another aid that was added to the BlackBoard® site was a link to a free online review game that students have reportedly enjoyed playing.

Other interventions that took place to help the students were in the preceptorship courses preceding the seminar course. The University of Texas Medical Branch (UTMB) CLS students take four preceptorship courses that comprise the clinical experience portion of the curriculum. The instructors added a self-study preceptorship guide for each clinical area containing open-ended questions that were prepared from the seminar objectives and were also consistent with the preceptorship objectives. These were provided to the students at the time they took each preceptorship course and students were told that the examination at the end of the each course would be drawn from the material covered by the questions in the guide. The preceptorship guide was turned in to the preceptorship coordinator and graded by the faculty member with expertise in that area. Because getting students to start studying early has been challenging, it was hoped that this measure would encourage studying earlier and provide them with early feedback on areas they needed extra help understanding.

Because the students were allowed two attempts at the final examination, taking different versions, they were provided with the objective for each question that they missed on the first examination attempt. While the actual questions were not released, as they are in a permanent question pool, this was an effort to help the students determine exactly what information they were lacking and needed to study before the second examination attempt.

RESULTS
To see whether or not this intervention equalized the preparation of online and on-campus students for the comprehensive exam, the scores for the 2008 and 2009 graduates from the CLS program at UTMB were examined. The 2008 students were the control group and the 2009 students were the intervention group. Average comprehensive examination scores for the seven areas tested can be found for 2008 students in Table 1 and 2009 students in Table 2. Twenty-seven (27) on-campus and 10 online students attempted the examination in 2008. Significant differences were seen between the two groups in two areas: microbiology and urinalysis. A third area, immunology, was lower in the on-campus group than in the online group and was of concern in both groups. There were 33 on-campus students and 10 online students attempting the examination in 2009. In 2009, only one area, immunology, showed a significant difference when online student scores were compared to on-campus student scores. In immunology, the average of the online students was significantly lower at 66.2 than that of the on-campus students at 73.6. All of the other six areas showed no significant differences between groups. Table 3 provides the comprehensive examination scores for online students in 2008 and online students in 2009. Scores in microbiology and urinalysis, the areas of major concern in the 2008 online group, improved significantly for the online students in 2009.
chemistry scores for both online and on-campus groups were down significantly in 2009 from 2008.

Table 1. Mean seminar final examination scores for 2008 students.

<table>
<thead>
<tr>
<th>Group</th>
<th>Blood</th>
<th>Chem</th>
<th>Hemat</th>
<th>Immuno</th>
<th>Lab</th>
<th>Micro*</th>
<th>Urine*</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-campus</td>
<td>76.6</td>
<td>82.1</td>
<td>74.8</td>
<td>69.9</td>
<td>82.9</td>
<td>81.2</td>
<td>75.6</td>
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<td>N=27</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Online</td>
<td>75.1</td>
<td>81.7</td>
<td>73.2</td>
<td>73.7</td>
<td>79.5</td>
<td>68.8</td>
<td>65.3</td>
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<tr>
<td>N=10</td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*P<0.05

Table 2. Mean seminar final examination scores for 2009 students.

<table>
<thead>
<tr>
<th>Group</th>
<th>Blood</th>
<th>Chem</th>
<th>Hemat</th>
<th>Immuno</th>
<th>Lab</th>
<th>Micro*</th>
<th>Urine*</th>
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<tbody>
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<td>75.4</td>
<td>77.7</td>
<td>73.6</td>
<td>72.7</td>
<td>78.6</td>
<td>77.5</td>
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<td>73.6</td>
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*P<0.05

Table 3. Mean seminar final examination scores for online students 2008 vs. 2009 Group

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<th>Blood</th>
<th>Chem</th>
<th>Hemat</th>
<th>Immuno</th>
<th>Lab</th>
<th>Micro*</th>
<th>Urine*</th>
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<tr>
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</tbody>
</table>

*P<0.05

CONCLUSIONS
The increase in class time, face-to-face interaction, recorded materials, and extra study materials appears to have equalized the results for online students on the comprehensive examinations in most areas. The decrease in the chemistry examination scores for all students between 2008 and 2009 may reflect the fact that a new chemistry instructor started in January of 2009 and that differences in emphasis were a factor. If chemistry scores do not improve again in 2010, further interventions will be required. The immunology scores remain of concern and further interventions will be tried to resolve this disparity. In general, additional emphasis on the immunology section is required for all students. Part of this may be due to the fact that immunology is not a discrete section of the clinical laboratory in any of the clinical affiliates, but rather spread through various areas of the laboratory. These laboratory areas may focus more on the analytes and instrumentation rather than the immunology concepts that drive the assays. Also, there is not a specific preceptorship rotation that reinforces many of the immunologic concepts. Additionally, some of immunology is strictly theoretical or conceptual. While it enhances the ability of the students to understand how tests work, they do not uniformly appear to be internalizing these theoretical concepts when working with a given test procedure. Further emphasis will be placed on playing the online review game in the immunology area, as well as more intense immunology review through questions and answer, written materials, and other means as they become available. Overall, the course improvements have provided the increased impetus for examination preparation that was sought.

REFERENCES
FOCUS: EDUCATIONAL TECHNOLOGY

Continuing Education Questions

SUMMER SUPPLEMENT 2010

To receive 1.0 contact hours of basic level P.A.C.E.® credit for the Focus: Educational Technology questions, insert your answers in the appropriate spots on the answer sheet that follows; then complete and mail the form as directed.

1. Educational technology is best defined as?
   a. Current technology used to enhance education
   b. Learning about computers
   c. Software development
   d. The replacement of traditional teaching methods

2. The following educational technology tool utilizes the internet to synchronously stream both audio and video.
   a. Podcast
   b. Web conferencing
   c. RSS feeds
   d. Wikis

3. One of the most common reasons resulting in high attrition rates in online distance courses is
   a. Lack of communication
   b. Finances
   c. Overstimulation
   d. Class schedules

4. Which of the following educational technologies would benefit an instructor interested in delivering a series of short audio clips throughout the semester?
   a. Podcasting
   b. Discussion forums
   c. Course management systems
   d. Wiki

5. An online course should begin with:
   a. A writing assignment
   b. Orientation
   c. An assessment
   d. Contest

6. One of the interventions that helped to improve online student scores was
   a. Adding on-campus visits by online students
   b. Answering questions by interactive video
   c. Asking students to take examinations without studying
   d. Replaying the current review session

7. Providing an impetus to study earlier was associated with
   a. Adding more face-to-face time
   b. Asking and answering questions by interactive video
   c. Providing the old review sessions along with new ones
   d. Tying the course objectives to the study guides

8. When reviewing with students, online faculty can
   a. Avoid seeing students fail
   b. Discuss more material at a quicker pace
   c. Improve comprehension by using interactive technology
   d. Use non-verbal cues to assess learner understanding and interest

9. No single laboratory at UTMB affiliates does all of the immunology testing. This could explain the
   a. Difficulty in reinforcing concepts
   b. Higher examination scores for all students
   c. Over-preparation in immunology by online students
   d. Underachievement in immunology by on-campus students
10. In which of the following areas were statistically significant differences seen between the scores of on-campus and online students in 2008?
   a. Chemistry and Laboratory Operations
   b. Microbiology and Urinalysis
   c. Hematology and Blood Bank
   d. Blood Bank and Laboratory Operations
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To earn continuing education (PACE) credit, (1) complete the form below, (2) record your answers, and (3) mail a photocopy with a check or money order ($18 for ASCLS members, $28 for non-members) to:

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A certificate of completion will be awarded to participants who achieve a passing grade of 70% or better. Participants should allow eight weeks for notification of scores and receipt of certificates.

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*Focus: Education Technology* Supplement issue carries 1.0 hours of basic level P.A.C.E.* credit. This form can be submitted for credit for up to one year from the date of issue.

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Last ________ First ________ M.I. ________

ASCLS membership number ____________________________ Licensure number ____________________________

(02) ADDRESS ____________________________

(03) CITY ____________________________ (04) STATE/COUNTRY ____________________________ (05) ZIP/POSTAL CODE ____________________________

(06) DAYTIME PHONE ( _______ ) ____________________________ (07) E-MAIL: ____________________________

(08) CREDIT CARD # ____________________________ TYPE (CIRCLE) AE MC VIS EXP. DATE ____________________________

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☐ Send my certificate of completion via email
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Participant Information

Please circle the most appropriate answers.

1. Is this program used to meet your CE requirements for:
   (a) state license (b) certification (c) employment (d) other

2. Did these articles achieve their stated objectives?
   (a) yes (b) no

3. How long did it take you to complete both the reading and the quiz? ___________ minutes

4. What subjects would you like to see addressed in future Focus articles?

Answers

Circle correct answer.

1. a b c d 7. a b c d
2. a b c d 8. a b c d
3. a b c d 9. a b c d
4. a b c d 10. a b c d

5. a b c d
6. a b c d
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