# Student Laboratories as a Component of a Web-based Curriculum

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**OBJECTIVE**: To enable place-bound working clinical laboratory technicians (CLTs) to benefit from hands-on student laboratory sessions taught in University of Texas Medical Branch (UTMB) facilities by UTMB professors.

**DESIGN:** Weekend student laboratory sessions similar to "wet workshops" were implemented and integrated into regular coursework. Student laboratory sessions of 12 hours to 16 hours in length were provided.

**SETTING**: The UTMB student laboratories.

**PARTICIPANTS:** Web-based education in Clinical Laboratory Science (WEBCLS) students who are working CLTs in rural place-bound situations.

**MAIN OUTCOME MEASURES**: Course grades and certification examination scores on laboratory and comprehensive examinations given to both on-campus students and WEBCLS students.

**RESULTS**: Of 68 WEBCLS students enrolled in laboratory courses during the calendar years 2003, 2004, and 2005, 66.2% earned grades of A or B in the course compared with 64.2% of students enrolled in the same laboratory courses on-campus. Over a three year period, the WEBCLS students averaged 564.8 on certification exam scores, while on-campus students averaged 470.9.

**ABBREVIATIONS**: CAP = College of American Pathologists; CLSs = clinical laboratory scientists; CLTs = clinical laboratory technicians; RBCs = red blood cells; UTMB = University of Texas Medical Branch; WEBCLS = web-based education in Clinical Laboratory Science (a program designed for off-campus CLT students to pursue the Bachelor of Science degree in CLS through distance education using web-based materials).

**INDEX TERMS**: clinical laboratory science programs; distance education; rural and underserved areas; web-based education; student laboratories.

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CLTs daily take on the responsibilities of clinical laboratory scientists (CLSs) because of the limited number of CLS graduates available to be employed in their area of the country.[1-3] There is only a 76% overlap in the job responsibilities of CLTs and CLSs, indicating that some job responsibilities may be underperformed in these situations.[4] The shortage of qualified personnel creates difficulty for the clinical facility in meeting Medicare reimbursement regulations for supervisory personnel.[5-7] Many of these individuals would like to continue their education but are limited by the declining number of CLS programs, the absence of such programs within their geographical area, and their increasing work obligations, current job and family responsibilities, and the financial burden of uprooting their families to move to an area where a CLS

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program is available. Lack of the ability to move upward in the laboratory is a major dissatisfier in job satisfaction. In a study by Doig and Beck, 85.5% of respondents to a survey felt that they lacked the availability of career advancement.[8] While parts of Texas are rural, and parts of the state are medically underserved, most CLS programs in the state are located in urban, well-served areas. The university-based CLS programs in Texas and the populations of those areas are detailed in Table 1. Sensitivity to these needs is critical in providing competent, well-educated, and dedicated CLS graduates to fill positions in all regions of Texas.

With 151 CLS programs having closed in the past ten years, those that continue need to operate in both cost-effective and in non-traditional manners.[9-11] Virtual laboratories have been used successfully as portions of courses taught in nursing, pathology, histology/cytology and pharmacy, however, their situations vary considerably from CLS education. These faculty report that student performance in virtual laboratory classes did not vary significantly from that of students educated in traditional student laboratory classes.[12-15] It was with these thoughts in mind that we developed WEBCLS to facilitate the educational transition from the associate degree CLT to the baccalaureate CLS for place-bound, working individuals. WEBCLS builds on the concept of CLT to CLS articulation, in which individuals having an associate degree in laboratory science follow a prescribed curriculum in a baccalaureate CLS program. Articulation agreements provide for the CLS program to give university credit for the medical laboratory courses already taken at the associate level. A major component and concern was the delivery of laboratory experiences to these students.

We needed to make certain that at least three criteria were met: 1) provide WEBCLS students with at least the same quality of experiences that we offered to on-campus students, 2) provide experiences which could be completed while employed in any geographical location, as long as the student could travel to Galveston occasionally, and 3) facilitate laboratory sessions of a length that would minimize travel and lodging expenses while providing appropriate laboratory experiences. The types of laboratory experiences considered were three-fold: introduction to and familiarization with laboratory experiences, problem-solving dry laboratory experiences, and "wet" laboratory testing experiences.

## TYPES OF LABORATORY EXPERIENCES

Introduction to and familiarization with appropriate techniques and routine instrumentation can be accomplished for articulating WEBCLS students using videotapes, narrated PowerPoint™ presentations, and written materials. These presentations may demonstrate the criticality of each step,

**Table 1.** University-based programs and area populations in Texas

| University-based programs | Metropolitan area | Area population | |
|---|---|---|---|
| University of Texas-Southwestern Medical Center<br>Tarleton State University | Dallas/Arlington/Fort Worth<br>Fort Worth | 5,161,544 | (24.75%) |
| University of Texas-MD Anderson Cancer Center<br>Texas Southern University | Houston/Sugar Land/Baytown<br>Houston | 4,715,407 | (22.61%) |
| University of Texas Health Science Center-San Antonio<br>Texas State University | San Antonio<br>San Marcos | 1,711,703 | (8.21%) |
| University of Texas- Pan American | McAllen/Edinburg/Mission | 569,463 | (2.73%) |
| Texas Tech University Health Science Center | Lubbock | 249,700 | (1.2%) |
| University of Texas-El Paso | El Paso | 679,622 | (3.3%) |
| Texas A&M University | Corpus | 403,280 | (1.9%) |
| University of Texas Medical Branch | Galveston | 57,247 | (0.3%) |
| Population outside metropolitan areas | | 7,303,854 | (35%) |
| Total Texas population | | 20,851,820 | |

explain the principle, discuss the purpose and use of controls and standards, and describe or demonstrate sources of false results. These presentations may include lectures, but are most often in the form of the demonstration of a technique, a video of the proper performance of a technique, a video of the improper performance of a technique with the student expected to find the errors, or the presentation of a situation in the laboratory upon which the student is to comment in some way. This format has been applied to the introduction of a new technique or re-familiarization with a previously used technique that will be performed in subsequent on-campus laboratory sessions. Evaluation entails written multiple choice and essay questions.

Problem-solving through the use of simulated laboratory experiences encompasses the preparation of laboratory scenarios that provide information regarding the performance of a procedure and may include the steps taken during the procedure, results of the controls and testing. Simulations, usually a single analyte run, do not involve patient scenarios or comparisons of several tests, in contrast to case studies. In some cases, the students are referred to previously distributed procedures, handouts, or textbooks. The student is expected to analyze the information provided and determine whether errors were made, discuss correction of the errors, appropriately interpret the results of controls and tests, and determine whether or not the results are reportable.

Case studies that include clinical history and test results have also been provided. Students are expected to answer questions related to the test results. These may include interpretation, possible causes of the test results, and whether or not the results are consistent with clinical information, including other test results obtained on the same patient. The student is also expected to determine whether technical errors have been made, what corrections are needed, and what further testing is appropriate.

Extensive explanation and justification of all answers is required. When answering cases, application of the WEBCLS student's previous laboratory education and experience is required. WEBCLS students are given much more detailed and extensive cases than would be provided to a non-articulation student. Cases include abbreviations and other laboratory information that the student is expected to understand from previous experiences, and explanations are not provided. For example, a patient history, type and screen results, and panel results may be provided, with the student required to interpret the results and recommend further testing. Or a case history of a patient with an infection may be provided, along with growth and biochemical characteristics of one or more organisms, requiring the student to identify the organism and discuss whether or not the organism(s) is/are likely the causative agent or normal flora in the site of the infection.

However, even using simulations and case studies, we felt some hands-on experiences were needed. Some procedures are technically difficult and hard to understand without direct intervention. Students must be able to test the effects of variables on outcome and ask their questions of immediately available experts. Practice laboratories provide the opportunity for the student to perform techniques with which they are not familiar in a non-clinical setting and allow faculty to assess the preparation provided by the familiarization and dry laboratory methods. For this to occur, the WEBCLS students needed to be on-campus. While on-site mentoring and checklists can aid the learner, attention to detail is variable and such instruction usually occurs in a work setting where teaching is not a priority. Tailoring of instruction to the individual learner is also more possible when the faculty can provide undivided attention to teaching, without the demands of patient care. The CLS faculty came to an agreement that the distance students would come to campus no more than two weekends a semester. The laboratories would start on Friday and Saturday mornings about 9:00 a.m. and finish between 5:00 p.m. and 6:00 p.m. If students were taking two courses that required such "weekend laboratories", the faculty would coordinate the work so that both laboratory courses could be dealt with in one weekend, realizing that this might run into Sunday. The reasons for this structure were two-fold: 1) students needed to be able to plan these sessions around their work schedules and 2) the cost to students of travel, lodging, and meals while away from home needed to be as reasonable as possible.

## PROVIDING AN OPTIMAL EXPERIENCE

Early learning experiences for the instructors included several things:

1. Our facility is in a tourist town with limited hotel facilities. Scheduling so that students are not competing for hotel space with major tourist attractions is essential.
2. Having on hand spare procedural handouts and extras of all materials that students are expected to print out and bring with them is absolutely necessary.
3. Providing time for professional socialization facilitates student bonding, both with faculty and with other students, is critical to student retention and development.
4. Because of specialization, CLTs cannot be expected to be

immediately conversant with all the techniques covered in prior CLT courses.

5. Despite the best laid plans, the antibodies for that weekend may still die, instruments may refuse to work properly, and dilution errors may still occur, so faculty need to be prepared with more materials than they expect to need for the entire weekend.

The following preparations are crucial to a successful laboratory experience:

**Planning time:** Planning specific times for each procedure for the entire weekend is crucial to success. If a procedure is not completed during the allotted time, it cannot be postponed to the next laboratory session. Miscalculations mean that time is lost, students become uneasy, and there is a loss of momentum.

**Sharing plans:** Share plans with attendees. Providing the students with schedules, handouts and reading assignments ahead of the planned laboratory experience helps students prepare and saves considerable time during the sessions.

**An initial assessment of student skill levels**: Diversity of individual experience necessitates a brief session where basic skills and techniques are monitored and refreshed. This places the group on a more equal footing for learning and allows for discussion of diverse approaches, along with inherent strength and weaknesses. This enables faculty to identify and correct suboptimal habits while increasing theoretical understanding. Absence of such basic technical skills causes a student to miss the total picture of the patient's problem that can be gained from advanced techniques and case studies.

**Reagents, equipment, and supplies**: Everything necessary for each procedure must be readily available. When each moment with the students is both limited and precious, locating materials in an unfamiliar laboratory can consume both time and patience. These students come with work experience and do not require education in laboratory materials management, as inexperienced students often do.

**Preparing specimens for use:** One way to provide samples for students to analyze is to obtain salvage specimens from clinical associates. This allows the students to observe a variety of different specimens, but makes it difficult to detect a specimen that performs in an unexpected way. Weekend laboratories involve reactions with which students are not practiced, so there is an advantage to having sets of specimens. Not all students get the same specimens, but several people within the group do. Several students observing the same reaction in a poorly performing specimen alerts the instructor to the need to check and verify, as opposed to convincing one student that he or she does not understand the technique.

## ADDED COST FOR STUDENTS ATTENDING WEEKEND LABORATORY

Direct costs include transportation, lodging, and meals. Lodging averages about $80.00 per night per student. Meals average $25.00 to $30.00 per person per day. The cost of transportation varies considerably depending on travel distance and model of automobile, but averages about $60.00 for the weekend. Thus, the average two-day weekend laboratory costs a student about $300.00, or $600.00 per semester.

## OUTCOMES ASSESSMENT

The WEBCLS program at UTMB includes four courses with weekend laboratories: Advanced Microbiology and Mycology, Immunology/Immunohematology, Hematology and Coagulation II, and Molecular Biology. In these courses, the same laboratory and comprehensive examinations are administered to WEBCLS and on-campus students. The WEBCLS students performed as well or better on these examinations as the on-campus students. In Advanced Microbiology and Mycology over the past three years, 23 WEBCLS students have completed the course with an average grade of 82%, compared with the on-campus traditional students' average grade of 79%. In Molecular Biology, both groups averaged 77%. A total of 68 WEBCLS students and 218 on-campus students enrolled in all laboratory courses during the calendar years 2003, 2004 and 2005. During that time, 66.2% of the WEBCLS students earned grades of A or B in the course compared with 64.2% of on-campus students enrolled in the same laboratory courses. WEBCLS student scores on certification examinations from 2002 through 2005 averaged 564.8, while traditional on-campus students averaged 470.9 during the same period. The probability value from an unpaired student's T-test, $p = 0.034743$, showed a significant difference in favor of the WEBCLS students.

Because the outcomes assessment shows parity on examinations, we believe that this course structure provides a student laboratory experience for WEBCLS students comparable to our regular on-campus laboratories for individuals with no previous clinical laboratory science education. With organization, faculty can cover a basic check up on techniques, numerous advanced techniques, and still have time for problem

solving discussions and case studies in each weekend laboratory session. The WEBCLS students have sacrificed time and money for this opportunity and typically bring an enthusiasm that can be infectious even on a day off. Weekend laboratories provide a solution for place-bound and non-traditional student access to laboratory educational opportunities that are minimally disruptive to their lives and work.

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