Introducing Clinical Laboratory Science: CLS Students Help Shape the Future

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OBJECTIVES: The profession of clinical laboratory science (CLS) is in dire need of increased exposure to young people. By introducing the clinical laboratory sciences to students at a critical point in their science education and by making it relevant to their lives, more choices are made available to them when considering future career options. With this in mind, the CLS faculty at Texas Tech University Health Sciences Center (TTUHSC) redesigned a recruitment program and developed it into one making use of CLS student knowledge, enthusiasm, and professionalism. CLS students were given the assignment of designing an entire curriculum for a ten day presentation of clinical laboratory science topics to middle and secondary school students. Following the presentations, participants in the program were asked to provide feedback regarding CLS student performance and overall opinion of their interest in clinical laboratory science. The objectives of this study were twofold: 1) to determine if educational methodologies could be appropriately applied by CLS students to present CLS disciplines to middle and high school students; and 2) to determine if the student presentation was successful in initiating interest in the CLS profession based on outcome measures.

DESIGN: As a component of the CLS laboratory management course, CLS students were instructed in education methodologies including objective writing, teaching-unit preparation, and evaluation tool design. In the following semester, these students were divided into groups and assigned a specific CLS discipline that would then be presented to middle and secondary school students in a two week, 30 hour educational program. This program was offered by the TTUHSC CLS program in cooperation with the Institute for the Development and Enrichment of Advanced Learners (IDEAL) at Texas Tech University. The curriculum prepared by the CLS students (with faculty supervision) provided the framework for the present study.

SETTING: Didactic instruction of the CLS students regarding objective writing, curriculum design, and preparation of evaluations was included as a component of a CLS laboratory management course. The educational program presented by IDEAL in conjunction with the TTUHSC CLS program within the School of Allied Health Sciences occurred in the CLS student laboratories located in Lubbock, Texas.

PARTICIPANTS: TTUHSC senior CLS students in a 2 +2 baccalaureate level CLS program acted as instructors in the educational program which was presented to middle and secondary school students from around the region. CLS program faculty served as supervisors of this program.

MAIN OUTCOME MEASURES: Questionnaires with Likert-scaled responses were used to evaluate outcomes. These questionnaires regarded 1) faculty assessment of CLS student performance relative to instruction in education methods; 2) participant feedback on the effectiveness and competence of the CLS student instructors and overall appeal of the presented subject material; and 3) peer evaluations of attitude, contribution, and effort of the group members.

RESULTS: CLS faculty strongly agreed that the CLS students demonstrated a high level of competence when writing objectives, planning age-appropriate curriculum and activities, and demonstrating a positive image of the profession. Regarding satisfaction of the IDEAL student participant, questionnaire responses demonstrated a high rate (84% or greater for middle school participants and 85% for high school students). The program design has been so successful that it has been implemented for several other programs offered by TTU and IDEAL.

CONCLUSION: The education methods used in presenting the IDEAL program mirror those found in clinical and academic settings and is an effective technique to introduce CLS students to the varied aspects of educational methodology. The presentation by the CLS students also demonstrated that

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introduction of clinical laboratory science disciplines early in the education of middle and secondary school students leads to an interest in the CLS profession and to the desire to learn more about it.

ABBREVIATIONS: CLS = clinical laboratory science; IDEAL = Institute for the Development and Enrichment of Advanced Learners; SHWYF = Shake Hands With Your Future; TTU = Texas Tech University; TTUHSC = Texas Tech University Health Sciences Center.

INDEX TERMS: clinical laboratory science; education methods; recruitment; teaching techniques.

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Introduction of young people to the CLS profession should begin at the age at which a child first understands what medical science involves. Most children comprehend the idea of using blood or other biological fluids to determine health status in the first grade, and further exposure to biological sciences (usually in fifth grade) continues to offer these young people a close look at human biology and physiology. By introducing them to the field of CLS at this stage in their education, these students begin to understand that there is a laboratory profession in which people are actually involved. Further presentation of this idea at a later stage in a child's scientific education only serves to reiterate their understanding of this science.[1] It can also serve as a recruitment tool to the profession. At the Summit on the Shortage of Clinical Laboratory Personnel held in 2000-2001, it was determined that there would be a shortfall of 4,000 individuals needed every year to fill positions in the clinical laboratory[2], a shortage that begins with decreased enrollment in laboratory science programs at the university level. Because of this very real deficit in the numbers of clinical laboratory professionals, it is clear that students in middle and secondary schools as well as those enrolled in college need to be made aware, first, of the existence of the clinical laboratory science profession, and secondly of the opportunities available in the field of laboratory science.

Funding to alleviate the shortage of laboratory personnel has been addressed as an amendment (H.R. 1175) to the Public Health Service Act. This bill endeavors to authorize appropriations for student loan forgiveness and for awards of grants or contracts to agencies that show initiative in expanding their CLS programs.[3] To address personnel shortage and program expansion issues, we have devised an innovative program that trains our CLS students to act as both recruiters for the profession as well as instructors of the CLS disciplines. This training not only gives CLS students an introduction to the concepts of curriculum development and teaching that they will use later as clinical instructors, but it also gives them the opportunity to serve as ambassadors for a profession that continues to need increased exposure. To accomplish these training objectives, we have included in our CLS curriculum the presentation of education methodologies and have combined these methods with a unique enrichment program offered by the Texas Tech University Institute for the Development and Enrichment of Advanced Learners (IDEAL). This program is designed to introduce science and technology to students in middle and high schools and is titled Shake Hands With Your Future.[4]

Recruitment is a difficult procedure at best, hampered by cost, lack of focus and ideas, and lack of interest at the administrative level. It appears that CLS programs that do not actively recruit new students do not survive, and high cost per student in CLS programs around the country coupled with decreasing enrollments have caused administrators to close a number of programs to maintain fiscal responsibility. For a program to survive, it is obvious that "creative solutions"[5] must be examined, including presenting all aspects of the clinical laboratory including research practice, veterinary laboratory medicine, the role of salesperson in the field, forensic laboratory practice, educator, pre-pathology medical education, and so on. To meet a recruitment need and to enhance the teaching effectiveness of future CLS professionals, the CLS faculty at TTUHSC developed a clinical laboratory offering within the TTU IDEAL program. This program is administered by IDEAL, the mission of which is "to provide distinctive and unique academic enrichment programs that promote academic excellence, citizenship/leadership,

diversity, and an appreciation of the arts".[4] The institute has been involved in the recruitment of academically talented students to Texas Tech University and in the introduction of underprivileged students to a collegiate experience. IDEAL offers a number of programs to these students, including art, aerodynamics, geology, physics, photography, and clinical laboratory science. It became apparent to CLS faculty that this would be the perfect system in which to reach out to young students as well as to involve undergraduate CLS students in teaching activities that allow them the opportunity of participating in the introduction of young people to the CLS profession.

METHODS

During the laboratory management course in our curriculum, senior CLS students are introduced to teaching methodologies, including objective writing, curriculum preparation, and outcome measures. They are informed that these procedures will be put into practice over the summer semester when the IDEAL SHWYF program is offered. The seniors are then randomly divided into four groups that each focus on one CLS discipline: hematology, clinical chemistry, bacteriology, or immunology/immunohematology. For participants in grades nine through 12, one group is devoted to genetics testing instead of immunology/immunohematology. Each group is then responsible for choosing how it will present the assigned discipline, realizing that the presentations must take into account the age of the students who will be attending; CLS faculty serve as supervisors who oversee one group each. Although class time is utilized for project preparation, the CLS students are also encouraged (not required) to meet outside of classroom hours. Student groups are given a budget to which to strictly adhere. Another aspect of their presentation to the SHWYF participants was a thorough review of all safety issues including universal precautions. Although CLS faculty were always available to offer advice or constructive criticism to the students, most groups devised innovative and clever ways to present their assigned disciplines on their own. CLS students were required to furnish the presentation packet to the faculty member in charge of their group; the packet included three to five objectives, the body of the presentation, questions, and references or web sites. This packet was used by the CLS faculty in the evaluation of the performance of the CLS student groups.

Although IDEAL's programs maintain a limited budget, much of its support derives from grants and donations. Administrative support is provided by TTU and TTUHSC. In regard to the program involving CLS, information-containing fliers are sent to middle and secondary schools across Texas, New Mexico, and Oklahoma. These info-letters are distributed to students in the appropriate grade levels by school administrators. Similar fliers are distributed to individuals who have participated in past IDEAL programs. Elementary or secondary school students who are interested in the programs are required to have the approval of their science teacher based on the student's science grades. The SHWYF program covers a two week period during which time students are allowed to enroll in two courses. Typically, the CLS course is offered only in the morning, and the presentations last approximately three to four hours each day for ten days. The cost to the enrolled students covers dormitory stay, food, and travel from the dorm to the site of the course. Scholarships and grants are offered based on need.

The number of students enrolled in the CLS component of IDEAL's SHWYF program is typically 20-25. The grade level of the participants alternates between calendar years: one year sixth through eighth graders participate and the next year it is ninth through twelfth graders. Roughly equivalent numbers of both sexes enroll in the program.

Actual laboratory activities are organized entirely by the CLS seniors with faculty supervision. Many begin their presentations with topic-specific background information using either handouts or PowerPoint. The participants then begin the hands-on aspect of the discipline of the day. These laboratory exercises are presented by the CLS students and observed by the faculty. In this evaluation, the hematology group placed red and purple chewy candies (not to be eaten in the laboratory, of course) in clean, closed test tubes to represent the ratio between red and white blood cells, then related these colors to those observed through a microscope on actual blood smears. The bacteriology group utilized marshmallows and agar plates to demonstrate disease transmission in a small population. To demonstrate how forensic medicine and toxicology apply to clinical chemistry, a crime scene, including a body and collectible evidence, was set up for the visiting scholars. In some instances, a Barbie doll house was used complete with toy wine glasses, plastic Barbie-size guns, and all the things that might be at the scene of a crime (Ken is dead) to give the students the opportunity to study a crime scene and test what might be evidence. The immunohematology group staged a "disappearing celebrity" show to illustrate the principles of blood typing for identification purposes. Genetics testing exercises involved restriction enzyme analysis and gel electrophoresis of DNA in a pseudo-parentage testing study. Following the laboratory exercises, a question-and-answer

Figure 1. AHMT 4320 – Laboratory management faculty evaluation of SHWYF presentation

Please return this form with your name on it to the faculty advisor that oversaw your SHWYF session. He/she will fill it out and hand it in to Mr. Le.

Student to evaluate: _____ Total points: _____

Please use the following scale to evaluate student performance. Circle your choice for each of the following statements.
1 = Strongly disagree 2 = Disagree 3 = No opinion 4 = Agree 5 = Strongly agree

1. Planned age appropriate, meaningful activities
   1 2 3 4 5
2. Wrote appropriate, testable objectives for the presentation
   1 2 3 4 5
3. Prepared relevant, understandable hand-out materials
   1 2 3 4 5
4. Was prepared and organized for each session
   1 2 3 4 5
5. Demonstrated a positive image and attitude of caring for the project
   1 2 3 4 5
6. Worked well with others in the group
   1 2 3 4 5
7. Attended all sessions at the scheduled times
   1 2 3 4 5
8. Answered SHWYF students' questions accurately
   1 2 3 4 5
9. Was respectful toward SHWYF students
   1 2 3 4 5
10. Put forth an equal amount of effort as other members of the group
    1 2 3 4 5

Figure 2. AHMT 4320 – Laboratory management participant evaluation of SHWYF presentation

Please complete the following evaluation of this session of SHWYF. Use the following scale to evaluate the sentences below.

1 = Strongly disagree 2 = Disagree 3 = No opinion 4 = Agree 5 = Strongly agree

1. The instructors were well prepared and organized.

1 2 3 4 5

2. The instructors were courteous and respectful.

1 2 3 4 5

3. The activities were fun.

1 2 3 4 5

4. I learned new things about clinical laboratory science.

1 2 3 4 5

5. I am interested in learning more about clinical laboratory science.

1 2 3 4 5

session ensued and a questionnaire requesting participants' feedback about the presentation was distributed. Questionnaires were collected upon completion.

Outcome measures are based on the results of these questionnaires that had been validated and edited to final form by faculty members in the TTUHSC School of Allied Health Sciences. Specific statements were presented followed by a Likert-scaled range of responses that include "strongly agree", ranked as five, down to "strongly disagree", ranked as one. One questionnaire involved faculty assessment of the performance of the CLS student groups (Figure 1). These questionnaires utilized statements with Likert-scaled responses and were collected by the instructor of the laboratory management course and used in assigning a grade to the CLS student presenters. A second questionnaire was designed by CLS students and validated by faculty members for distribution to the SHWYF student participants (Figure 2).

Validating faculty members were made aware that this questionnaire would be distributed to young, varied-age participants. This questionnaire was distributed to the participating SHWYF students following the laboratory activities and requested their ranked opinion of the presentations and likelihood of their continuing interest in CLS. This questionnaire was considered to be the most critical in our assessment and in planning for the next IDEAL presentation. Respondents were asked to remain anonymous. Frequency of responses for each age group and each question was analyzed and converted to a percentage of the total sample.

The final questionnaire was distributed to CLS students and was an evaluation of their peers that worked within their assigned groups. Results of this survey are not reported in this manuscript.

RESULTS

Outcome measures are limited to responses on two questionnaires: one of CLS student assessment by CLS faculty (Figure 1) and one prepared by CLS students, validated by faculty, and distributed to SHWYF program participants (Figure

Table 1. Percent response (number of total) to evaluation statements of student participants (n = 50) in grades six through eight evaluating clinical chemistry

Statement number	1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
1	0	0	0	0	100 (50 of 50)
2	0	0	0	0	100 (50 of 50)
3	0	0	4 (2 of 50)	0	96 (48 of 50)
4	0	0	0	0	100 (50 of 50)
5	0	0	8 (4 of 50)	4 (2 of 50)	88 (44 of 50)

Table 2. Percent response (number of total) to evaluation statements of student participants (n = 50) in grades six through eight evaluating microbiology

Statement number	1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
1	0	0	0	8 (4 of 50)	92 (46 of 50)
2	0	0	4 (2 of 50)	8 (4 of 50)	88 (44 of 50)
3	0	0	0	8 (4 of 50)	92 (46 of 50)
4	0	0	4 (2 of 50)	8 (4 of 50)	88 (44 of 50)
5	0	0	12 (6 of 50)	4 (2 of 50)	84 (42 of 50)

2). Because in-person distribution of the questionnaires was performed, response rate was 100%. Each questionnaire was analyzed according to the frequency of responses and then converted to a percentage of the total sample.

Evaluation of CLS student presentations by CLS faculty demonstrated a very strong student performance overall. There would be an occasional student who would not contribute to the group effort or attend all scheduled planning sessions; however, the majority of students were enthusiastic and positive about their task. The entire program gives the CLS students the opportunity to "show off" their knowledge in their role as representatives of the profession. In addition, a learning experience concerning the preparation of a curriculum, maintenance of a budget, and working with peers was achieved based on the high scores the CLS students attained. All of these skills are considered important in the development of a well-rounded laboratory professional.

Regarding SHWYF program participant questionnaires, evaluation statements are the same for each discipline (hematology, clinical chemistry, etc.) and age group. Results of the clinical chemistry and microbiology SHWYF presentations to sixth through eighth graders are indicated in Tables 1 and 2. The majority of student participants expressed positive views of the activities presented and acknowledged the desire to further their knowledge of clinical laboratory science. Similar response rates were obtained from hematology and immunology/immunohematology presentations. Results regarding hematology and genetic testing presentations made to ninth through twelfth graders are indicated in Tables 3 and 4. The participants in this age group also responded in a positive way regarding the laboratory activities as well as their wish to learn more about the profession. Similar results were obtained for the other disciplines. These results are the compilation of two years (1998-2004) of evaluations for each age group. During two years of this time period our CLS program was not involved with SHWYF.

Table 3. Percent response (number of total in parentheses) to evaluation statements of student participants (n = 40) in grades nine through twelve evaluating hematology

Statement number	1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
1	0	0	0	0	100 (40 of 40)
2	0	0	0	0	100 (40 of 40)
3	0	0	0	5 (2 of 40)	95 (38 of 40)
4	0	0	0	0	100 (40 of 40)
5	0	0	5 (2 of 40)	10 (4 of 40)	85 (34 of 40)

Table 4. Percent response (number of total in parentheses) to evaluation statements of student participants (n = 40) in grades nine through twelve evaluating genetics testing

Statement number	1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
1	0	0	0	0	100 (40 of 40)
2	0	0	0	0	100 (40 of 40)
3	0	0	0	5 (2 of 40)	95 (38 of 40)
4	0	0	5 (2 of 40)	0	95 (38 of 40)

Results of this study indicate that the majority of participants are strongly interested in the field of clinical laboratory science. The present study concerns a sample size of only 50 sixth through eighth grade and 40 ninth through twelfth grade participants; a larger sample might demonstrate different responses. Of course, the final outcome measure of the success of the presentations in garnering interest in CLS would be actual enrollment figures in a CLS program of those who participated. This outcome remains to be assessed. However, the positive outcomes reported in this study come from young students who are beginning to form ideas about their future and could be construed as positive indicators of future CLS program enrollment.

CONCLUSION

Although there is a great deal of fun and inventiveness involved in the SHWYF presentations, there is a serious side to this presentation technique. The future of the CLS profession and CLS university programs is in the hands of CLS professionals, faculty, and students. It is difficult to devise new ways to introduce individuals to the profession, particularly to those who could be exposed early enough to have an effect on their educational choices. Through the SHWYF presentations, young children in the community and, more importantly, students about to enter college are exposed to clinical laboratory medicine and its many facets. Senior CLS students have a wonderful opportunity to be involved in the future of the CLS profession by taking on the role of instructors. By writing objectives, preparing age-appropriate presentations, and assessing outcomes, these seniors are also being prepared for their role in clinical instruction. However, the most compelling part of the CLS student involvement in this program was the observation of their eagerness to present a science that they had become intimately involved with over the course of their first year in the CLS program. They demonstrated their creativity and enthusiasm by sharing their knowledge to those who may be interested in following in their footsteps. Based on the outcome measures used, the participants indicated positive attitudes toward all aspects of the program. This is the kind of spark the CLS profession needs to advance and circumvent future shortfalls because of lack of interest.

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