Course Background

MMBio 407 Clinical Microbiology is a part of the Medical Laboratory Science program and major. Only senior level students admitted to the major are eligible to take the course. Currently, there are no microbiology laboratory prerequisites prior to taking the course, so the course covers introductory and advanced clinical material in a 4-credit course.

The course is two hours of lecture and six hours of lab (spread over Monday through Thursday) each week, with one exam and one quiz per week. We work with over 40 organisms in the laboratory, and discuss multiple times that amount in the lecture.

An adjunct faculty assists in the laboratory, but there was no written material for the laboratory when I began teaching this course. My primary goal before teaching the course was to create a lab manual for the students and myself. Although I created new lectures and exams, I followed an outline for the course material from the previous instructor.

Learning Outcomes

1. Perform the full range of clinical laboratory tests in clinical microbiology and play a role in the development and evaluation of test systems and interpretive algorithms.
   *Relates to Program Learning Outcome: #1

2. Have diverse responsibilities in areas of analysis and clinical decision-making, regulatory compliance with applicable regulations, education, and quality assurance/performance improvement wherever laboratory testing is researched, developed, or performed
   *Relates to Program Learning Outcome: #2

3. Possess basic knowledge, skills, and relevant experiences for the following:
   - Communications to enable consultative interactions with members of the healthcare team, external relations, customer service, and patient education
   - Financial, operations, marketing, and human resource management of the clinical laboratory to enable cost-effective, high-quality, value-added laboratory services
   - Information management to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information
   *Relates to Program Learning Outcome: #3, 4, 5

Course Activities

Lectures were given two times per week. Questions and discussions within the context of the lecture were encouraged.
Reviews were done in place of lecture prior to midterm and final exams. The midterm review was done as a spelling bee. Once an organism was spelled correctly, we reviewed the pertinent information about the organism. This format was very engaging for the students and I plan to use it again in the future. The review for the final exam was discussion based, and designed to lead students to predicting what they would expect to see in the laboratory based on case histories and clinical information.

Exams were given in written form and in the laboratory as practical exams. They will be discussed below.

Discussions on career opportunities were held about jobs in hospitals or industry following a conference I attended and met with several such companies. We also had two conversations on furthering education and knowing when and how to make sacrifices for future goals. I used the Faculty Women’s Association “By Study, By Faith” as part of this.

Demonstration material was prepared in the lab for students to observe and record organisms and their reactions throughout the course.

Known samples were given to students for them to work up and see expected behavior patterns. These were generally given to groups to work together and foster discussion of the work.

Unknown samples were given to students weekly to identify the organisms. New procedures were explained and demonstrated for known and unknown organisms. During the second half of the class, clinical context and case histories were introduced with samples.

Demonstrations and known and unknown samples were the primary activities used to help students learn to perform the full range of clinical microbiology tests. (LO #1) Students not only performed the tests themselves, but they also were responsible for the decision making process of how the organisms should be identified with the given information. (LO #2) Lectures provided the basic knowledge and laboratory activities provided the skills and relevant experiences referenced in LO #3.

Assessments of Student Learning
Weekly lab quizzes were given on Thursdays to emphasize the principles and skills taught in the laboratory that week. Special emphasis was given difficult subjects for the students that week, after they the topics had been visited multiple times.

Weekly lecture exams were used to cement knowledge of the material covered in the readings and lecture each week. Through the first half of the semester, each week was a unit on a different group of bacteria. Through the second half of the semester, each week was a unit on a system of the body and the interactions of organisms with
the body site. Lecture exams provided an opportunity for students to confirm they had a sufficient grasp of the material before moving onto a new subject.

Each student submitted weekly lab worksheets on Thursdays. Lab worksheets reported all of the work done by the student and final identification of the organisms they worked with. Students were required to report data in standard format, teaching one important method of communication in a hospital laboratory. Lab worksheets were graded meticulously and returned early the next week for students to take the skills they learned and improve during the following weeks.

The midterm written exam was administered partway through the semester, an important time because it marked a shift in the way material was presented. The vast majority of organisms referenced in the second half of the semester had already been covered and were discussed again in terms of their relationships to the human body.

The midterm practical exam was administered over a one-week period. On the first day, students rotated through 12 stations with evidence (cultures, biochemical tests, etc.) of different organisms that they were to identify based on the given information. Then, students were each given 5 unknown organisms with no background to identify. Through the exam, students were required to use the basic knowledge and the skills they had gained through the semester. 33% of the final grade was for the 12 stations, which focused on student ability to integrate information presented to them. 33% of the final grade was for the correct identification of the 5 unknown organisms they were given. The final 33% was awarded for the correct workflow of the 5 unknown organisms, which required implementation of the skills they had gained in the laboratory.

The final written exam was comprehensive over the whole semester. I feel like this exam did a great job of recognizing if students captured the big picture of the course. There were many, many details in the course, and one of the largest difficulties is combing through to find the relevant details for a particular clinical setting. Each week students learned a few more pieces of the puzzle, and the final exam was for the whole puzzle. Students were required to pass the final exams with 70% or higher; one student did not accomplish this and I felt that was the only student who should not have passed the class. However, I believe the cutoff should be raised to 75% in future semesters. The next lowest student score was in the upper 70s.

The final practical exam mirrored the midterm, except with 10 stations. Also, all unknowns were given with clinical background, or a case study, and the students were expected to identify the clinically relevant organism, instead of any organism present. This helped the students apply the knowledge and skills they had used for a clinical background. Grading mirrored the midterm practical. Again, only one student did not pass with the required 70% and I felt this was an accurate assessment.
Student Achievement of Learning Outcomes

LO #1 Perform the full range of clinical laboratory tests in clinical microbiology and play a role in the development and evaluation of test systems and interpretive algorithms.

Students completed the full range of clinical microbiology lab tests that are performed in our lab throughout the semester, as evidenced by weekly lab worksheets. The average on the weekly worksheets was 87%. Earlier in the semester, students were graded more heavily on performing the tests, which were all new. Later in the semester, students were graded more heavily on correctly identifying the organisms.

LO #2 Have diverse responsibilities in areas of analysis and clinical decision-making, regulatory compliance with applicable regulations, education, and quality assurance/performance improvement wherever laboratory testing is researched, developed, or performed

Students were involved in the development and evaluation of test systems throughout the course. For several procedures, students were given the option of multiple types of the test to use, such as for coagulase testing, and determined which method to use. In the first half of the course, students designed a flow chart for the identification of *Enterobacteriaceae*. There were given 8 biochemical tests to choose from to use in their charts. I feel like this helped many of the students understand the broader concept of organism identification, but several students relied on instructors and fellow students too much in this process. Next year, I would like them to create a more structured flow diagram as a graded assignment to improve this activity.

During the second half of the semester, students were given mock clinical specimens with the responsibility to work-up the clinically relevant organisms; instructors were available to assist and answer questions. During the final practical exam, students were required to work-up six unknown specimens with case histories as if they were clinical samples in a hospital, with no assistance. Students were required to receive a 70% on this exam to show proficiency and pass the course. All but one student passed this exam.

LO #3 Possess basic knowledge, skills, and relevant experiences for the following:

- Communications to enable consultative interactions with members of the healthcare team, external relations, customer service, and patient education
- Financial, operations, marketing, and human resource management of the clinical laboratory to enable cost-effective, high-quality, value-added laboratory services
- Information management to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information

Student learning of this objective was measured by the lecture exams. Parts of this objective are more suitable for the microbiology clinical internship the students
complete and will be removed from the objectives for this course in future semesters.

**Steps Planned or Taken to Improve Teaching and Student Learning**

The primary step taken to improve this course was to create a written laboratory manual with protocols. Previously, laboratory instructions were given orally or in succinct hand written instructions, with no real protocols. The development of this manual took many hours, but provided the students with objectives for each laboratory unit, expectations of the students for the week, protocols for new procedures, and standardized worksheets to fill out so the students understood what was expected to be recorded to receive credit for their work. Student feedback on the laboratory manual was positive. I kept a specific copy of this manual in the lab for myself and my assistants to record any errors with the lab manual or suggestions on how a lab could be improved or better explained. These changes will be incorporated into the lab manual the next time the course is taught.

One of the most beneficial things I did this semester was a midcourse evaluation and consultation with my faculty mentor and consultant from the Center for Teaching and Learning about the results. I learned how my students viewed the course and their learning in the course, and together we agreed on ways to improve. Ratings of my teaching and the course dramatically improved from the midcourse evaluation and the final evaluations, and many of the student comments reflected that they felt the midcourse evaluation taught them that I cared about the students, their learning, and their suggestions and opinions. I was grateful for an opportunity to further connect with my students.

I wrote and received a teaching enhancement grant (TEG) for the College of Life Science for this course. The TEG was used to purchase 20 iPad minis for use in the laboratory, which students used to create photo documentation of student work. Microbiology is a very visual field and the photos were used to verify student work and enable discussions of myself and students outside of the laboratory. Student surveys specific to the iPads were completed mid-semester and prior to the final exam and showed positive feedback and increased confidence in student work. For the second part of the TEG, I am working with a student this summer to create mock clinical specimens with multiple organisms. These protocols will be used in future semesters to help prepare the students further for working in clinical laboratories.

In future semesters, I plan to create expanded mycology and anaerobic bacteria units for the lecture and laboratory. I created a survey for medical technologists in clinical microbiology labs that my students have internships at, to see how well prepared the students are when they arrive and what could be done better in the classroom. When I receive the results of this survey, I will work to incorporate the suggestions into the course. I plan to distribute this survey every 1-3 years to have a benchmark to compare student learning.
Scholarship Strategies Final Report  
Mary F. Davis  
June 2015

Status of scholarly goals:
1. Publication of a review article in Clinical Experts in Immunology on electronic medical records and multiple sclerosis, in collaboration with Dr. Jonathan Haines. This article was submitted in June 2014 and accepted in December 2014 in Clinical Experts in Immunology.
2. Publication of a genetics paper of clinical traits of multiple sclerosis, to finish my dissertation publications. Publication of this article was delayed due to revisiting one of the analyses and performing an updated statistical analysis for the timed 25-foot walk in collaboration with Erika Ball in the Department of Statistics and Benjamin Peaden, an undergraduate student in my lab. The analysis is complete and Benjamin wrote a preliminary draft of the paper. An abstract of the work was submitted for the Annual Meeting of the American Society for Human Genetics (ASHG) this fall. Submission of this publication is my primary scholarly goal this summer.
3. Presentation of a poster at the American Society for Human Genetics meeting in October 2014. I presented a poster at ASHG 2014 in San Diego, CA on comorbidity studies of multiple sclerosis. The study was designed and implemented with undergraduate students, Scott Frodsham and Mackenzie Olsen, in my lab.
4. Submission of a proposal to BioVU for new studies of multiple sclerosis in collaboration with Dr. Joshua Denny at Vanderbilt University. I submitted the proposal, data use agreement, and IRB approval with Dr. Denny and received approval for these studies. The research studies are currently ongoing.
5. Submission of a NIH AREA grant for studies of multiple sclerosis, as the main PI. I have gathered preliminary data for this grant and outlined it, but I have yet to submit it. I intend to submit this grant to either the National Multiple Sclerosis Society or the NINDS by October 2015. However, I did submit a proposal to Teva, a pharmaceutical company. The proposal met with a positive response and a contract is being discussed.

In general, I feel that I have made great progress in my scholarship in the past year and a half. There have been several setbacks, but I have also begun additional collaborations that were not planned when I wrote my faculty development plan. I have started collaboration with Dr. Max Muenke at the National Institutes of Health on a whole-exome sequencing project in a multigenerational family with FG syndrome. I am assisting in a natural language processing PheWAS with Dr. Josh Denny at Vanderbilt University, and I submitted and received approval for a BioVU study on X and Y chromosomes. I also submitted a grant proposal with Dr. Denny to Teva for multiple sclerosis research. I completed two new analyses with undergraduate students in my lab that we are writing papers for this summer,
presented at two conferences, and three undergraduate students have submitted abstracts to present at national conferences this summer and fall.

The two major hurdles I have experienced in my scholarship are the large amount of time required to complete paperwork and receive approval for my studies with human medical records and DNA and the overwhelming effort required to prepare new courses to teach. I have completed the paperwork necessary for my three major research areas, which should not need to be revisited for a while, at which time I hope it will go smoother since I have been through the process previously. For the second hurdle, in the winter semester, I prepared and taught two new hours of material each day for MMBio 407 Clinical Microbiology, with one written exam each week, including creating a laboratory manual. It was challenging to meet my goal of 1½ hours of research per day while teaching this course, but having the goal kept it in my mind and encouraged me to do more than I may have otherwise. It was also beneficial to have several students in my research lab who were already well into projects that I could work with to keep me involved and invested in the ongoing research projects. I also held a weekly lab meeting with my students that kept me motivated in continuing the research projects. I will teach the same course each winter semester, so the preparation load will hopefully decrease each year, but I recognize that this semester with a heavy teaching load will always be a slower paced time for my research.

Creating a schedule of “due dates” for myself has been very effective. Even when I do not meet all of the deadlines, it has helped motivate and pace out the work that needs to be done. This summer I revised my goals, set due dates, and mapped out week-to-week work to complete. By setting aside specific hours each day for various ongoing research studies, I am more productive.
I have met many individuals this past year and discussed several potential collaborations. My goal was to have focused discussions on research collaborations with at least five individuals and start at least two to three projects with others. This was easier than anticipated, although keeping the projects continually moving forward is more difficult than expected. Below are three collaborations that are ongoing in my lab.

I am collaborating with Dr. Josh Denny at Vanderbilt University, and this project has moved along nicely, with three papers we are currently writing. These projects required a significant amount of time to complete the paperwork, including several proposals, data use agreements, and IRB approvals.

I have begun a familial syndrome analysis, searching for rare variants, with Dr. Max Muenke’s group at the NHGRI. We have completed the necessary paperwork, enrolled patients, collected phenotype information and DNA, and we are currently waiting for genotyping and sequencing results. This project will expand the types of studies we work on in our lab, focusing on rare variants as opposed to common variants. The most challenging aspect of this project is that the distance to collaborators makes it difficult to frequent discussions of how to move the project forward. We communicate through email and have met at two conferences this year, which has made a big difference in the productivity of the project.

A third project I have begun is working on systemic lupus erythematosus (SLE) with a student in Dr. Brian Poole’s lab, following up research they have seen with the mice in their lab. We have identified patients with SLE and/or malignancies through electronic medical records and are comparing the effect of SLE treatments on the development of malignancies.

Barriers to collaborations I have encountered are the lengthy amounts of paperwork involved in data transfer between universities and coordinating with multiple IRBs to receive approval for the projects. However, having been through this process now I am more confident that it will go smoother for future collaborations. I have also learned to become more vocal in which aspects of a project I would like to be involved in or in charge of, and I have learned the importance of speaking honestly about expectations and goals and keeping a written record of conversations so they can be referred to in the future. I plan to continue the collaborations I have started and to pursue additional collaborations both at BYU and at other institutions in the future.