Integrating Technology in a Drug Assay Course
The Use of Virtual Labs and Supporting Tools*

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Introduction

Maintaining high standards of science training is important for pharmacy graduates to practice knowledgeably, responsibly and confidently. It is an important step to educate pharmacists in the practice of "good science" which is "evidence-based, convincing, explanatory, honest, testable, and systematic." Instrumentation and resource constraints are maximal in the pharmaceutical analysis laboratory due to the nature of the experiments to be conducted and the need to provide an as much individualized learning experience as possible. The Medicinal Chemistry 409 Lab has undergone a transformation from traditional instructor taught-sessions to learning through web and media-based tools. In place of introductory lecture that graduate student instructors (GSIs) have traditionally given at the beginning of each lab session (30-45 minutes, twice a week for three weeks for each set of experiments for each GSI), we introduced a mixture of videotaped introduction and/or virtual labs for each of the ten lab techniques taught in this course. In addition, we introduced videos that demonstrated the operation of various laboratory equipment (laboratory technique videos). After viewing the videos, students were required to take online quizzes to assess understanding of the techniques and the student's preparation for the lab sessions. Our study compared the use of the various teaching methods and their impact on the educational process. Surveys examined students' perceptions regarding the effectiveness and applicability of the various tools.

Laboratory Set-Up and Tools Used

Students ran ten experiments over the course of the semester, including Buffer Preparation, Acid-Base Titration, Colorimetric Analysis, U Spectroscopic Analysis, Fluoremetric Analysis, Qualitative and Quantitative HPLC Analysis, GC-MS Analysis, ELISA Assays, Gel Electrophoresis and Southern Blots.

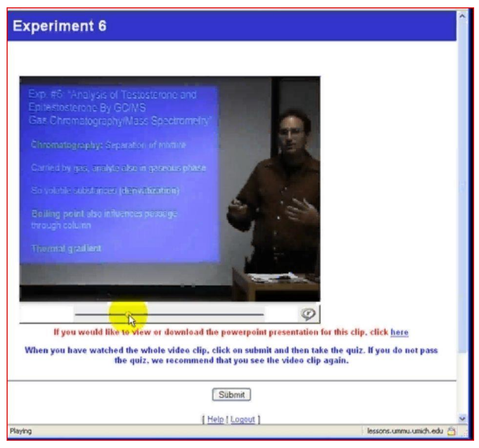
Students are expected to utilize these techniques to identify and/or quantify various drug samples and apply that knowledge to case studies that involve different drug groups.

All students ran the first experiment concurrently.

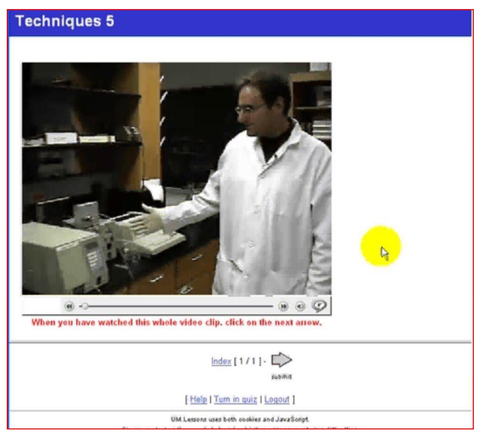
For the remaining nine experiments, students were divided into three groups. These groups then rotate in three week blocks for the sequence of three experiments

Tools introduced included:

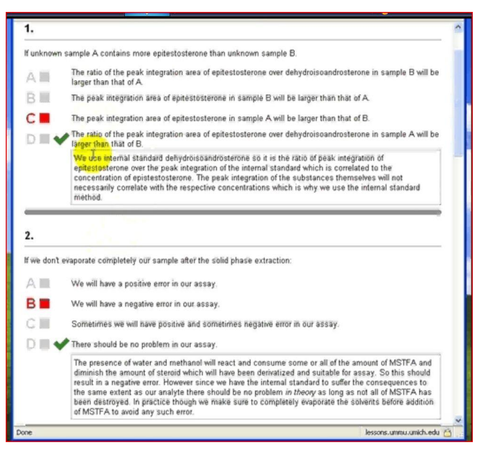
1. Videotaped introductory lectures
2. Videotaped demonstration of equipment operation
3. Virtual labs
4. Online lab reporting
5. Online quizzes



Online lecture instruction about chromatography theory.



Experimental demonstration of analytical instruments.



Providing on-screen feedback on online quiz answers.

How do the Virtual Labs Work?

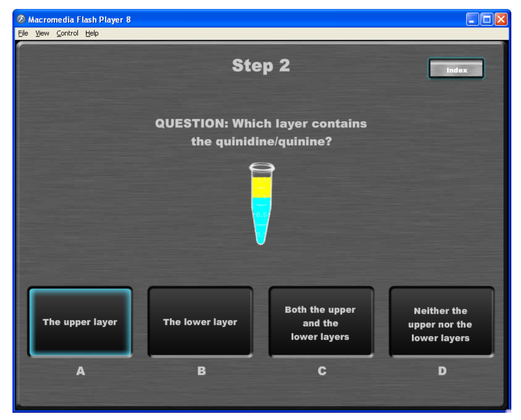
The virtual labs are computer modules that lead students on an audiovisual virtual tour describing the actual experiment, complete with expected results and questions regarding each step. Each virtual lab typically starts with an introduction to the equipment used, followed by basic questions regarding safety and proper lab technique. Once students answer the related questions correctly, the virtual lab proceeds into a step-by-step description of the protocol, with images, interactive simulations, and animations illustrating each step. As the student progresses from one step to the next, they are required to answer questions that test their understanding of the experiment protocol. All questions include explanations of the reasoning behind the correct answer. The virtual labs also provide an opportunity for illustrating the consequences of making any errors students may commit during the experiment. Finally, the virtual labs provide an in-depth look at some of the equipment utilized.

Results

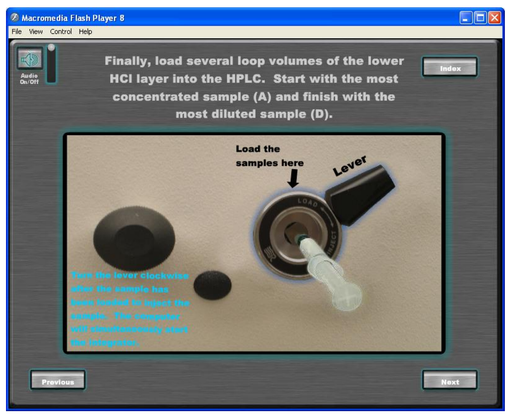
Statistical analysis were performed using ANOVA and Student's t-test. P-values < 0.05 denoted by (*) indicate statistical significance.
Results for Fall 2004 represent students enrolled in the traditionally-taught course, while Fall 2005 and beyond represents students enrolled in the course after the implementation of the aforementioned innovative tools. Improvements to the tools were introduced each year based on student and faculty surveys.

Images from the Virtual Labs

Gel Electrophoresis

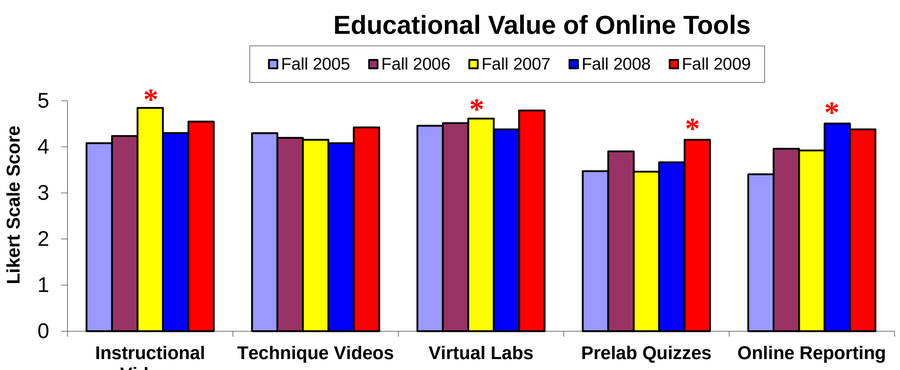


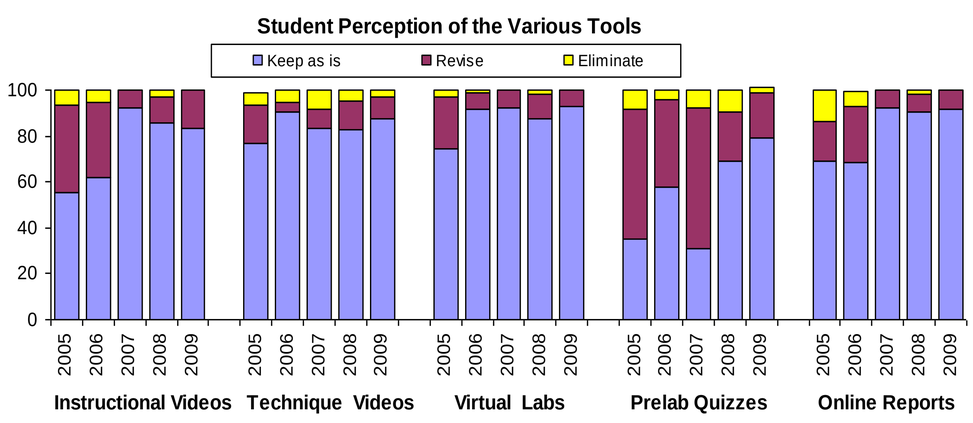
Sample Question (HPLC)

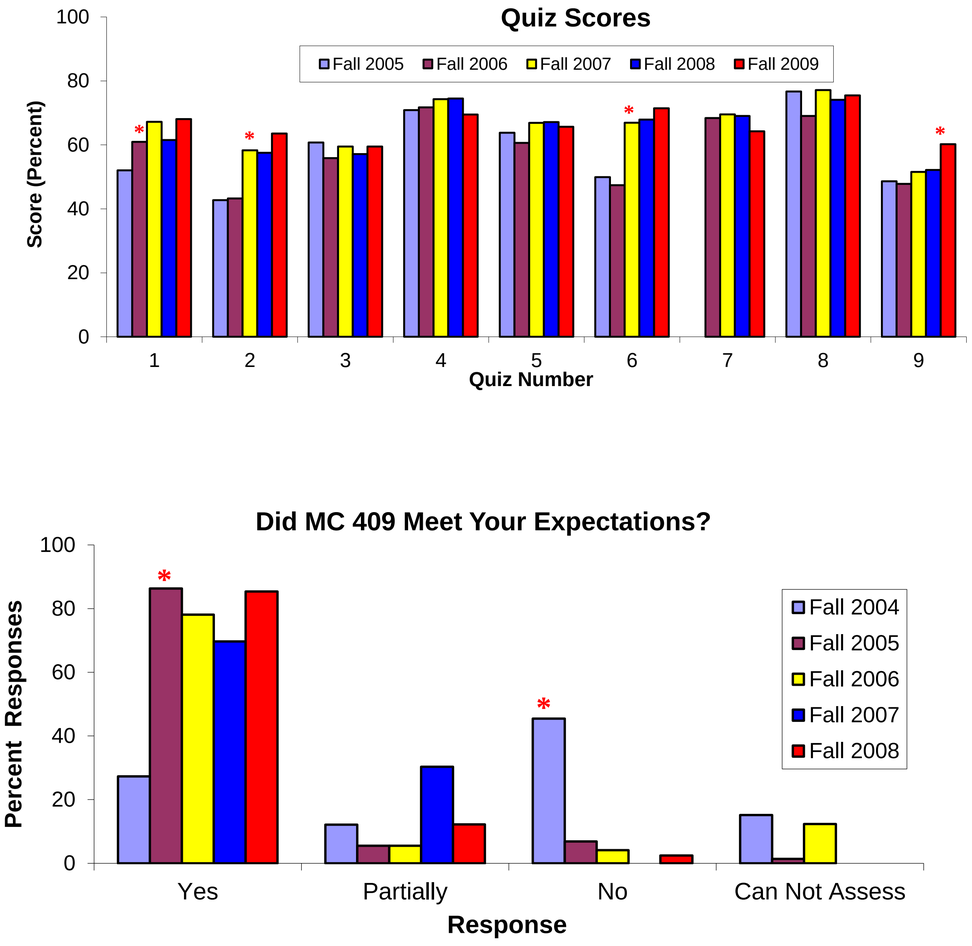


HPLC

Enzyme Stability



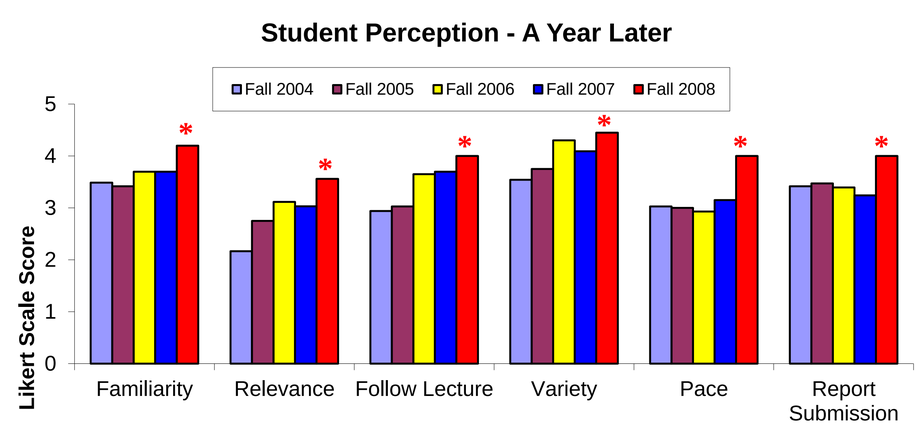




Fall 2005: Virtual Labs 8 and 9 introduced
Fall 2006: Virtual Labs 1 and 7 introduced
Fall 2007: Virtual Labs 2, 3, 5 and 6 introduced
Fall 2008: Virtual Lab 4 introduced

First semester student responses were collected at the conclusion of the MC 409 course.

Fourth semester student responses were collected during the middle of the winter semester one year following the completion of the MC 409 course.



Conclusions & Future Directions

- The changes introduced have shown improvement in students' perception of the course, in particular regarding its relevance to pharmacy practice, familiarity with techniques and meeting students' expectations. This positive perception continued as students progressed further into their Pharmacy education.
- The innovative tools were well received, and students have recommended that they be kept as an integral part of the course, either as is or with modifications. Students seem to prefer the virtual labs to any other tool introduced.
- Analysis of student performance appear to indicate that, in many cases, the virtual labs helped students better understand the protocol prior to exposure to the actual wet lab (as demonstrated by their performance on the prelab quizzes).
- Improvement of resource utilization, offering a variety of educational exposure, reducing year-to-year inconsistencies, and having a highly structured laboratory format.
- This study also provides an alternative solution for delivering instructions to the increasing class sizes and its effect on laboratory courses at colleges of pharmacy.
- Provides a blueprint for an efficient approach to include active learning and problem solving in the laboratory and addresses other issues related to streamlining the laboratory. The wealth of online tools and the use of a novel web-based approach could be expanded into other courses as well.
- Resources required are minimal once the tools are created and are amenable to modifications and updates as deemed appropriate.

*M. Waldman-Dunham, K. Ghirtis, and M. Beleh "Integrating Technology in a Drug Assay Course: The Use of Virtual Labs and Supporting Tools" *Am J Pharm. Educ* . 2012 In Press.