AC 2009-1312: WEB-BASED CLASSES FOR ENHANCEMENT OF PRELABORATORY LECTURES

Tiffany Hesser, University of New Haven

Tiffany Hesser is currently a Visiting Instructor and Organic Laboratory Coordinator at the University of New Haven in Connecticut. She is also involved with the The Summer Institute for Young Women in Science and the Chemistry and Math Enrichment Program.

Web Based Classes for Enhancement of Pre Laboratory Lecture

Abstract

The use of web classes, such as Tegrity Campus[1], as a supplement to pre laboratory reading or a replacement for pre laboratory lectures could become a standard tool in laboratory education protocol. In classes with multiple lab sections and instructors, pre laboratory lectures can lack consistency and it can be difficult to gauge the students' level of preparation. With the ever increasing exposure to technology, students generally prefer information in a digital and multimedia form, rather than textbook readings. Therefore, this method can prove to better prepare students prior to laboratory experiments, increasing the overall understanding of the chemical reactions and concepts. It can also increase safety within the lab using a method current students can relate to and prefer.

This process is currently being used at the sophomore level in Organic Chemistry laboratories at the University of New Haven for approximately 111 students with majors in chemistry and chemical engineering among others. Each pre lab lecture is recorded by the laboratory coordinator, and students are required to view the videos prior to the laboratory. Recordings include general information on chemical reactions and chemical hazards, information on glassware set up, procedure and waste disposal.

To assess the effectiveness of using Web based lectures to prepare students for the weekly labs, data has been obtained from laboratory instructors, teaching assistants and laboratory assistants of how the lectures have impacted students' preparation. Feedback has been obtained through student surveys following the completion of the labs, questioning students about the usefulness and ease of using a web program for pre laboratory lectures, if the video method is preferred to supplemental readings or if it helped to enhance instruction from the text.

Overall, the research proved to be a useful tool in saving laboratory instructors and students' time, while enhancing the laboratory experience and student satisfaction utilizing tools most higher education institutions have available.

Introduction

Traditionally, laboratory learning has been approached using a constructivist style, with instructors acting as facilitators to help students perform procedures and, ideally, gaining conceptual knowledge along the way. This approach has a valuable place in science education, where it is imperative that students develop a set of complex skills that are often taught by simulating authentic research.[2] Most laboratory protocols expect students to meet a certain level of preparation before entering the laboratory. Research suggests that advance preparation is an effective way to promote student learning and interest in the classroom. Preparation is particularly important in laboratory activities in which safety concerns are present. The richer and broader learning experiences provided by laboratory work have been shown to be important in attracting and retaining students.[3]

Accreditation standards often require that classrooms and laboratories should not only accomplish program objectives, but should also provide an environment that is conducive to learning.[4] Such an environment can be fostered by using teaching methods that are student-oriented. It has been suggested that today's students absorb material differently then did previous generations.[5] They are very comfortable with technology and prefer to receive information through digital sources.

As the popularity of technology in the classroom grows, it raises questions about the benefits of such a trend ("e-learning") and its role in a laboratory setting. Some research supports the benefits of such techniques and suggests that is may even be linked to better student performance on assignments, exams and overall class scores.[2]

This study examined student satisfaction and preparation when using a new technology: pre-laboratory lectures delivered via video through an on-line server (Tegrity Campus and Blackboard)[1,6]. The impetus for this approach was the growing number of students who seemed unprepared for basic laboratory procedures, despite assigned reading for the class. Other studies have reported similar experiences at other institutions, including one performed in Norway [5]. In that particular case, pre-lecture notes where delivered via mobile phones for a biology lecture, a process referred to as "m-learning". The study reported favorable results in better student preparation prior to lecture and higher levels of student satisfaction.

In the fall of 2008 students in organic chemistry at the University of New Haven were provided with short pre-laboratory lectures via video, which they could access at any time through the university website. The video lectures allowed uniformity of basic preparation information and also helped to create a safer environment, by assuring that all students have heard, seen and read the safety precautions pertaining to each lab. This was an important objective to meet as student and instructor numbers increase. In addition, the students would be more engaged by providing information in such a visual setting and therefore more likely to complete the assignment and proper utilize the information. Being better prepared for the lab should allow them to appreciate the purpose and science behind the experiment, rather than being completely focused on small procedural steps. If students are given the intellectual freedom to focus on these important lab concepts, they have the potential to take more away from the lab experience.

Introduction of Tegrity Video Modules

Organic Chemistry at the University of New Haven is typically completed at the sophomore level. It is required for chemistry, chemical engineering and forensic students as well as numerous other majors. In the fall of 2008, 111 students in 6 separate sections completed the course. Approximately 60% of the students were forensic science, chemistry or chemical engineering majors, while the remaining 40% represented 14 different majors. Twenty two students were pursuing double majors (appendix Table 4). It should be noted that no attempt was made to isolate the results for any particular major in assessing the impact of the video lectures. This is consistent with the historical position of ABET (Accreditation Board for Engineering and Technology) that Chemical Engineering students should take the same versions of Chemistry courses that are taken by students majoring in Chemistry.

In previous years, a commercially available laboratory textbook was used for organic chemistry. For each experiment students were assigned 2-10 pages of reading on reaction schemes or other background information. Modifications were often made to the text experiments in order to utilize available equipment and reagents. To implement the modifications a separate handout or a chalkboard was used to explain the changes prior to each lab. Each experiment also used a variety of equipment to expose student to the various glassware used in organic laboratories. Providing this information to the students would create an expectation among instructors that students would come to lab prepared to identify appropriate equipment and able to complete the experiment

In addition, many labs required use of an analytical tool, such as melting point apparatus, boiling point determination or other instrumentation. Analysis requirements vary regularly to provide exposure to different techniques over the course of the year. An additional 2-10 pages of reading was often required for the analysis. In previous semesters, safety hazards and waste disposal was written on the board as well as given on a handout and would be ideally reiterated by the instructor.

During the last few years the enrollment has increased resulting in increases in the number of lab sections (5 to 7 per semester) as well as the enrollment in each section. Some sections now have 24 students (previous limit was 16) and must run in two separate lab rooms. The larger number of student and increased numbers of instructors and student lab assistants created some discrepancies with information provided to the students. It may also increase the number of students who enter the lab unprepared.

In response to this situation, a web-based video service (Tegrity Campus[1]) linked to our course management software (Blackboard[6]) was implemented. The use of a video lecture with required viewing for all students works to unify the basic topics being covered by each section, as each section completes the same experiments and sees the same assessment methods following a laboratory experiment in spite of numerous instructors. The Tegrity Campus also allowed instructors to monitor who had watched the video prior to lab by accessing the reports from the website.

The lectures were recorded following laboratory preparation by faculty and staff. A laptop computer was used with a small portable webcam. The presentations, varying from 18 to 30 minutes in length, were pattern templates designed to meet the needs of visual, auditory and kinesthetic learners. This was done using a Power Point lecture on relevant concepts, with a procedural video and narrative. The Power Point could be designed to be shown on screen with the video or switch between the video and Power Point. The presentation included identification of new glassware, equipment assembly, any modifications to the text experiments, overview of analytical methods, safety information and waste disposal procedures. The students were asked to refer to the text throughout the video as the video was designed to augment, not replace, student preparation. The video modules are interactive, allowing students to replay certain parts or search for certain terms within the lectures. It has been suggested, that this feature of e-learning is more beneficial to the student than live stream.[2]

It was believed that students would prefer the video preparation to pre laboratory lectures in class and would be more prepared to properly and safely conduct the experiment. The Tegrity lecture would also provide a level of consistency for each section of the lab and ensure all the instructors that a given amount of preparation was done by the student prior to lab. The video lectures have the potential to create an environment of higher level learning as the student focuses on the procedural concepts of the experiments prior to lab and increase the procedural, declarative and conditional knowledge for the students during the lab session.

Assessment Methods

Surveys were given to students, instructors and student lab assistants to assess the level of satisfaction with the video lectures as well as the level of student preparation for the lab work. Of the 13 experiments conducted during the period studied, 12 included video lectures while one was conducted using procedures previously used. Use of the traditional approach was intended to give students a comparison experience when surveys were to be conducted. The surveys focused on the student's overall impressions and satisfaction with video lectures in comparison to text reading alone or instructor presented pre laboratory lectures. (Surveys can be seen in the appendix.). Students were asked to rate their experiences on a scale from 1 to 5, where 5 strongly agreed and 1 strongly disagreed with a set of given statements. Students were also asked to comment on their personal experiences.

Instructors and student lab assistants were given similar surveys to examine their perception of student preparedness in this particular semester in comparisons with previous semesters in this same course. All instructors and student assistants surveyed had previous experience with the lab. Instructor and student lab assistants were also asked to add comments and make comparisons within those comments to previous experiences.

Results of Surveys

In the fall of 2008, 111 students were enrolled in Organic Chemistry Laboratory 1. Eighty three surveys were collected from the students, six from graduate or undergraduate assistants and instructors.

Table 1

Averages	St. Dev.	Questions for Students on Web Based Learning Experience
4.06	***1.12***	*I found that accessing Tegrity and other web based documents was easy.*
4.05	***1.19***	*I found that accessing Tegrity and other web based documents was convenient.*
4.18	***1.03***	*I found that being able to revisit before and after completing the lab was useful.*
3.92	***1.28***	*I preferred Tegrity Lectures to a prelab in person.*
4.04	***1.05***	*When Tegrity was not used, I feel my instructor provided an adequate and informative prelab lecture in its place.*
3.94	***0.96***	*I felt that the length of Tegrity was adequate.*
4.18	***1.24***	*I felt that the Tegrity videos helped with the glassware set up for most of the lab, more so than the set up from the text.*

Findings from the surveys located in Table 1 suggested that students preferred the video pre laboratory lectures to their experience with traditional delivery methods. Although it was not directly questioned, several students wrote in comments saying that it was useful to have a visual understanding of the steps prior to lab, and that this approach raised their level of confidence upon entering the lab. In the web lectures, students were actually shown the procedure using the correct glassware and technique, allowing them to anticipate their own activities during lab. For example, organic sample are commonly dried with a sodium sulfate anhydrous. This is done by adding the anhydrous to the sample in a test tube, shaking it and watching how the solid anhydrous moved within the solution. Students are told to watch for a "snow globe effect", meaning free floating granules indicate that the anhydrous has removed all the water from the sample. This can be a difficult visual for students and in previous years has lead to continuous questioning. This year, students were able to watch the process on video prior to lab.

The survey also conveyed that students believed that the videos were easily accessible and that being able to watch them on their own schedule prior to lab, was convenient and beneficial. In addition, students commented that they found using the lecture after lab was helpful in writing reports as the lectures often contained equations, formulas or the analysis process. For example, students were introduced to gas chromatograph spectra in this particular course. Although the pre laboratory lecture gave limited background on this instrumentation as well as examples of resulting spectra, this information may not have been meaningful until students had received and were analyzing their own results. Thus the web lecture provided a just-in-time learning opportunity for students to analyze their own results in a similar manner to those results being analyzed in the video lecture.

Importantly, students felt the visuals provided by the video were more helpful than drawings provided by the text. Laboratory textbooks often contain a page within the introduction or appendix that students can reference throughout their learning that contains pictures of most of the glassware that will be used in the lab. The procedures will often reference these, assuming that the learner has accessed this page. In practice, students would often spend significant time trying to identify the glassware referenced in the procedure while conducting the experiment. This wastes valuable class time and places the student focus on procedural steps, rather the larger concepts and ideas that a lab is intended to teach. Overall students preferred the visual aspects and the pattern template that the video prelab offered in comparison to traditional reading, this benefit was highlighted by many students on the surveys through comments as well as the survey itself.

Table 2

Average	St. Dev	Questions for Instructors and Assistants on Web Based Learning Experience
4.29	***0.88***	*I found that being able to access Tegrity and Web based documents prior to lab was convenient is helping the students and being prepared.*
4.71	***0.45***	*I felt that the Tegrity videos helped students with the glassware set up for most of the lab, more so than the set up from the text.*
4.43	***0.73***	*I felt that the Tegrity videos provided students with the tools to successfully and thoroughly complete the lab.*

The results of the surveys completed by the instructors and assistants in Table 2 were also supportive of the benefits of video lectures. In addition to the numerical questions in Table 2,

instructors and student lab assistants were asked several specific questions about the degree of preparation of the students, in comparison to previous semesters. Assistants and instructors with previous organic lab experience felt that students were more prepared and able to go directly to work upon entering the lab. A typical comment was: "It was much better than in prior experiences. They knew what was going on and seemed more familiar with equipment and the procedure".

One assistant also felt that the numbers of procedural questions decreased with introduction of the video lectures, due to the fact that students were better prepared. Another experienced assistant commented that this particular video experience caused students to ask more specific questions about what was happening in the lab and use assistants to check work rather than for complete direction of set up or procedure as done in previous years.

As intended, the assistants and instructors did not feel that the Tegrity lectures allowed students to do less preparation for the course, but instead made it easier to successfully complete the required preparation. This was an important aspect because the web lectures were not intended to decrease the responsibility and time of preparation for students. Assistants also commented on surveys that the video lectures led to higher levels of student preparation and "smoother, faster transitions right into the experiments." This outcome may be a result of the videos or the ability of the instructor to ensure all required preparation has been completed by each student prior to coming to the lab. The student assistants also noted that the Tegrity lectures helped them to be better prepared for the laboratory work by being able to review the experiment prior to working alongside students in the lab.

One issue regarding the video modules noted by students and assistants alike was that the students did not seem to retain the information if the video lectures were not watched directly prior to lab. Even if the students took notes; they seemed to lose the pattern template that was created by the video. Even referencing notes they had taken in their lab notebooks did not benefit them if they had watched the video many days prior to the lab. This phenomena was discovered early in the semester and was rectified by recommending that students watch the video as close to their own labs as possible.

Also, one student commented that with the video a communication link was lost between themselves and the instructor to ask questions as they arose during the video. Although this need could be meet with ensuring enough instructor and assistant presence within the lab itself, so as student reached certain points, they were able to easily assess help. One particular student also felt that with the introduction of the pre laboratory videos, her instructor often assumed she had a higher level of knowledge about the procedure than she actually did, creating an environment in which this student felt intimidated asking questions.

Table 3

Year	Student Count in Laboratories	Average Grade Ratio	
2008	*111*	*1.13*	
2007	*104*	*1.22*	
2006	*78*	*1.17*	
		1.17	**Average**
		0.04	**Standard Deviation**

0.10	**p value 07-08**
0.40	**p value 06-08**

Although this study examined the introduction of video lectures to student's satisfaction and preparation, data (Table 3) was examined to ensure there was no negative outcome on student grades as a result of this technology. A ratio was obtained of the final laboratory grade to the final lecture grade for each student that successfully completed both. While the average ratio decreased this year, p values obtained through a student t test are greater than 0.05, suggesting with 95% confidence or greater that there is no statistically significant difference in the average ratios from students that completed the course while the video modules where being introduced.

Conclusion

While this is a newly developed protocol for this course, the introduction of video pre laboratory lectures was a success and we are enthusiastic about its future use within our institution. This study was designed to examine student's satisfaction of the implementation of new technology and examine how it may affect student preparation. It was also intended to ensure that with increased numbers of instructors teaching the course a basic level of information was delivered. Based on this, our impression is that this new technology was a success. Students were pleased with the introduction of technology. Importantly, background and safety information was unified among multiple sections and instructors and assistants felt that lab preparation has improved. In light of this, we look forward to receiving future data on this topic and perhaps examining the overall affect on student grades and outcomes with each passing year.

Current student assistants and instructors commented that procedural knowledge and preparedness had increased among students. This has the potential to lead to a more intellectually beneficial, efficient and safe laboratory setting for everyone. In addition, students preferred learning from a media that they are comfortable and familiar using.

References:

1. Tegrity Campus 2.0, www.tegrity.com , Copyright 2008 Tegrity Inc.
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3. Zhang, D., L. Zhou, R. Briggs, J.Nunamaker, "Instructional video in e-learning :Assessing the impact of interactive video on learning effectiveness", Information and Management, 43(2006)15-27
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6. Blackboard Academic Suite, www.access.blackboard.com , 1997-2007 Blackboard Inc.

Appendix:

Table 4

Number of Majors in Organic Chemistry
(133 Majors Total, 111 Students, 22 Double Majors)

B.A. Psychology	1
B.A. Psychology - Community-Clinical	1
B.S. Marine Biology	3
B.A. Global Studies	1
B.A. Chemistry	1
B.S. Biology - General	10
B.S. Biology - Pre-Medical	21
B.S. Environmental Science	3
B.S. Dental Hygiene	1
B.S. Biotechnology	2
B.S. Nutrition and Dietetics	2
B.S. Chemistry	8
B.S. Chemical Engineering	6
B.S. Information Technology	1
B.S. Forensic Science	4
B.S. Forensic Psychology	1
B.S. Forensic Science	5
B.S. Forensic Science - Biology Concentration	32
B.S. Forensic Science - Chemistry Concentration	25
B.S. CJ - Investigative Services	1
Unknown	4

Organic Chemistry Tegrity Survey INSTRUCTOR AND ASSISTANT
Fall 2008

5= Strongly agree; 4= Agree; 3= Somewhat Agree; 2= Disagree; 1= Strongly Disagree
Please offer as much detail as possible on the survey!

How many times have you been a LA or TA in the past?	1 x	2x	3x	4x	5+ x	*Please comment:*
I found that being able to access Tegrity and web based documents prior to lab was convenient in helping the students and being prepared..	1	2	3	4	5	*Please comment:*
I felt that the Tegrity videos helped student with the glassware set up for most of the lab, more so than the set up from the text.	1	2	3	4	5	*Please comment:*
I felt the Tegrity lecture provided students with the tools to successfully and thoroughly complete the lab.	1	2	3	4	5	*Please comment:*

- Please list any other ways that you felt Tegrity lecture better prepared the students for the laboratory. Please be as detailed as possible in your answers and maybe even cite some examples.

- Please compare the student laboratory techniques to your previous experiences with our students. Was it better, worse or the same?

- Do you feel the Tegrity lecture allowed students to do less prep work on their own?

- Please list any other ways that you felt Tegrity lecture did not help or hindered the laboratory instruction.

- Please list any other ways the instruction could realistically be improved. Please use the back if necessary.

Organic Chemistry Tegrity Survey STUDENT
Fall 2008

5= Strongly agree; 4= Agree; 3= Somewhat Agree; 2= Disagree; 1= Strongly Disagree
Please offer as much detail as possible on the survey!

I found that accessing Tegrity and other web based documents was easy.	1	2	3	4	5	*Please comment:*
I found that accessing Tegrity and other web based documents on my own schedule was convenient.	1	2	3	4	5	*Please comment:*
I found that being able to revisit the lecture before and after completing the lab was useful.	1	2	3	4	5	*Please comment:*
I preferred the Tegrity lectures to a prelab lecture in person.	1	2	3	4	5	*Please state your reasoning:*
When Tegrity was not used, I felt my instructor provided an adequate and informative prelab lecture in its place.	1	2	3	4	5	*Please comment:*
I felt that the length of the Tegrity lecture was adequate.	1	2	3	4	5	*Please state your reasoning:*
I felt that the Tegrity videos helped with the glassware set up for most of the lab, more so than the set up from the text.	1	2	3	4	5	*Please comment:*

- Please list any other ways that you felt Tegrity lecture helped in the laboratory instruction.

- Please list any other ways that you felt Tegrity lecture did not help in the laboratory instruction.

- Please list any other ways the instruction could be improved. Please use the back if necessary.