

What's in a Lab? Online Science Laboratories

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Why Do We Have Laboratories?

There are many reasons we choose to offer laboratory classes. For students that do not plan on working in a science field, we seek to offer basic laboratory and measurement experiences. It fosters critical thinking and gives students some basic skills they might utilize around the house or in the workplace. These experiences also shed light on basic data collection and manipulation. Although students may not realize it, they collect data daily and make choices based on that data. For example at the store they may be looking at prices of a certain product. That is simple data collection. They may find themselves collecting data in the workplace even though they are not in a scientific field. We as everyday individuals are bombarded with statistics and it is important to understand the interpretations. Every person should understand the scientific method. We are taught parts of this method throughout our educational experience. In addition to these practical applications, the kinesthetic learning style is one that many rely on as their primary learning style. It is important that these students are allowed to experience the scientific concepts from the classroom in the laboratory setting. And finally some students are planning on working in a laboratory field and need to practice skills they will perform throughout their careers.

What Can Be Done Online?

In order to teach a lab course that utilizes the Internet, there are several models we can follow. First we can teach a totally web based course that includes no class meetings. In this model all communication and activities are done via the Internet. Second, we can use an inverted model. In this model pre-activities and/or practice activities can be done outside of the classroom and the actual lab can be performed in the classroom. For example a difficult chemistry lab could be practiced virtually online with no spilled or wasted chemicals and then students would know what to expect come lab day. A similar model to the inverted model is the hybrid model. In this model some of the work is done online while some is done in the classroom. How this work is divided would be up to the instructor. Finally, in the web enhanced model, most of the work is done in the classroom but there are some research or assignments done online. In our project we chose the totally web based model for our approach.

Is It for Real?

Obviously there are two ways to perform a lab experiment: virtually or really. The real way includes actually touching the equipment and performing the lab in real time. There are multiple methods to perform a lab virtually. One way is through a computer simulation. The student can manipulate parts of the simulation and run the experiment multiple times. The student is actually interacting with the experiment and they are free to try outrageous combinations if they want to.

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Things can be shot and blown up with no real damage. Another virtual laboratory approach is using a remote approach. Experimental apparatus is actually manipulated by the student from a remote location via the Internet. For example a camera or telescope can be moved and focused by a student from a remote location. These types of experiences tend to be expensive to create and maintain. A third approach to virtual labs is to have the lab experiment recorded in either still photos or a movie. The student then takes data from the actually video or pictures or some of the data is provided from the original experiment. This can be very useful when the apparatus is expensive or an experiment is difficult to recreate. The down side is that the student cannot really interact with the experiment. They cannot change the variables and experiment. Students have reported that they like having “good” data that they know will work but often prefer to do the lab themselves. (Bhargave et al., 2006) We used a combination of these approaches in our project.

Considerations When Choosing a Lab Approach

It is important to keep several things in mind when choosing the right lab experience for your students. Obviously the danger of the experiment is important. The expense of the lab equipment is also an issue. Can your students afford lab equipment if they are asked to purchase it and to take it home? The distance your students will be away from the campus is a consideration as well as what the exact objectives and goals are. Our project was focused on the data collection and manipulation as well as the scientific method more than the complexity of the experiment. That gave us some flexibility.

Why Put PHY 103 Lab Online at Miami Middletown?

In addition to myself, Mrs. Sue Ellen Radcliffe and Mr. Dwight Portman worked on this project. Concepts in Physics Laboratory (PHY 103) is a one credit hour course that meets the Miami Plan liberal education requirement for a physical science laboratory. The lab can be taken by students from any one of a number of support courses: Astronomy, Physics in Sports, Energy and Environment, Physics and Society. We had already put Astronomy, Physics and Society and Energy and Environment in an online format for our nontraditional students. The online classes were very popular, especially in the summer. It seemed a logical conclusion to put the lab online as well.

There are advantages and disadvantages to putting this laboratory online. The advantages include flexibility for the busy student. They can perform their lab when it is convenient for them. One of the best advantages is that they are encouraged to work with others when they gather data. Students have worked with significant others, each other’s children and even grandchildren. Physics is enjoyed by the whole family. This is a great thing. The lab course is somewhat self-paced. The students can take their time on a lab activity or work more quickly. They can even repeat the lab as often as they need. Most laboratories move at the pace of the fastest person in the group which is not advantageous for other students.

Disadvantages include the fact that the teacher is not readily available during the lab activity. If a student has a significant question, they must wait until they get a reply which can be frustrating. On the other hand they may be more apt to find a solution on their own. Another disadvantage is that we are limited in the equipment that we can use for the labs as well as the expense. Preplanning becomes crucial. Flexibility can also be a disadvantage as students tend to put off doing their lab until right before it is due and then they become frustrated and perform poorly.

Types of Labs Used in PHY 103 at Miami

We have a variety of labs in this course. We have a majority of the lab exercises which are actual hands on laboratories. The students purchase a kit and utilize the contents to perform the labs. Much of the equipment is either measurement tools or toys. We include toy cars, balls and poppers just to name a few. In addition to the hands on labs we have a few simulations and a couple of video analysis labs. The variety is nice for the students.

Lab Components

Each lab contains similar components. The students know what to expect for each lab.

- Objectives – clearly state what each students should know at the completion of the lab.
- Review web links – these are links chosen by the instructor that review the material that the lab covers.
- Support Material – short lectures or examples of the calculations found in the lab.
- Lab – each lab is posted in WORD format so the students can download it, fill it in, and upload back to the Blackboard CMS.
- Blog Journal Entry – The students are given a topic to reflect on in an online journal. Students are placed in groups and can read each other's reflections.
- Lab Quiz – There is a short online quiz of 5 questions that the students complete at the end of the lab. Questions are randomized and reflect the objectives.

How the Project Began

The pilot course was created with the assistance of an internal grant that supplied money for the lab writers as well as seed money for kit equipment. As kits are now purchased, new kits can be created. The pilot was successful and now the class is in its third offering. Student attitudes toward a science lab activity improved and their confidence in doing it themselves improved as well. (This is based on an anonymous survey given before the class and after completion of the course.)

Kit Contents

- spring scale(10N)
- polarized film - 2 sheets
- platform scale
- safety ruler
- balloons – 2
- windup measuring tape
- stop watch
- battery car
- pull-back car
- chalk
- 2c batteries
- 3 poppers
- 3 balls
- foil
- centripetal force apparatus
- yellow and red filter paper
- ABC block
- tower block
- CD

Issues Encountered to Date

There have been a few issues that we have encountered and attempted to deal with. The procrastination of the students is a big issue. They wait too long to start their lab and then get frustrated or have questions that it is too late to answer. One strategy to deal with this has been to offer a proof read to those students who hand in their labs 1-2 days early. They then have a chance to make changes. Not many have taken advantage of this. Another was to give a bonus point for early submission. Another problem is that many classes feed into this lab. Some may have covered a topic more thoroughly than another. I have been adding short tutorials that give examples of the lab calculations. This has seemed to reduce questions to some extent. We have also battled the false view that this class is “easy”. I think many students have been shocked as to how difficult the course was. We try to inform students up front so they are prepared. We have also had some minor technical issues but they were dealt with on a case by case basis.

Assessment

The course has been assessed utilizing multiple means. We have done online Small Group Diagnoses (SGID) which allow the students to bring up course issues and then vote on how important those issues have been. In addition we had a pre and post survey about student attitudes toward lab courses. And finally the department evaluation was posted. All students are invited to participate in an online survey for all Miami online students but participation is voluntary.

Conclusion

I believe that this course is a useful laboratory course for students in need of their Miami Plan physical science lab requirement. It allows students with awkward schedules to complete this requirement. The objectives are being met in a flexible format. It also greatly compliments our other online physics courses.

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