

A Cocktail of Objectivism and Constructivism are Flipped and Blended into an Effective Lab Course

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ABSTRACT

The Ohio State University recently transitioned from a quarter academic calendar to a semester academic calendar which opened the doors for curriculum and course renovation. Instructors and designers of a hands-on laboratory in Mechanical Engineering were challenged with the task of increasing enrollment while improving quality of instruction and maintaining cost per student. Two historically contrasting learning theories, Objectivism and Constructivism, were used together with flipped and blended classroom techniques to result in an effective course that appeals to various learning styles. Enrollment issues were relieved by the integration of anytime/anyplace laboratories. Pre-lab activities including simulated laboratories, theoretical models, relevant public videos, and social media helped boost the class to achieve greater excellence. Experiential learning activities allowed students to obtain a real-life experience using the topics within the course. The course design focused on interactive engagement, peer teaching, and continuous feedback. The techniques implemented increased student awareness of how course topics are applied in everyday life. Course evaluation comments revealed that students felt confident and motivated to use course topics outside of class and appreciated having flexible learning options.

INTRODUCTION AND METHODS

The faculty and staff associated with a junior level measurements course in Mechanical Engineering at The Ohio State University were posed with the task of increasing enrollment from an average of seventy students to, at present, three hundred students. This task was difficult due the length of the lab (3 hours), the number of lab apparatus (6), and necessary equipment maintenance. Supplementary to hands-on laboratories, strategies were put in place to utilize numerous methods of anytime/anyplace learning, experiential learning, interactive engagement, and flipped classroom techniques. Specific strategies, as discussed below, were designed to help with enrollment and space issues while others were developed to focus on quality of teaching. The resulting course has a weekly lecture, following the objectivism theory, and a weekly lab activity, focusing on constructivism theory.

Simulated Labs and Theoretical Calculations

A typical lab course has students come to a lab to run through an experiment then go home to analyze the data and write a report. When thinking of this in terms of Blooms Taxonomy², the students were Applying, Analyzing and Evaluating before Remember and Understanding. To build the learning pyramid properly and increase depth of knowledge, it was decided to have students complete anytime/anyplace pre-lab activities each week before coming to class. Pre-lab exercises ranged from developing and analyzing a theoretical model to interacting with simulated graphical user interface (GUI) models of the system. When students arrive at lab, they have an idea of how the system works, realistic numbers they should obtain from the experiment and have a general feel of desired educational outcomes from the experiment. Student comments show that they like increased familiarization of an experiment before starting the hands-on work and they are more confident they will leave the lab with adequate knowledge and data to write a report. Teaching associates noticed that

students will troubleshoot issues sooner rather than later and they have a tendency to tinker with the system: both of which are key in the learning how physical systems behave.

Experiential Learning Open Lab – “Choose your Own Adventure”

A constructivist approach to motivating and engaging students is to implement free choice learning into a course design. Using Kolb’s Experiential Learning Model³, a semester long “choose your own adventure” project was implemented into the course. The open lab project allows a group of three students to pick a measurement topic of choice. The students check-out a data acquisition device (NI MyDAQ) and a sensor of choice from the university for home use. If this topic were to be chosen for a presentation at the ASEE conference a student group currently enrolled in the class will take and present real-time data of the presenter’s calories burned during the talk. Their overall goal with this project is to determine calories burned during a teaching session and potentially relate the results back to teacher ratings. During the open lab project there are many milestones throughout the semester which integrate interactive engagement⁴ with the GTA and many opportunities for feedback. Students have commented that this is the most interesting and enjoyable project they had in their curriculum. GTAs and instructors very much enjoy the final presentations, as there is a wide range of topics and information being shared.

Flex Lab – Complete on your own time

A flex lab was implemented for three main reasons: peer teaching, exploration learning, and lab space availability. Working in groups is very important but there are times in which groups are just too large for everyone to fully understand the concepts. When students are working in a lab with a teaching associate (TA) present, they tend to ask questions sooner than they would have if they were not present in the room at the time. In the flex lab, students come to the lab at any time of day with one other student. They run through the experiment, interact with equipment and take an online quiz. Learning by teaching (LdL)⁵ has proven effective as a way to learn material. The flex lab model results in the students asking each other questions, forcing them to peer teach. The flex lab has some step-by-step guidance that follows the objectivism model but also has some open-ended exploration sections which follow the constructivism approach. Throughout the experiment, especially during the exploration sections, students must troubleshoot equipment issues and understand realistic data output. Lab space availability benefits from this structure because it freed lab space that week for another lab section that is running a lab that needs to be done in a traditional method. Students have stated they enjoy the flexibility of the lab and instructors have noticed that students ask well thought out questions and are less hesitant to touch and tinker with general lab equipment (oscilloscopes, function generators, power supplies).

Social Media and Third Party Software

Real – life examples of the material being taught are very useful in not only helping students understand the system but also in helping them retain the information^{6,7}. Throughout the semester the lab supervisor posts interesting videos, ideas, and websites related to the course topic on Twitter. It is felt that the students are motivated to follow the links because of the casual manner in which they are distributed. It is not mandatory to follow the feed: it is framed to be fun and interesting.

Remote Lab

In a typical hands-on lab course students work in a group of three students which means there is a chance that one, maybe even two, may never touch the equipment. Students running a lab also get worried that they may run out of time and leave without good data to

analyze. This anxiety generates the tendency to run through the lab very quickly and not pay attention to details or go off the beaten track and play with the equipment. One of the best ways students learn is to troubleshoot so it is preferred to have the students play, tinker and generate questions. To help these issues a remote lab was implemented into the curriculum. A remote lab is a physical piece of equipment located on campus which the students run remotely anytime/anyplace. There is a webcam for them to view what they are doing to the physical system. They are interacting with the remote equipment through a LabVIEW GUI interface. Similar to research activities, students are not limited on the number of revisits to the experiment to take more data.. Currently in Spring 2013 semester, the remote lab is not implemented in this course due to a conversion to semesters at The Ohio State University and security standard updates that need to be performed on the servers running the remote lab. Once the transition to semesters has settled in, the hope is that the current heat transfer remote lab set-up will be running again. This lab may be placed in a subsequent lab course due to content in which the hope is that a new remote lab that is aligned with the desired outcomes for this course will be developed.

RESULTS AND FUTURE WORK

An innovative approach combining both objectivism and constructivism learning theories was applied to a hands-on laboratory Mechanical Engineering measurements course. Objectivism Theory is used within class lectures and step-by-step procedures, allowing student learning to reach the second level of Bloom's taxonomy (Remembering and Understanding). Constructivism Learning Theory is applied with open-ended and free learning methods lifting the students to the fifth level of Bloom's Taxonomy (Applying, Analyzing and Evaluating). The strategies implemented used experiential learning, technology integration, and flipped classroom techniques to appeal to various learning styles, resulting in increased depth of learning and material retention. The refined pedagogy increased student engagement, motivation, and confidence. Course administration of the course improved as well. This course model results in the ability to accept higher enrollment while improving quality instruction and maintaining cost.

In the future, course developers would like to have students write reflection papers on their hands-on activities, essentially following the Constructivism Learning Theory. Also, mobile-friendly pre-lab videos which show an instructor running through the basics of the experiment will be posted. Lastly, course lecture will be flipped by providing online videos of the lecture in order to provide more effective instruction during in class time.

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