

Illuminating Project-Based Learning in an Introductory Agricultural Mechanics Course

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Introduction

Project-Based Learning (PBL) has been identified as a way to increase student motivation in subject matter and achieve higher levels of learning (Jones et al., 2013; Son & Penry, 2022; Zhang & Ma, 2023). This could impact student engagement in the course and future interest in related studies. A meta-analysis of PBL on student learning effects stated that PBL, when compared to traditional teaching models, increased student academic achievement, attitudes toward subject matter and thinking skills (Zhang & Ma, 2023). The purpose of this innovative idea is to describe the implementation of a semester-long project constructed in an introductory agricultural mechanics' course.

How it Works

The introductory course at [University] is described as a course designed to acquaint students with a wide range of concepts, principles and applied technologies in agricultural engineering. The course is designed to be a blend of theory and hands-on application. The instructor develops activities that would touch on each of the course objectives and result in a final project. Through all of the application activities, students complete a bedside lamp that they finish by the end of semester and take home.

Each part of the lamp is broken into four content areas: 3D printing, electrical, woodworking and welding. Within each content area, the course also reviews safety and career opportunities in each associated industry. To start, students complete an online training on how the 3D printers operate. Then the instructor provides the printable file that students use to print out the lamp shade. This process takes eight hours of print time. Students learn about the 3D printing process and learn how to use slicing programs for 3D prints. This takes one week of laboratory activities.

For the electrical component of the lamp, students are required to purchase an outlet and lamp kit online. The instructor provides website links in the syllabus to ensure the correct items are purchased. Students are responsible for purchasing these items because they will cut the wires to the outlet fixture and use a digital multimeter to identify the hot, neutral and ground wires in the circuit. Once the wires are identified, they will wire in the lamp light in parallel to the outlet circuit. The instructor then tests the circuit to ensure everything is wired correctly. Students learn how to troubleshoot electrical circuits and compare parallel and series circuits. Additionally, they receive experience using a variety of electrical tools such as wire strippers, digital multimeters, and pliers. This takes two weeks of laboratory activities.

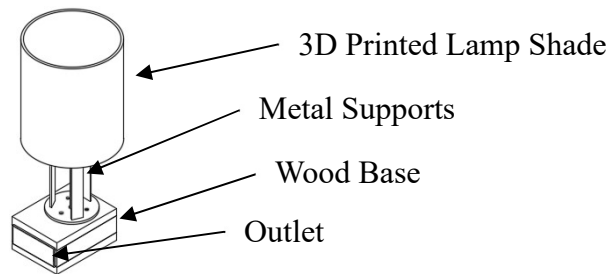
For the woodworking component of the lamp, students build a small box that will house the outlet and attach the metal middle support of the lamp. This requires students to interpret plans for equipment setup to make the small box. Students will then measure, mark and drill holes for the metal attachment and wiring. They will then use a variety of woodworking tools such as table saws, miter saws, router tables, sanders, drill presses and clamps. This takes three weeks of laboratory activities.

Finally, students design two circles and three rectangular supports for the middle of the lamp. They first design the tool paths on a CNC plasma table and cut them out. Then, students use an angle grinder to clean the steel. After, they fabricate the middle support by placing the

rectangle pieces around the top and bottom circles and welding them together. Students again need to interpret plans to place the supports, set welding machines parameters and perform the welds. Most students in this course have not welded before, therefore three weeks of laboratory activities are dedicated to learning how to weld and one week is used for fabrication. See Figure 1 as it identifies each of the major components.

Figure 1

3D modeled example of lamp project with identified components



Results to Date

This project was piloted in spring 2023. One laboratory section completed the project. Thereafter, both fall 2023 and spring 2024 introductory courses adopted this project. Every student has completed the full project as outlined above. Students have not described a cost or time barrier in completing the project. Anecdotally, students have expressed their enjoyment of creating a project they have as their own and are able to use.

Future Plans/Advice to Others

Future plans include refining design plans and lesson plans. The instructor would also like to incorporate other content areas in agricultural mechanics such as concrete and plumbing to the project. If planning to incorporate this or a similar project, it is suggested to build the project first to identify bottlenecks and complications that may arise. Be sure to budget enough class time to demonstrate the needed tools and equipment and allow extra time for students who are operating equipment for the first time.

Costs

Students would need to purchase the electrical components, everything else would be provided by the department. Much of the project can be completed with additional scrap and extra materials from other projects. The electrical components cost \$27.00 online. For a class of 30 students, one 4' x 4' x 10 ga sheet of mild steel would be used for the middle supports (\$90.00). For 30 students, one sheet of 4' x 8' plywood would suffice (\$45.00). Both the 3D print materials (PLA) and fasteners are \$2.00 per student. The total cost for one lamp is \$35.50 or for a class of 30 students \$1,165.00.

References

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