

A COVID inspired accessible first year design activity appropriate for introductory course

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GIFTS: A COVID inspired accessible first year design activity appropriate for an introductory course.

The goals of our first semester, single credit, workshop-style Introduction to Biomedical Engineering course are to introduce students to the discipline and our curriculum, to perform quantitative problem solving, to practice effective teamwork, and to apply the design process. The course covers these goals in a project-based learning style by stepping through the design process for a single device. The course is also scenario-based, in that students receive memos from a fictitious company that addresses the team as professionals, rather than students. The weekly course format is to introduce a concept in large group lecture, to practice the concept in workshop, and to apply the concept to the semester long design project.

In response to the pandemic, we introduced a Portable Air Filtration System as a new project for fall 2020 for two reasons. First, the recent relevance and awareness of airborne particles motivated students. Second, whereas earlier projects required a wetlab, this project was completed in classrooms. Due to COVID-related changes in capacity and cleaning procedures, we could not schedule the course in labs. We substituted paper and spreadsheet based modeling, available empirical data of fans and filters, and relevant standards for experimental testing.

Student teams were presented with the overall objective for a device from the fictitious VP of research and from this developed the problem statement, utilized data and modeling to make design decisions, and built the prototype which concluded with its evaluation (Table 1). Evaluation criteria, based on design specifications that students created collectively, included cost, portability quantified by size and weight, filtration effectiveness, and noise. Evaluating the effectiveness was easily performed inside a transparent chamber using a fog machine and optical imaging of the fog clearing, resulting in a fun cumulative experience during the final weeks. Teamwork was evaluated at regular intervals using peer evaluation and instructor observations. The design process was assessed using design reviews at weeks 9 (in person/hybrid) and 14 (remote).

Table 1. The overall schedule for the semester-long design process.

Weeks	Topic	Activity
1-2	Intro to course and project	Define customer requirements and engineering requirements/specifications.
3-4	Brainstorming and decision matrix	Brainstorm concepts, identify subsystems, perform background research, and apply decision matrices
5-6	Visual communication and technical presentation of data	Sketch subsystems and practice pencil/paper and computer-aided graphing.
7-8	Data-driven design	Perform calculations and modeling to support data-driven design decisions.
9	Preliminary design presentations	Present design process, current design, and provide peer feedback.
10	Engineering economics	Practice engineering economics concepts.
11-12	Build	Build prototypes.
13-14	Test and present final results	Final testing of prototypes and presentations of the process and final results.

Overall we are very excited about how this project went and recommend it for any introduction to engineering course that has a focus on design. We will share materials that we used to deliver this, as well as access to a digital repository of materials. See our KEEN card Intro to Engineering Freshmen Design Project, <https://engineeringunleashed.com/card/2507>.