ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #35487

Project-based learning modules for an introductory engineering course scaled for different learning modalities

Dr. Haritha Malladi, University of Delaware

Haritha Malladi is an Assistant Professor of Civil and Environmental Engineering and the Director of First-Year Engineering at University of Delaware, Newark, DE. She is passionate about undergraduate education and teaches the first-year experience course incoming class students in the College of Engineering at UD. She obtained her Bachelor of Technology degree in Civil Engineering from National Institute of Technology, Warangal, India. She earned her Master of Science and doctoral degrees in Civil Engineering from North Carolina State University in the USA. Her disciplinary research interests lie in the area of sustainability in asphalt pavements using material considerations, green technologies, and efficient pavement preservation techniques. Her doctoral work focused on improving the performance of recycled asphalt pavements using warm mix asphalt additives. As a postdoctoral scholar at North Carolina State University, she worked on several NCDOT sponsored research projects including developing specifications for crack sealant application and performing field measurements of asphalt emulsion application in tack coats and chip seals. Her undergraduate teaching experience includes foundational engineering mechanics courses like statics and strength of materials as well as courses related to sustainability and infrastructure. Alongside teaching, she is passionate about science communication and public involvement in science. She has been invited to conduct several workshops on communicating technical concepts to different target audiences. She is interested in incorporating data-driven research, citizen science, and experiential learning into teaching and outreach.

Prof. Jenni Buckley, University of Delaware

Dr. Buckley is an Associate Professor of Mechanical Engineering at University of Delaware. She received her Bachelor's of Engineering (2001) in Mechanical Engineering from the University of Delaware, and her MS (2004) and PhD (2006) in Mechanical Engineering from the University of California, Berkeley, where she worked on computational and experimental methods in spinal biomechanics. Since 2006, her research efforts have focused on the development and mechanical evaluation of medical and rehabilitation devices, particularly orthopaedic, neurosurgical, and pediatric devices. She teaches courses in design, biomechanics, and mechanics at University of Delaware and is heavily involved in K12 engineering education efforts at the local, state, and national levels.

GIFTS: Project-Based Learning Modules for Introductory Engineering Courses Scaled for Different Learning Modalities

Systems thinking, spatial visualization, and data analysis are technical skills that are important across different disciplines in engineering. Additionally, abilities to collaborate effectively in teams and to synthesize and communicate technical information are key "durable skills" in student professional development. Project-based learning (PBL) is an important pedagogical structure to inculcate these skills in introductory engineering courses.

This Great Ideas for Teaching, and Talking with, Students (GIFTS) paper describes the structure of a one-semester introductory engineering course that incorporates two modules for project-based learning, whose learning outcomes focus on improving these technical and durable skills. The first module is a mechanically oriented product design that incorporates physical prototyping. Students worked in teams to develop a three-dimensional model that can be assembled using parts that were laser-cut from a single 8x10 sheet of wood. The second module focuses on performing life cycle assessment to compare the environmental impacts of common consumer goods. Student teams picked two common product choices and performed a streamlined analysis to determine which product consumed fewer resources and/or released fewer emissions. Prior work by the authors describes these modules in detail [1], [2].

At our institution, Introduction to Engineering is a 2-credit semester-long course that is required for all engineering and computer science students in their first semester; ca. 650-700 students. Social distancing mandates during the COVID-19 pandemic have given impetus towards delivering this in-person course using online and hybrid learning modalities. Students work on the same team of 4-5 throughout the semester on scaffolded weekly activities related to the two PBL modules and submit weekly peer evaluations via CATME Team Tools [3].

The in-person course version (2019 and prior) consisted of two evenly split large lecture sections that met twice weekly. Students were assigned to sit with their teams in the classroom, which had tables arranged cafeteria-style in a large auditorium. The one-hour in-person meetings consisted of faculty and guest lectures that were punctuated with active learning exercises like small group discussions and iClicker responses. Undergraduate "peer leaders" (1:25 peer leader to student ratio) were assigned to each team; they sat near their teams and helped facilitate the active learning exercises. This provided a "small class feel" in a large enrollment course section [4].

For the online course version (2020), all instructive lecture material was delivered asynchronously with formative quizzes that tested the students' engagement with the material. Course materials required for physical prototyping were mailed to all the students. With instructor-provided lesson plans, peer leaders conducted small group weekly Zoom "workshops" that enabled students to work in their teams during class time on the PBL activities. Groupwork submissions from these workshops were also graded formatively. The course was well-received by the students [1], [5], [6]. Based on the wins from the online version, the hybrid version (2021) is planned around asynchronous lectures and moving the weekly workshops into in-person "discussion" sections.

[1] J. Buckley, H. Malladi, A. Trauth, and M. G. Headley, “Novel Hands-on Product Design Module for Online, Large-enrollment FYE Courses,” accepted for publication, ASEE Annual Conference & Exposition 2021.
[2] M. Roth and H. Malladi, “Incorporating Life Cycle Assessment in an Introduction to Engineering Course,” presented at the 2020 ASEE Virtual Annual Conference Content Access, Virtual On line, Jun. 2020. doi: 10.18260/1-2--34809.
[3] M. L. Loughry, M. W. Ohland, and D. J. Woehr, “Assessing Teamwork Skills for Assurance of Learning Using CATME Team Tools,” *J. Mark. Educ.*, vol. 36, no. 1, pp. 5–19, Apr. 2014, doi: 10.1177/0273475313499023.
[4] J. Buckley *et al.*, “An FYE Course Structure for Collaborative Learning in Large Lecture Courses,” presented at the 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana, Jun. 2016. doi: 10.18260/p.26206.
[5] H. Malladi, A. Trauth, J. Enszer, M. G. Headley, and J. Buckley, “Transforming a Large Lecture FYE Course Structure into Virtual Collaborative Learning,” accepted for publication, ASEE Annual Conference & Exposition 2021.
[6] H. Malladi and M. Roth, “Implementing Life Cycle Assessment Module in Introduction to Engineering in Different Modalities,” accepted for publication, ASEE Annual Conference & Exposition 2021.