Introduction and Objectives
Most lower-level undergraduate engineering classes revolve around solving problems from textbooks with very little emphasis on applications to the real world.

The goal of this project is to provide opportunities for students to apply theoretical knowledge on authentic engineering assignments.

The present work aims to foster problem solving, creative thinking, interpersonal skills, and allow us to identify the best practices to initiate project-based learning.

The high-level goal is to integrate design, fabrication, and characterization of engineering structures to the course curriculum by means of unique class projects.

Developmental History
The present work showcases implementation of a class project in a key undergraduate course, CE 301 Statics and Dynamics, offered to civil, environmental, architectural, petroleum, and aerospace engineering students.

This class is a stepping stone for most engineering disciplines that include classic problems on structures, forces, and energy.

In the past, the course was delivered in a traditional lecture format. Over the past few semesters, the course has undergone a series of transformations embracing active learning.

Currently, this course engages students both inside and outside of the classroom by incorporating various elements of a flipped class such as video lectures, in-class problems, and more substantive group work.

Work towards implementing out of class team-based design projects is underway. As a first step in this direction, a popsicle stick bridge project was assigned to student groups.

The project also provided students with a hands-on experience not provided by traditional lectures and gave us real feedback on an actual implementation of project-based learning.

Case study: Low-cost bridge prototyping
This bridge design project follows on the heels of a study of equilibrium and provides a real-world design problem that requires the students to research designs, identify alternatives, and work together as a team to creatively produce a product.

Problem statement: Design and build the best prototype bridge within the design constraints.

Student Learning Activities and Materials
1. Research familiar designs
2. Differentiate and select "the transferable design concepts" through qualitative analysis
3. Analyze transferable designs through quantitative studies
4. Judge/predict the structural performance and implement modifications
5. Build a prototype
6. Test prototype
7. Present results through project presentation and report writing
8. Reflect on the design and suggest further modifications

Execution
This project spanned two weeks and required the services of two undergraduate teaching fellows who helped with project management and execution.

Primary Challenges
1. Identifying appropriate project:
   - Identify and meet desired learning objectives
   - Adequate level of rigor
   - Create a unique project to foster student creativity
   - Promote group work
2. Development of appropriate scripts and contexts to guide students through project
3. Effective means of evaluating outcomes of the project
4. Evaluating future feasibility of project-based learning

Issues to Resolve
Implementation
- Creating uniform student groups

Pedagogical
- Identifying benefits students accrue from design-build-test project
- Effective means of evaluating outcomes of the project

Results and Discussion
The project provided:
1. Students with a hands-on experience not provided by traditional lectures.
2. Linkages in introductory mechanics courses between the principles of statics and dynamics to their design applications while fostering problem solving, creative thinking, and interpersonal skills.
3. Feedback on an actual implementation of project-based learning which could be extended to other disciplines.

The high-level goal is to integrate design, fabrication, and characterization of engineering structures to the course curriculum by means of unique class projects.

Such a project offers inexpensive means of achieving higher-level learning outcomes for large classrooms, institutions with limited finances, and K-12 learning.

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