Foster Engineering Identity through Collaborative Learning in Math and Basic (CLIMB) Engineering

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WIP: Fostering Engineering Identity through Collaborative Learning in Math and Basic (CLIMB) Engineering

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Abstract

This work-in-process paper presents an overview and early activities of a project recently funded by the National Science Foundation (NSF) Improving Undergraduate STEM Education: Hispanic-Serving Institutions (HSI) program. This Track 2 project aims to improving the retention and graduation of Mechanical and Aerospace Engineering (MAE) students by developing their engineering identity in their freshman/sophomore years. Past studies on engineering identity primarily focus on a single course with design components. This project will study the implementation of collaborative learning and design thinking (DT) in three freshman and sophomore courses for fostering engineering identity. It is expected that the project will generate new knowledge on how to produce a more diverse and innovative engineering workforce, which are critical for maintaining the United States' position as a global leader in science, technology, mathematics, and engineering (STEM).

Introduction

STEM education researchers have produced compelling evidence connecting the lack of STEM identity to high attrition rate and lack of diversity in STEM fields as well as connecting design experiences to engineering identity formation[1]. It was found that "intentional implementation, including organization and framing of design thinking pedagogy, was an essential foundation for fostering student interest."[2] Peer Led Team Learning (PLTL), an active learning pedagogy, has also shown to improve student performance, retention, and commitment to engineering[3].

This work-in-process paper presents an overview and early activities of an NSF funded project that aims at integrating PLTL and DT to foster engineering identity in MAE freshman and sophomore students. A survey questionnaire that combines measures on engineering identity, belonging,

groupwork, and DT from published paper was developed and implemented. Four PLs have been recruited for the first implementation of in-class PLTL (iPLTL) in spring 2025.

Project Overview

Figure 1 presents an overview of the project. The project will implement in-class PLTL (iPLTL) in two freshman courses, namely UNIV1131 University Success and MAE1140 MAE Problem Solving, preparing students for collaborative learning without a peer leader (PL) in a MAE gateway course MAE1312 Engineering Statics. Students in these three courses will learn how to apply design thinking (DT) strategies to solve complex math, engineering, and life problems. Following the DT process for curriculum development, the PIs will collaborate with students participating in a summer fellows program to create course content, including YouTube videos. The student summer fellows will also participate in undergraduate research, accelerating their transition from engineering students to practicing engineers and researchers.
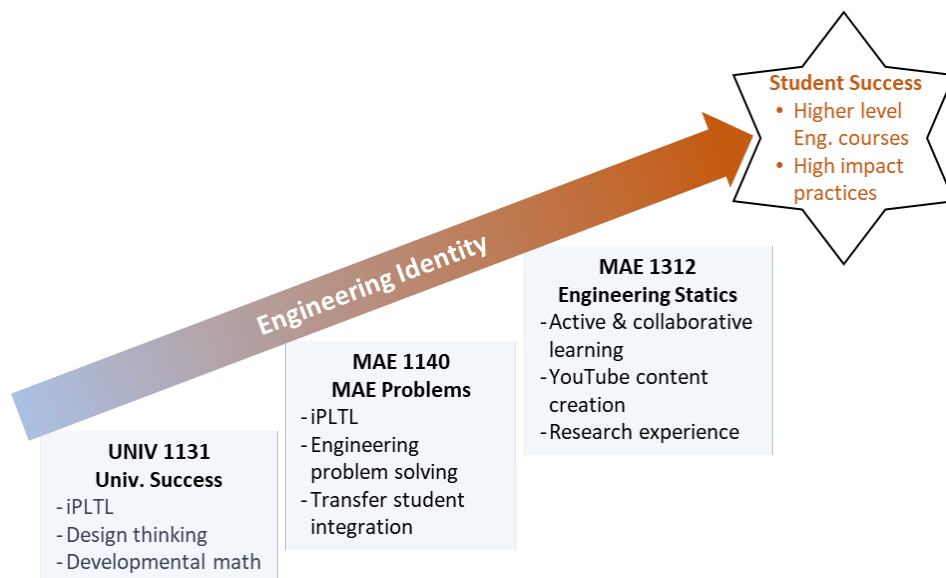

Figure 1: Project Overview - Foster Students' Engineering Identity Through Collaborative Learning and Design Thinking.

Early Activities

Develop Assessment Instrument

The team plans to use pre-surveys and post-surveys to assess the students' engineering identity development by comparing data from study and controlled groups. In addition to engineering identity, the survey also assesses belonging, groupwork, and DT. To evaluate the language and clarity of the questions, the survey was administrated to all three courses in fall 2024. The survey was assigned as a quiz that the students must complete to receive credit. However, they had the option to not participate in the research, which means their data will be collected but not used for research. The questionnaire has received IRB approval and has administrated to MAE1140 MAE Problem Solving at the beginning of spring 2025. A post-survey will be administrated to the same group of students toward the end of spring 2025.

Recruit Peer Leaders
The position announcement received more than 100 applicants. 12 students were short listed, seven were interviewed, and four were selected. The four students recruited come from diverse background and ethnicities. The PLs received a three-day training and continuing mentoring.

Implement In-class PLTL (iPLTL) in MAE1140
iPLTL is implemented in MAE1140 MAE Problem Solving in spring 2025. After 15 minutes of lecturing, the class is divided into four groups, each led by a PL, to solve the assigned problems. Meeting weekly, the PLs and the instructor collectively develop the strategies for iPLTL activities.

Summary and Conclusions

This work-in-process paper presents an overview and early activities of a recently funded NSF project on fostering students' engineering identity. A survey questionnaire combining published measures was developed and administrated to three courses to evaluate the language and clarity. Four peer leaders have been recruited for implementing iPLTL activities in a freshman problem solving class in spring 2025. Results comparing data collected from study and control groups will be published in future publications.

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