

Understanding the Impact of Institutional Supports on the Motivation, Belonging, Identity Development, and Persistence of Engineering Students

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Abstract

This NSF PFE-RIEF project is giving the PI an immersive experience working on social science research that will inform the design and implementation of institutional supports that encourage engineering student persistence. The PI and Mentor are collaboratively leading paper and proposal submissions derived from and in support of research on academic and co-curricular interventions that encourage engineering students' motivation, belonging, and identity development. The ongoing work is assessing changes in these psychological processes over the course of students' undergraduate careers and determining if changes in these processes mediate changes in student persistence and success.

The project is structured to educate the PI in the psychological knowledge base and instruments related to student motivation, identity development, and sense of belonging. The PI is working directly with the Mentor to build foundational knowledge of the psychological literature, collect and analyze longitudinal data on changes in psychological processes over the undergraduate careers of multiple engineering student cohorts, and develop new project foci based on their ongoing collaboration. Specific training efforts include discussion of the relevant literature, analysis of data, preparation of journal and conference publications, and development of grant proposals for future research endeavors. The mentoring program for the PI has been structured to begin with a year of immersion followed by application of the acquired skills.

To date, our research has focused on multiple factors associated with engineering student success. These include understanding the utility of standardized tests and high school GPA for predicting student persistence and examining the role of career fair participation in enhancing student motivation and persistence. The results of this research will be broadly applicable to engineering programs, all of which would benefit from a better understanding of how to allocate resources to best support student success. The PI anticipates continuing research on designing institutional supports to encourage student persistence and success throughout the rest of his career.

Genesis of Project

The project is based on a longstanding collaboration between the PI and Mentor investigating the relations among institutional structures and psychological processes in undergraduate engineering students. From 2012-2017, the PI (Walton) was director of the College of Engineering (CoEng) program for first-year students. During this time, the PI performed annual assessments for program evaluation and continuous improvement. When the Mentor (Linnenbrink-Garcia) joined the team, our efforts expanded beyond program assessments to include measures of student motivation, behavior, and attitudes. The Mentor led design and implementation of the assessments, formulation of research questions, and analysis of the longitudinal data with the aim of improving understanding of the development of undergraduate engineering students' motivation and the role of motivation in supporting their persistence in engineering. Over time, the PI acquired a surface knowledge of the tools and techniques used by

the research team. The current project is providing the funding support and training necessary for the PI to take a more active role in leading research efforts. The project has two foci: **i) educating the PI on the tools and approaches applied in collection, processing, and analysis of longitudinal datasets compiled from multiple sources** and **ii) assessing the links among institutional supports, psychological processes, and student outcomes.**

Research Design

The project is focused on understanding the underlying psychological processes associated with persistence of engineering students (Figure 1). The goal is to develop a clearer understanding of what types of institutional support structures contribute to these psychological processes (students' feelings of belonging, their motivation in engineering (self-efficacy, value, cost), and their development of an identity as an engineer) and how these processes are in turn associated with persistence in engineering. We are studying these research questions in the context of the CoEng at Michigan State University (MSU).

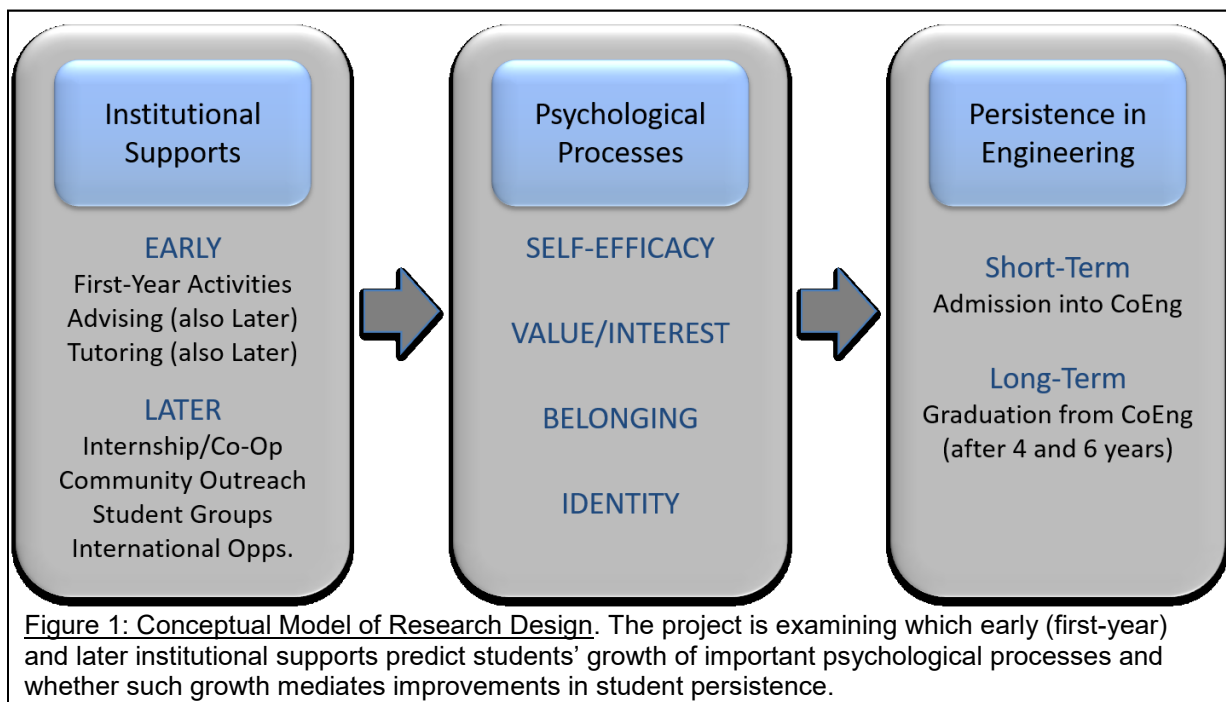


Figure 1: Conceptual Model of Research Design. The project is examining which early (first-year) and later institutional supports predict students' growth of important psychological processes and whether such growth mediates improvements in student persistence.

Procedure and Data Collection: To date (including work prior to the current RIEF project), we have collected longitudinal data from six cohorts of students, beginning with those who entered in Fall Semester, 2015. As of Spring Semester, 2021, we will have nearly complete data on three cohorts of students with partial data on three others.

Surveys measuring students' attitudes and beliefs about engineering (motivation, identity, and belonging), career intentions, as well as their participation in various institutional supports (e.g., first-year programs, tutoring, academic advising, and career fairs) and demographics are completed yearly. We administer a fall baseline survey immediately prior to the beginning of the academic year that is only completed by first-year students. This baseline survey focuses on students' entering attitudes and beliefs about engineering, thus providing a baseline for our student population even before they have begun collegiate coursework. The follow-up survey is

given about two-thirds of the way through Spring Semester. It is completed by students every year, starting in their first year, and includes assessments of psychological processes as well as questions designed to assess the degree to which students utilize available supports within the CoEng.

Our procedures for collecting these data depend on our access to students at different stages in their program. The fall survey is emailed to all incoming first-year engineering students prior to attending a college-wide orientation that occurs immediately prior to the start of classes. The spring survey is administered as extra credit/course credit in the student's engineering course or emailed directly to students who are not enrolled in our target courses. Administering the survey in three introductory courses offered in the spring captures approximately 75% of first-year students. However, for the remaining first-year and older students, we have developed an approach for identifying high enrollment classes that maximizes contact with our sample and provides an accurate representation of the population in terms of both grade level and engineering major. For those receiving the survey via email, we have found that paying students \$10/survey improves response rates.

In addition to these survey measures, we collect institutional data including information from the registrar (grades, major, and degree completion), the career services office (participation in professional development activities, career fairs, and internships/co-ops), academic advising, and tutoring services. By combining institutional data with the self-reported data in the surveys, the PI and Mentor are testing the hypothesis that students' use of/participation in institutional supports, both academic and co-curricular, is associated with enhanced motivation, sense of belonging, development of engineering identity, and, ultimately, persistence as an undergraduate engineering student.

PI Mentoring Plan

The goal of the PI mentoring plan is **to educate the PI in the psychological knowledge base and instruments related to student motivation, identity development, and sense of belonging**. The PI is working directly with the Mentor to build foundational knowledge of the psychological literature, collect and analyze longitudinal data on changes in psychological processes, and develop new project foci based on the ongoing collaboration between the PI and Mentor. Specific training efforts of the project include discussion of relevant literature, analysis of data, preparation of journal and conference publications, and development of grant proposals for future research endeavors.

The PI mentoring program was structured to provide a first year of *immersion* followed by *application* of the acquired skills and knowledge.

Immersion

The focus of the first year of the mentoring program was on the PI's development of the skills and knowledge fundamental to the social science approaches applied by the Mentor. The PI attended the Mentor's lab meetings, discussed ongoing project goals, and organized presentations and publications. The PI also attended an advanced doctoral course in the College of Education, CEP 910 – Motivation and Learning, taught by the Mentor. The hybrid course met both in person and online, making it convenient for the PI to participate. The content of the

course, which includes enduring questions about motivation and learning, the roles of skill vs. will in motivation, and higher-order thinking in learning, has supported the PI in engaging in discussions with the Mentor and the members of her research group.

The specific milestones for year 1 of the project are numbered below. Progress on the milestones is described below each.

- 1.) Compare different instruments for assessments of motivation, identity, and belonging
- 2.) Select appropriate instruments for specific research questions
- 3.) Evaluate the psychological literature related to motivation, identity, belonging, and persistence

To achieve these milestones, the PI participated in CEP910: Motivation & Learning, as mentioned above. The course covered the study of motivation and approaches for encouraging student motivation. Participation in the course gave the PI an opportunity to review a curated set of papers that covers a wide range of approaches to the study of motivation. Topics included Expectancy-Value Models; Social Cognitive Theory; Attribution Theory; Theories of Intelligence and Ability Beliefs; Achievement Goal Theory; Intrinsic vs. Extrinsic Motivation; Interest and Flow; Supporting Motivation in the Classroom; Sociocultural Influences; and Technology, Motivation, and Engagement. As part of the course, the PI read assigned articles, engaged with discussion boards, and attended class meetings. The readings helped the PI develop his vocabulary regarding the science of motivation.

- 4.) Implement appropriate analytical approaches for quantitative datasets
- 5.) Create an outline for a research proposal based on psychological theories related to motivation, identity development, belonging, and persistence

In preparing submissions for both the AERA and ASEE meetings, the PI worked closely with the Mentor and her doctoral students to plan the goals of the submissions and questions to be asked. In doing so, the PI gained further understanding of the outputs of the approaches, which were typical methods for the quantitative research principally performed by the Mentor.

Application

During the second year of the mentoring program, the PI focused on execution of the surveys and submission of a proposal to present at a social science research conference.

The specific milestones for year 2 and the progress toward each milestone are described below.

- 1.) Design data collection and analysis approaches for longitudinal datasets

The PI has become more familiar with the types of models that are useful for analyzing the longitudinal data being collected. For instance, the PI has become more comfortable with growth curve models, which the team has used in multiple conference papers. At this point, the PI is reasonably able to question modeling choices (such as linear vs. quadratic) and understand better how to interpret the variety of factors (RMSEA, etc.) that describe goodness of fit. The PI's understanding of related topics like measurement invariance has also improved. Overall, the PI has made significant progress in this area since the start of the project.

2.) Lead submission of a proposal to a principal educational psychology conference (e.g., AERA)

In collaboration with the Mentor and her research team, two submissions were prepared during the first year of the project. The first was accepted as a poster for the AERA conference in April 2020, with the PI as the lead. The second was accepted for the ASEE meeting in June 2020, with the PI's doctoral advisee as the lead.

AERA – Taking the next step to engineering careers: Career-related activities, value, and belonging

Walton, S. P., Lira, A. K., Lee, A. A., Lawson, H. D., Bovee, E. A., Briedis, D., and Linnenbrink-Garcia, L. (2020). Accepted for poster presentation at the annual meeting of the American Educational Research Association, Virtual.

In this study, we investigated the relations among career fair participation, belonging, value, and engineering persistence controlling for initial levels of these potentially mediating psychological mechanisms. Our findings suggested that students who participated in a career fair were more likely to secure an internship. Interestingly, and contrary to other work, we found that career fair participation did not relate to persistence in an engineering major or career intentions. As to mediation, we found attainment value and belonging did not significantly mediate the relations between career fair participation and persistence outcomes, when controlling for prior levels of attainment value and belonging. Overall, our results demonstrated that, though the relations between career fair participation and outcomes were not mediated by attainment value and feelings of belonging, these motivational variables were important predictors of students' participation in career fairs.

ASEE – Predicting engineering student success: An examination of college entrance exams, high school GPA, perceived competence, engineering achievement, and persistence

Lawson, H.D., Lira, A.K., Lee, A.A., Linnenbrink-Garcia, L., and Walton, S.P. (2020). Presented at the ASEE Annual Conference and Exposition, Virtual.

In this study, we examined the relations among prior achievement, initial levels and growth in academic self-efficacy, and persistence-related outcomes for undergraduate engineering students. Latent growth curve analyses suggested that students with higher math ACT scores and higher high school GPAs had lower declines in academic self-efficacy across four years of college. Our analyses showed that math ACT scores and high school GPA directly predicted changes in self-efficacy and further predicted persistence in engineering and cumulative college GPA; however, neither predicted engineering career intentions. Additionally, math ACT scores predicted initial levels of self-efficacy but high school GPA did not.