

Mentor-focused Professional Development for Investigators Initiating Discipline-based Educational Research (DBER) in Biomedical Engineering

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Abstract

Our work (NSF PFE: RIEF Award 1927150) initiates a discipline-based educational research study of student design self-efficacy in an undergraduate biomedical engineering (BME) program. A key component of this work focuses on our own professional development as engineering education researchers, which contributes to our abilities to undertake current and future engineering education studies. Our professional development goal is to establish and follow a mentoring plan that facilitates our development of engineering education research skills. We targeted three areas for learning and development as researchers: (1) social science research in design education, (2) mixed methods research, and (3) evidence-based teaching. To that end, we strategically invited engineering education research mentors to our team, deliberately structured our mentor conversations with literature readings to foster growth, and purposefully documented this process by continually responding to reflection questions in a professional development journal. Our approach to include our own professional development in our Research Initiation in Engineering Formation grant has proven instrumental in collecting data and in connecting us with the engineering education community.

Choosing Mentors and Developing a Mentoring Plan

Our engineering education research is discipline-specific and focuses on identifying how self-efficacy relates to engineering design achievement in an undergraduate BME curriculum. Two goals of our research include: 1) to increase self-efficacy of undergraduate BME students by providing project-based learning experiences throughout the curriculum; and 2) to identify if biomedical engineering student self-efficacy differences correlate with student ability to effectively translate fundamental knowledge toward engineering design.

Since we bring disciplinary expertise, our choice of mentors parallels the engineering education research topics required to successfully approach our study's research goals. Again, we targeted three areas for development: social science research in design education, mixed methods research, and evidence-based teaching. To gain understanding of how and why student design ability changes in response to design situations, we sought an associate professor in a large school of engineering education with experience in design learning through the lens of educational psychology and engineering education. To aid our research methods development and data analysis from self-efficacy surveys, we approached an assistant professor in a large school of engineering education with mixed-methods research as a primary skill to learn techniques of qualitative data collection and integration of qualitative and quantitative data analysis. Our third mentor is an assistant director of a center for teaching and learning and helps us ensure that our gained knowledge is put to use in the classroom through curricular design and assessment. In addition to our three project mentors, a program evaluator helps us monitor our data collection and hone our survey refinement skills.

Our mentoring plan is based on the following principles:

- 1) *Frequent meetings with project mentors*
- 2) *Emphasis on knowledge acquisition and fundamental research skills*
- 3) *Continual reflection on professional development and ongoing research*

The first year of our structured mentoring plan consisted of performance indicators which included: 1) a way for us to learn from our mentors (i.e., consistent mentor discussions), 2) an overarching goal of developing an instrument helpful to our proposed research (i.e., a self-efficacy survey instrument for BME students), and 3) targeted efforts toward research proposal writing (e.g., identification of future engineering education opportunities). Regularly scheduled meetings with pre-identified literature structured our mentor discussions. To supplement our original list of primary literature (Figure 1), our mentors continually identified relevant literature for subsequent mentoring sessions. To date, our mentor meetings have been invaluable in guiding us in understanding engineering education fundamentals and in pushing us to refine our developing skillsets.



Figure 1: Primary literature chosen in design education and student self-efficacy during the year of mentoring [1]–[5].

Documenting the Mentoring Process

Using an autoethnographic approach to examine our own professional development over the course of a year, we used a professional development (PD) journal to document our mentoring plan, interactions with our mentors, attendance of professional development events, and continual journaling on self-reflection questions. Captured in a central location, the PD journal maintained mentor meeting agendas, research journal articles and questions, and meeting notes. In the first year of our project, we logged eight mentor meetings where we participated in partial or whole readings from eleven books and journals that describe educational research theories and methods related to self-efficacy [6]–[9], focus groups [10], mixed methods research [2], [3], [11], [12], thematic analysis [13], and exploratory and confirmatory factor analysis [14]. After each mentor meeting, we independently reflected on six questions, which were developed by our mixed methods research mentor. Entries to date compile reflections that identified the learning and value of our work as engineering education researchers and that collaborative experiences have been essential to refining our research skills. The six prompts are:

1. *How confident are you that you will be able to elicit a thorough and accurate account of changes in your students' self-efficacy? Why?*
2. *Describe what you have learned during the past month regarding **Educational Theory**.*

3. Describe what you have learned during the past month regarding **Educational Research Approaches**.
4. What questions are you struggling with as you engage in this process? How do you hope to address these questions?
5. Do you have any other comments about the process that was not addressed above?
6. What is your publication and dissemination plan?

Our mentoring plan has allowed us to focus our engineering education research efforts on identifying how self-efficacy relates to engineering design achievement in an undergraduate BME curriculum. Because of the initial success with our mentoring plan approach, we have administered a quantitative self-efficacy questionnaire and a qualitative questionnaire with questions mapped to Bandura's four identified sources of self-efficacy beliefs (mastery experiences, vicarious experiences, verbal persuasion, and emotional and psychological states) [15]. Our DBER work continues to focus on refining our mixed methods study, to hone our quantitative and qualitative self-efficacy instruments, and to analyze preliminary data.

Future Directions

In our initial year, our professional development structure has given us an entry point into engineering education research and more broadly has supported our own fluency in classroom assessments, journal reviewing skills, and grant writing. Our research efforts during the second year of our NSF PFE: RIEF award have been toward data collection and data analysis, where we strive to translate lessons learned from our mentors into practice. We have chosen to continue documenting our growth through our professional development journal and meeting with our mentors, although less frequently, during the second year of our professional development plan. As we look to disseminate the findings of our initial work, our mentor meetings have transitioned more toward methods refinement and engineering education research writing discussions. Given our successes with the described mentor-focused professional development, we recommend this structure to investigators looking to initiate DBER work.

Our abilities as engineering education researchers will continue to evolve because of our deliberate focus on professional development in the early stages of our grant. We plan to work with one of our mentors to discuss and analyze our professional journal entries in a meaningful way. Furthermore, we are now better equipped to mentor STEM colleagues who are beginning educational research, to engage undergraduates interested in teaching and learning, to serve on review panels for grant proposals, and to engage in annual discussions about our own professional goals in engineering education research.

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