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Board 253: Developing Professional Identity: Integrating Academic and Workplace Competencies within Engineering Programs

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Abstract

Chemical engineering education needs to be updated to reflect its growth and inclusion of elements from various fields, such as pharmaceuticals, renewable energy, biotechnology, and consumer products. As the industry continues to expand and there is a greater need for communication and leadership abilities in the 21st century, engineers who are working are anticipated to possess both technical expertise and professional skills. However, the typical chemical engineering undergraduate core curriculum has not adapted to prepare students for the multiple needs encompassed by the chemical industry. Lack of industry-relevant examples/topics and applications in the course contents results in less motivated and/or engaged students. Students therefore often struggle to identify with the profession and are not ready for the workforce when they graduate. This NSF PFE: RIEF project examines a unique experience where a student-faculty-industry integrated community is created to help bridge the gap between industry needs and the competencies developed within chemical engineering programs.

The project's main goal is to better understand how implementing contemporary industry problems into one of the sophomore chemical engineering courses impacts students' engineering identity formation and self-efficacy development. To analyze the impacts of the intervention, this project employs design-based research (DBR) approach to guide the development, implementation, and evaluation of materials and methods reflecting the proposed synergistic model for a course and program design. Implementing contemporary industry-relevant problems into the course will foster student-industry-faculty engagement (PI, engineering Co-PI, and course instructor), develop student knowledge, skills, and abilities needed in the chemical engineering world today and in the future, and support professional identity formation. Moreover, industry-student engagement through the methods proposed will develop students' societal and environmental awareness.

To understand the impacts of the intervention on self-efficacy and engineering identity, we worked with industry mentors and designed contemporary industry-relevant problems, introduced them to the targeted course, developed and employed instruments for self-efficacy

and engineering identity, and conducted interviews with focus groups. To measure the impact, qualitative and quantitative methods are used. This content analysis helped the project team identify challenges, difficulties, and gains of adopting this approach to the engineering program and provide an appraisal of student outcomes, including cognitive and affective responses. In this poster, the project team will share their results from Fall 2021 semester.

Major Activities

To understand the impacts of the intervention on self-efficacy and engineering identity, contemporary industry-relevant problems were designed, introduced to the targeted course, instruments for self-efficacy and engineering identity were developed and employed. Spring 2021 semester was deployed as baseline condition with two industry relevant contemporary problems were introduced to the course. First full design was deployed in Fall 2021 with three mentor problems implemented, with mentors visiting the class and students presenting to mentors at the end of the semester. Problems were coming from plastic recycling, pharmaceuticals and carbon recycling. Students had struggled with the plastic recycling problem since they did not have any background on solids handling. In addition, they complained about the high stakes of the problems. Based on feedback from Fall 2021 semester, implementation was redesigned and only two mentor problems were introduced to the course in Spring 2022 semester along with mentors visiting the class and students presenting to mentors. All these three semesters, engineering identity and self-efficacy was measured with validated instruments pre and post semester [1,2]. In addition, ten randomly selected students, stratified by gender (considered as binary), were interviewed pre and post semester. Interview questions include engineering identity development as well as impact of the implementation. Some examples of interview questions are as follow:

- What does chemical engineering mean to you?
- Why did you choose this major, and what are your plans after graduation?
- Did you know any chemical engineer before?
- Do you consider yourself a chemical engineer? What does it mean to you to be a chemical engineer?

- Do you feel that you are part of the chemical engineering community?

Contemporary Industry Problems Design

The project team has been working with industry mentors to design the problems, gains and challenges of designing the problems were published in 2021 ASEE conference [3]. Mentors were selected from diverse participants of gender, age, ethnicity, and area of expertise. Problem topics were intentionally selected from global problems such as plastic recycling, renewable fuel, and carbon recycling.

Introduction of Contemporary Industry Problems into Targeted Course

During Fall 2021, three mentor problems were introduced to the course along with mentors visiting the class in the beginning of the semester and students presenting to mentors at the end of the semester. In the beginning of the semester, when mentors visited the class, they introduced themselves, their area and first part of their problem. Problems were both in the video format and paper format. Video link was always included in the HW along with the written question. Each problem had 3-4 sections, which makes 9-10 homework questions.

Instrument Development and Employment

Two survey instruments to measure self-efficacy and engineering identity were chosen based on the literature [1,2]. Both surveys were piloted in previous classes and employed in the targeted course during Spring 2021 baseline condition. During Spring 2021 semester, we had a low response rate to survey questions (18 at the beginning of semester, and only 5 at the end of semester), possibly because of minimal in-person contact with students due to the asynchronous delivery of the course. Our advisory board suggested to employ the survey during discussion session along with giving extra credit as an incentive. During Fall 2021 semesters, both suggestions were implemented which increased the response rate to 90%.

The graduate research assistant interviewed ten randomly selected students, stratified by gender, at the beginning and end of the Fall 2021 and Spring 2022 semesters to determine reactions to the instructional design and instructional events and materials. The graduate assistant transcribed interviews via software tool “Trint”. PI, social science co-PI, the graduate student and undergraduate students coded and analyzed the interviews using analysis software MAXQDA. Three cycles of coding were performed, one cycles as individual coding, one with group coding and one with refining the codes with the group. Responses were analyzed.

Ongoing and Future Work

The project had two full design implementations: Fall 2021 and Spring 2022. During both semesters, survey and interview data were collected. Interviews were coded individually and as a group and started to be analyzed. Survey data was cleaned, organized, and stated to be analyzed. Data analysis is still ongoing and will be disseminated in the future conferences and journal articles.

Generation of Knowledge

The findings of this project were presented at the American Society for Engineering Educators (ASEE) conference in 2021 and 2022, American Institute of Chemical Engineering (AIChE) conference in 2022 [. In addition, the project team joined community of practice (CoP) meetings and shared her findings with the chemical engineering faculty.

Conclusion

One of the main focusses of this project is to develop PI's skills on engineering education research. With working social science mentor, she has been gaining knowledge and expertise on quantitative and qualitative social science research methods. Through the project, project team was trained and improved on social sciences research methods.

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