Board 399: The Freshman Year Innovator Experience (FYIE): Bridging the URM Gap in STEM

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The project focuses on increasing "effective STEM education and broadening participation" in underrepresented minority (URM) STEM students at the University of Texas Rio Grande Valley (UTRGV) to successfully face academic and professional challenges, recently exacerbated by the COVID-19 pandemic. The Freshman Year Innovator Experience proposes the development of self-transformation skills in freshman mechanical engineering students to successfully face academic and professional challenges exacerbated by the COVID-19 pandemic while working on two parallel projects of technical design innovation and academic career pathways. The authors will present the work in progress and preliminary results from a pilot implementation of the Freshman Year Innovator Experience. This project is funded by NSF award 2225247.

Introduction

Freshman engineering students can have a hard time transitioning to college. The freshman year is critical to the students' academic success; in this year they learn basic skills (Vargas Hernandez et al., 2018) and establish essential networks with other students, faculty, and resources. How can we help these freshman engineering students in this transition? We propose that freshman students can learn from the engineering design innovation process and apply it by analogy to the design of their academic pathways. There are multiple similarities between product innovation (i.e., technology) and the continuous academic challenges faced by the student. Engineers as designers and innovators have a vast and rich repository of techniques, tools, and approaches to develop new technologies, and a parallelism can be drawn between the design and innovation of a technology (e.g., redesign of a kitchen appliance), and the "design" of the students' academic career pathways. The purpose of this paper is to present the progress on the project supported by NSF award 2225247.

The main objective of this project is to help freshman engineering students develop problem-solving skills that can be applied to their academic success. The college readiness, and hence the academic success of incoming students at UTRGV College of Engineering and Computer Science (CECS) needs to be improved. Statistics, shown in Table 1, indicate low levels of retention and graduation rates particularly for CECS.

Table 1. UTRGV College of Engineering and Computer Science First Year Full Time Freshman 1st Year Retention Rate.

Cohort	Retention Within College	Retention Within University
Fall 2015	62.3%	78.2%
Fall 2016	66.6%	77.0%
Fall 2017	64.7%	74.9%
Fall 2018	69.4%	78.5%
Fall 2019	67.2%	79.0%
Fall 2020	53.3%	60.9%

There are multiple factors that play a role in these low levels of attainment (Brown, 1994; Betz, 1997; Collea, 1990), chiefly among them (1) socioeconomic factors of the Rio Grande Valley (RGV) region (Rodriguez-Hernandez,et al., 2020; Bozick, 2007; Byrne and Flood, 2008; Casillas et al., 2012; Cowan et al., 2012; Erola et al., 2016; Gerken and Volkwein, 2000), (2) first generation Hispanic students, and (3) the effects of COVID-19 pandemic (Mudenda et al., 2020; Forakis et. Al., 202; Novak-Pintarik and Kravanja, 2020; Brancaccio-Taras et al., 2021; Pokhrel and Chhetri, 2021).

- Some of the observations from undergraduate faculty advisors are as follows:
- Some students are not aware when they are in academic trouble.
- Study habits are not well developed.
- Traditionally, students avoid asking for help early on.
- Only some students create a support network, study group, or learning circle.
- Some students are not aware of the value of extracurricular activities until they are ready to graduate.
- Among other basic situations.

These observations motivated the creation of a one-week onboarding intervention (Boost-camp) (Vargas Hernandez et al., 2022). In this one-week intense experience, students participate on a variety of activities including:

- Faculty talks.
- Student organization's introductions
- Hands-on projects
- Lab visits
- Networking opportunities
- Among other experiences.

These bootcamps started in the summer of 2021 with funding from 3M Company focusing on a cohort of 50 freshman Mechanical Engineering students. This Boostcamp allowed incoming students to learn, develop skills, and establish networks that otherwise would have taken months or semesters to achieve. In the summer of 2022, the Boostcamp expanded to include students from other departments in CECS and faculty representing every department received training with the intention to expand the Boostcamp offer. Although these Boostcamps have an important impact on the students, these are time and resource intensive. While the organizers continue expanding these Boostcamps, it became clear that we needed to explore other simultaneous approaches to improve freshman college readiness and academic success.

An important conclusion of these Boostcamps is that students effectively develop particular skills and learn how to deal with specific situations. What if we could teach these students the process of problem-solving to face the continuous sequence of academic challenges that students face throughout their academic career? For a student, each challenge is new and requires a new solution. This happens to be the definition of innovation: a new way to solve something for the first time. Hence, we could help students develop the necessary skills for problem solving in their academic context, to self-transform, to self-innovate, to see themselves as a project, not too different from an engineering project, where student learn to improve, solve, and innovate a technical product, and learning by analogy, adapt that richness of technical innovation, design thinking, problem solving, and entrepreneurship to self (Chaplin, 1989; ASME, 1995; Marra et al., 2000; Lammi et al., 2013; Anning, 1997; Apeode et al., 2008; Christensen and Schunn, 2007; Davis and Sumara 2006; Grinter, 1956; Jonassen, 2000; NAE, 2004; Silk and Schunn, 2008).

Proposed Approach

The central idea in this proposed approach is to have students work on two parallel projects, one is the technical redesign of simple kitchen appliances (e.g., a toaster), and the other the design of their academic path (i.e., courses to take, extracurricular activities, habits, skills, etc.). While the students work on these two parallel projects, a periodical intervention will help them connect the technical approaches to their academic project. For example, using journals and reflection to understand how students had to frame a problem, ask for help, evaluate options, and decide to improve a toaster and how they need to frame their academic problem, ask for help, evaluate options, and decide for their academic path project.

The authors identified two important courses to intervene: UNIV 1301 Learning Frameworks and MECE 1101 Intro to Mechanical Engineering. These two courses teach a variety of important topics, and both traditionally had project elements of technical innovation (MECE 1101) and career path planning (UNIV 1301) that required to be formalized into proper projects. For this purpose, the Challenge Based Instruction (CBI) approach (Fuentes et al., 2008; Bransford et al., 1999; Freeman et al., 2016) was chosen to guide the steps of the parallel projects. CBI promotes engagement when properly implemented, and this is critical for Freshman, URM, Engineering students. Figure 1 represent the overall approach having the two courses, each with their corresponding project (technical or academic), both following the CBI steps, and having a connection between the two projects to draw knowledge by analogy; this is referred to as adaptive expertise in CBI.

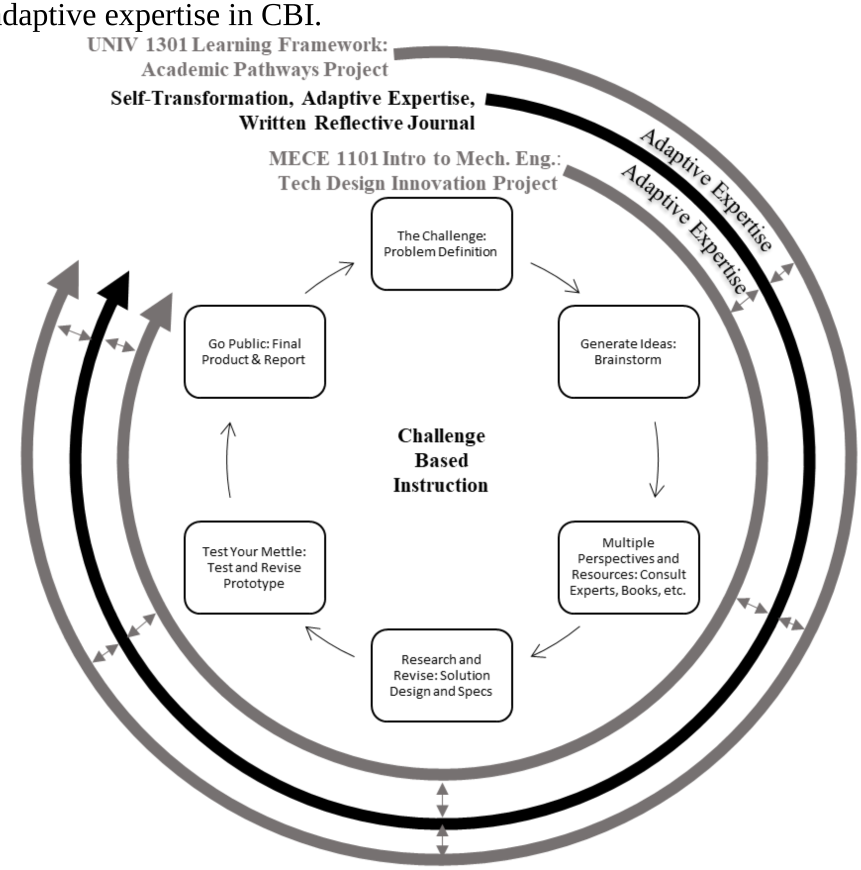

Figure 1. Overview of the FYIE Approach.

This approach requires the revision of both UNIV 1301 and MECE 1101 courses as well as the development of adaptive expertise interventions. For this reason, a pilot implementation is undergoing during the 2023 spring semester.

2023 Spring Pilot Implementation

During the 2023 Spring semester, selected sections from UNIV 1301 and MECE 1101 participate in a pilot implementation. In this pilot, 4 sections of UNIV 1301 match two sections of MECE 1101, one section of MANE 1101 (Intro to Manufacturing and Industrial Engineering), and one section of CIVE 1101 (Intro to Civil Engineering). A total of 8 instructors are involved in these pilot implementations. The authors helped the instructors plan their implementation during the Fall 2022 semester and closely follow implementation of the projects in their respective courses. In this first implementation, each instructor is following a general project guideline (i.e., CBI) while exploring different implementation approaches:

- MECE 1101 sections are using Arduino controllers for their projects.
- MANE 1101 section uses a catapult kit and 3D printing.
- CIVE 1101 section uses a paper tower project.
- UNIV 1301 sections used various approaches for the academic paths project including journaling, reflection, and guest talks, among others.

The 1101 Intro sections have a clear advantage implementing engineering related projects while the UNIV 1301 academic paths project has more flexibility in its definition. From this Spring 2023 pilot experience we are defining a framework for implementation of the academic paths project in UNIV 1301. This framework has the following elements:

- The academic path project challenge is better defined with a series of questions to solve.
- During the process, students can receive templates and suggestions, as well as tools for problem solving.
- The resulting artifact is a “prototype” of the students’ academic path that will be presented. The artifact should showcase the career path instance and proof that the student developed problem solving skills (result and process).

The pilot will continue this semester and the lessons learned will inform the implementation in the Fall semester. Currently, the adaptive expertise interventions connecting technical innovation with career paths exploration are currently under development. The approach is to give students a simple to follow guide; figure 2 in the next page gives an idea of how the engineering project and the academic path project are interrelated.

Future Work

The immediate next step after the 2023 Spring semester pilot implementation is to prepare the 2023 Fall semester implementation. This will include a more detailed implementation framework for 1101 Intro and UNIV 1301 sections. Further, the objective is to expand the interventions to include other departments in CECS and possibly to other colleges such as the College of Science or College of Business. Our vision is to have a sequence of interventions that continue this Freshman Year experience with Sophomore, Junior, and Senior Year Innovator Experiences, with an increasing portfolio of skills each year.

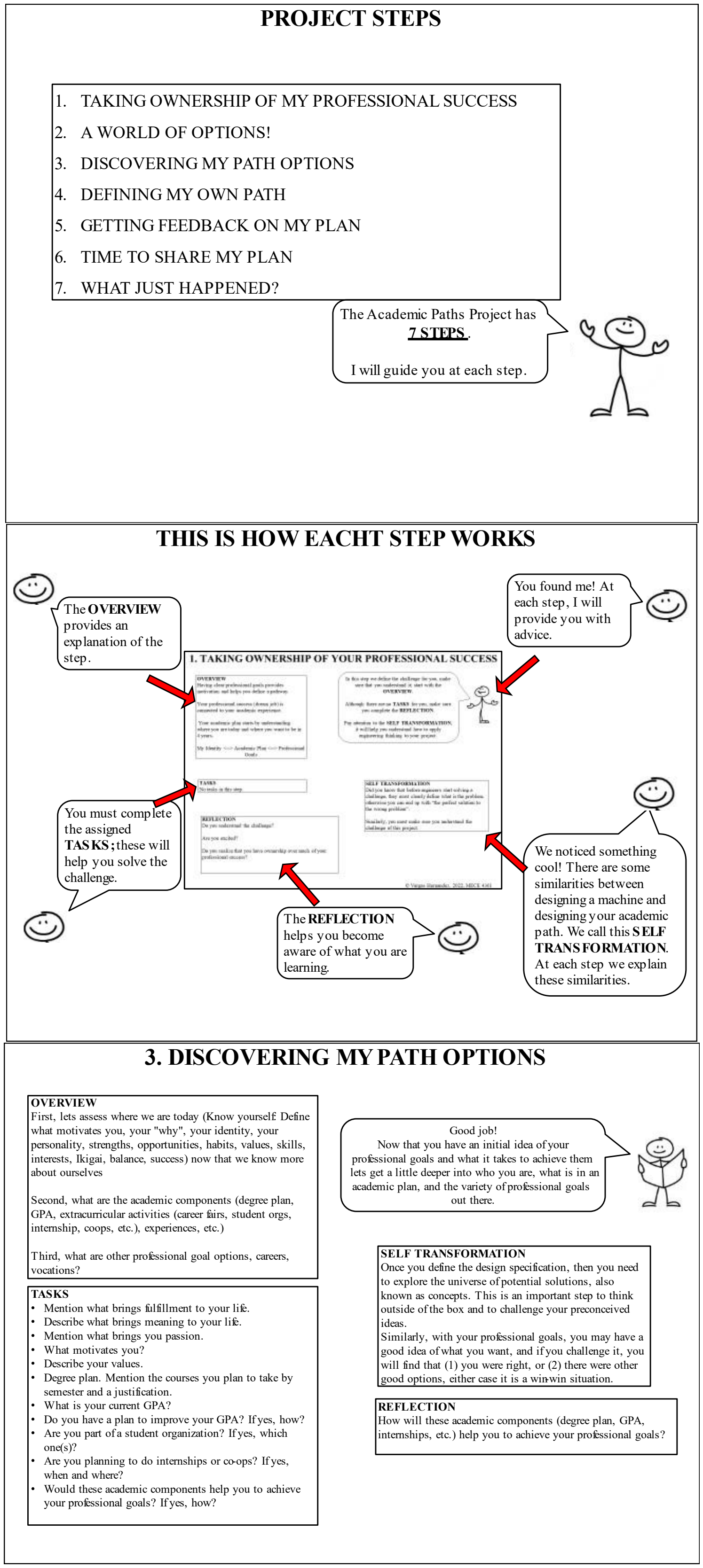

Figure 2. Samples from the Academic Path Project.

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