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# Evaluation of an EPIC Student Experience to Broaden Participation in Engineering Programs (Work in Progress)

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## Abstract

Recruiting and retaining a diverse talent pool has been long recognized as essential to keep our nation's economic and intellectual preeminence but is an area in which we continue to fall short. Historical barriers could be lifted by providing institutional initiatives to support underrepresented students in higher education engineering programs. The Equal Partners in Inclusive Community (EPIC) program was established in fall 2019 to address the needs of and provide support mechanisms for underrepresented minority (URM) groups pursuing baccalaureate degrees in engineering. Under a limited budget, three initiatives were designed to create a respectful and safe environment for students, faculty, and staff, to strengthen community bonds and contribute to the cultivation of diverse student retention in the engineering college: a Speaker Series, a Mentorship Program and *Epic Fail*. This paper presents the findings from our formative evaluation of the EPIC program. Positive preliminary program results were obtained, suggesting improved self-belonging, self-efficacy and career interest in participants. Areas for improvement were identified. It is the authors' hope that this work may provide context for other institutions as they develop initiatives to move towards a more equitable and welcoming space for all students in engineering programs.


## Introduction

Recruiting and retaining diverse talents, including women, underrepresented minorities, and persons with disabilities within engineering disciplines has been long recognized as essential to keep our nation's economic and intellectual preeminence (Public Law 105-255, approved on Oct 14, 1998) [1]. In 2000, the Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology development reported that "a culturally diverse workforce creates competitive advantage through greater creativity and innovation; increased organizational flexibility thanks to higher levels of divergent thinking; and better decision making based on multiple perspectives (less "group think") as well as a critical analysis of alternatives" [1]. This focus has become even more critical as the problems facing our society grow increasingly complex, and solving them requires creativity and innovation, at which inclusive teams thrive [2].

In 2002, Bill Wulf, a past president of the National Academy of Engineering stated that "as a consequence of a lack of diversity (in engineering) we pay an opportunity cost, a cost in designs not thought of, in solutions not produced. If we do not engage women and other underrepresented minorities in the engineering enterprise, we are ignoring more than 50% of the intellectual capacity." Engaging women, underrepresented minorities, and persons with

disabilities (referred to in this paper as URM) requires engineering to not only become a more attractive option for all students but also to help those already attracted to the field to be retained in the programs and persist.

We have long known of issues that affect retention in STEM disciplines, particularly for URM. In a landmark study of retention in science and engineering majors, it was found that it is not primarily cognitive capabilities that distinguish students who leave science and engineering and those who stay [3]. In the Congressional Commission's report, disparity issues in engineering relating to URM were listed as lack of role models, public image, isolation, stereotype threat, lack of influential mentors, lack of opportunities, workplace hostility, and work/life balance challenges.

There has been a plethora of initiatives put in place to increase the retention from traditionally underrepresented groups. Programs that provide co-curricular support, also called engineering student support centers (ESSCs) or minority engineering programs (MEPs), are present at about half of accredited engineering programs nationwide, according to a recent census of these programs [4]. Some of these initiatives include, but are not limited to, cognitive interventions; advising and counseling; orientation and preparatory programs; and special retention and self-identity development programs [2], [3], [5]. In addition, building community through interventions via peer support and providing role models help students recognize and visualize themselves as "fitting in," i.e. belonging and as likely to succeed in engineering [2], [6]. The census study identified that academic support services, workshops and networking sessions were the most commonly offered programmatic activities, whereas peer mentoring and faculty/staff mentoring programs were the least commonly offered programmatic activities [4].

As the global pandemic stretches into 2021 and higher institutions continue to turn to remote education, one should also recognize the increasingly conspicuous value of providing necessary support to students through various initiatives in order to boost their feelings of belonging and self-efficacy. To respond to the need for necessary student support to broaden participation and success in engineering majors, the EPIC program was created in 2019. With a focus on underrepresented students in the college, the program goal is to build a STEM identity through a Speaker Series, a Mentorship Program and the *Epic Fail* event, designed to:

- develop a sense of belonging
- improve self-efficacy
- increase retention

Based on the program goal and activities, the program director sought to explore if EPIC was meeting its goal and collaborated with evaluators who focus on STEM education initiatives to develop and conduct a program evaluation. Program evaluation is defined as "the systematic collection of information about the activities, characteristics, and outcomes of programs to make

judgments about the program, improve program effectiveness, and/or inform decisions about future program development [7, p. 23].” Evaluators investigated the initial implementation of EPIC, in order to determine if the program is meeting its overarching goal and to identify areas for improvement for future program development and implementation.

## Literature Review

Areas of the research literature relevant to this evaluation include challenges of URM retention in engineering and constructs identified to improve retention, perceptions of self-efficacy, and sense of belonging.

### *URM Retention in Engineering*

Nationwide, about one in two students who start in engineering graduate from engineering, and 50% of this attrition occurs during the freshman year [8]-[11]. Besterfiled-Sacre et al. [8] described education as a combination of content knowledge, technical skills, and attitudes. This study noted, “Engineering students begin their college education with a set of attitudes about engineering and their abilities to succeed. These initial attitudes and their changes during the freshman year affect students’ motivation, performance, and ultimately retention in an engineering program.” Accordingly, supporting students early on with their academic performance, motivation, self-efficacy, and sense of belonging plays a critical role in retaining engineering students [4].

One of the significant characteristics of students who persist in engineering is their gender [4], [12]. Dell et al. [13] explicitly stated and confirmed that women leave engineering programs at higher rates than men. In a 2020 report of the National Science Board [14], it was noted that women make up about half (52%) of the college-educated workforce in the US. Although the number of women in science and engineering jobs rose from nearly 1.3 million to nearly 2.0 million from 2003 to 2017, women accounted for merely 16% of the engineering workforce in 2017.

Race and ethnicity are other characteristics that distinguish variations in persistence. The National Science Foundation reports that while Black/African American and Latinx students are just as likely to have the intent to pursue a STEM major and have gradually increased their share of STEM degrees, they are still underrepresented in STEM educational attainment and are less likely to earn a degree in STEM fields [15]-[17]. Previous research has concluded that it is not necessarily a lack of interest in STEM fields that leads to underrepresentation but rather low retention and degree completion rates [17].

To understand overall factors that influence retention across higher education institutions, social scientists have investigated means for engaging students that result in higher levels of success.

Astin's Student Involvement Theory [18] highlights the importance of focusing on the actions of students to increase motivation and satisfaction with one's college experience. Tinto's Theory of Student Departure [19] explores the psychological, sociological, organizational, and economic perspectives that influence student departure and have been the primary source of reference on why students leave higher education prematurely [19]-[21]. While Astin and Tinto's works have been instrumental in studies of retention, they have been critiqued by subsequent scholars for a deficit model that focuses on a student's weakness or failure to acclimate to the academic and social environment as a reason for departure instead of examining a more complex set of psychological and sociological considerations over which the culture and organization have influence [21].

As a result, research in the last twenty years has focused more on what institutions can do to help support students in higher education. The work of Deci and Ryan on the Self-Determination Theory [22] shows that students need support to develop basic psychological needs of autonomy, competence and relatedness that lead to learning and connection with others, and more recently they have shown this is universal across age, ethnicity, and culture [23]. With relation to STEM students, affective factors have been shown to be key determinants of success, particularly for URM; however, social science theories are not frequently applied in engineering programs within higher education [24].

Making these connections and identifying mechanisms for promoting student success becomes especially important when considering women and students from underrepresented groups in STEM fields. Seymour and Hewitt [3] have shown that the "educational experiences and culture of the discipline" have a larger impact on student retention than individual competencies. Interventions, such as mentoring, that develop a positive culture within engineering by supporting the development of one's science identity, self-efficacy, cultural and social capital, and sense of belonging have been shown to increase retention of URM students [24], [25].

*Importance of Student Self-Efficacy*

Bandura's Social Constructivist Theory [26] has been widely used to define self-efficacy and how it impacts one's ability to be successful in attaining new skills [27]. Self-efficacy is a student's belief in their ability to succeed in an area, and this is especially important in the rigorous field of engineering. Not only can it be used to predict student success in a discipline, but it has also been shown to independently be tied to student persistence in engineering [28]-[30].

At-risk freshmen have been shown to have lower confidence in their ability to succeed in their engineering courses, and women are also prone to lack of self-efficacy and self-esteem, especially if they are sitting in a room full of male students [28], [31]. Furthermore, a cross

sectional study conducted by Concannon and Barrow [30] showed that freshman women in engineering have lower coping self-efficacy and career outcome expectations than their male counterparts. Castellanos and Gloria [32] noted many Hispanics are at risk for low belief in their abilities and place in higher education due in part to transformational issues as they assimilate socially into a predominantly White discipline. Therefore, understanding how to support the development of a student's academic self-efficacy, especially for URM, is key to addressing the nation's shortage of engineering graduates and lack of diversity in the field.

There are four primary sources for establishing self-efficacy: mastery experience, vicarious experience, social persuasion and physiological reaction [26], [30]. Limited role models and peers in STEM who are from underrepresented groups make it less likely that students will have vicarious experiences of success or receive the social persuasion needed to build self-efficacy [33]. This can be ameliorated by helping students think and feel like scientists through the acknowledgment of their science identity from meaningful people like peers, faculty, and industry mentors [34]. Studies have also shown that particularly for female engineering students, those in freshman interest groups have higher career outcome expectations than other female engineering freshmen not in interest groups [29].

*Developing Sense of Belonging*

Sense of belonging is defined as one's perceived sense of being valued and accepted within a community and is considered to be a basic human need [35], [36]. For URM students, developing a sense of belonging may be challenging due to internalized negative stereotypes, differences in cultural norms, lack of influential peers and faculty mentors, and perceptions of racism [37]. Findings in a study by Jordan and Sorby [38] support this idea showing a lower overall sense of belonging for URM engineering students across multiple institutions compared to White engineering undergraduates. Without a sense of connection to one's social and academic environment, a student's academic self-efficacy may suffer and result in lower retention of URM students in engineering programs [37]. Furthermore, subtleties that reinforce a lowered sense of belonging may lead to URM students discouraging other same-race peers from pursuing degrees within their field [39].

Alternatively, students who are able to find support in their college environment through peers, faculty, and advisors may find more success in their academic experiences [37]. A student's sense of belonging within their discipline at higher institutions has been shown to be associated with academic motivation, institutional commitment and intent to persist [36], [40]. Additionally, higher academic self-efficacy and placing value on required tasks increases sense of belonging [24]. Students feel a stronger sense of university belonging when there is a social connection to peers and university personnel [41].

**Our Program**

Northern Arizona University is a college in the rural southwest that serves just under 30,000 undergraduates and graduates at a main campus that is primarily residential, multiple satellite campuses statewide, and online. Its proximity to large tribal areas leads to a substantive percentage of American Indian students compared to the national average and the university has recently achieved status of a Hispanic-Serving Institution (Table 1). It also has a high percentage of first-generation college students, with approximately 46% of the student population identifying as such.

The overall student population is 3% American Indian/Alaskan Native, 3% Black/African American, and 25% Hispanic/Latinx with 64% of the students identifying as female and 36% male. The demographics of the students within engineering college (also housing informatics and applied sciences) are very similar to the overall university except a slightly lower percentage of Hispanic/Latinx students at 21% and a starkly different divide among genders with 21% of students identifying as female and 79% male. Table 1 indicates that representation within the engineering college by different demographics has been consistent between 2011 and 2020, except for Hispanic/Latinx and two or more.

*Table 1: Undergraduate student demographics in the engineering college from 2011 to 2020*

| **Race/Ethnicity** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|---|---|---|
| American Indian/Alaska Native | 6% | 5% | 4% | 3% | 4% | 3% | 3% | 3% | 3% | 4% |
| Asian | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 3% |
| Black/African American | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Hispanic/Latinx | 11% | 13% | 15% | 15% | 16% | 16% | 16% | 18% | 20% | 21% |
| Native Hawaiian/ Other Pac Islander | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Non-resident Alien (International) | 9% | 13% | 14% | 19% | 18% | 20% | 21% | 19% | 13% | 8% |
| Not specified | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 2% | 1% |
| Two or more | 3% | 4% | 5% | 4% | 5% | 5% | 5% | 6% | 6% | 6% |
| White | 65% | 60% | 57% | 53% | 53% | 50% | 49% | 49% | 51% | 55% |
| **Total (#)** | 1782 | 1986 | 2167 | 2398 | 2533 | 2781 | 2911 | 2923 | 2660 | 2410 |

Engineering college administrators identify retention as a challenge. Over the last four years, an average of 57% of engineering students were retained after one year, 44% after two years, and 39% after three years. Half of URM students and one-third of female students do not complete their engineering program, making the college's female retention akin to the national averages and retention of students underrepresented in the field slightly higher than that reported nationally [42], [43].

Based on the supporting literature and recognizing our unique population, the College of Engineering, Informatics, and Applied Sciences established the EPIC program in fall 2019, by resurrecting a previously existing MEP, with the goal to address the needs of and provide support mechanisms for URM pursuing baccalaureate degrees in engineering. EPIC has placed its focus on connecting students to others who may provide the needed emotional and psychological support through mentorship, professional seminars and the sharing of lessons learned from failure. It is believed by having students observe the successes and failures of others, they can recognize their own capabilities of academic achievement.

The program's initiatives were designed to create an inclusive environment while working with a limited budget. One of the features of the program that make it unique from most MEPs is the fact that inclusivity is fully embraced by excluding no one, including students from majority populations. Diversity is recognized across many spectrums, and by including all, even those from majority groups, it is believed the program can help to close the achievement gap [44]. The program director, appointed by the dean, is an underrepresented non-tenure track faculty woman of color. She was provided a course release on her statement of expectations and supplemental summer pay. She sought to collaborate with other programs with similar goals, and in particular, leveraged resources to develop mutually relevant programming with the Southern Nevada-Northern Arizona Louis Stokes Alliance for Minority Participation (SNNA-LSAMP) staff. The program director also hired a part-time student worker, who was expected to work about 10 hours per week.

The vision for this program is to be a central element of the student experience that enhances academic, professional, and personal development and broadens participation from underrepresented students in engineering, informatics, and the applied sciences. EPIC is established to become a positive force as part of the college's commitment to promoting a diverse and inclusive environment for all college students. There are three main initiatives under the program: (1) Speaker Series (2) Mentorship Program and (3) *Epic Fail*.

*Speaker Series*

The first initiative, the Speaker Series, showcases role models from academia or the workforce with the goal to motivate current URM students to achieve their full potential by defying

stereotypes, helping them build their network, and connecting them to future opportunities. This initiative was selected because research showed lasting benefits of such seminars/workshops, including early awareness of the academic expectations in technical courses and the necessity to remain connected to their student peers, course professors or academic advisors throughout their college careers [3].

Initially, potential speakers were identified based on recommendations from a group of faculty organized by the director. Special attention was paid to include speakers from diverse and underrepresented backgrounds to serve as role models. Later this initial list grew by adding people from the director's personal network and recommendations from the dean's office. The invited speakers were asked to provide information on career development, challenges of the workplace with solutions, and projects and research that they have produced. In addition, the speakers were asked to share their personal stories, wisdom, experience, and useful insight about working in the real world, information that they wish someone had passed along when they were in college.

Flyers were created for each speaker containing the title and abstract of the talk, featuring the speaker's headshot and the meeting details. Flyers were posted within the college building on electronic displays, added to the university events calendar, posted on the college's social media outlets and sent out as an attachment in mass emails to all students, faculty and staff a week before the event, with a reminder email on the day of the event.

*Mentorship Program*

The second initiative of the program is the Mentorship Program. This program fosters connecting freshmen and sophomores with upper-division students, alumni, practicing professionals and faculty to build strong and nurturing mentoring relationships. Existing research shows that a strong relationship with an aspirational mentor is one of the most positively impactful forces in the academic success of underrepresented students, and these students often lack the opportunities to build such relationships [45]-[48]. The program director recruits mentors by using recommendations from the dean's development officer, other faculty, and personal connections.

At the beginning of each semester, a survey goes out to all freshmen and sophomores in the college to explain the purpose of the program and recruit new participants. The survey asks students to provide information about themselves, areas of interest, what they expect from their mentors and a description of their ideal mentor. In the first semester of the program, the program director received 11 responses. She matched the mentees with volunteer mentors, and criteria for matching included hobbies and career interests as well as personal experiences and shared backgrounds. At each session, mentors and mentees met individually (meetings were virtual

after the pandemic) to discuss current academic performance and set personal and professional goals. In addition, mentors and mentees were encouraged to communicate via phone or email outside of scheduled sessions.

In the second semester (fall 2020) when the new version of the survey was sent out, the program director received 72 responses indicating their interest level in the program. Sixteen students (22%) indicated that they were not interested, 31 students (43%) said, "Maybe, it depends", and 25 students said, "Yes, I am interested. Contact me with more information". The students who were interested in the program received a personal phone call and were invited to a "Speed Networking" kickoff event to choose their mentors, which was inspired by feedback received at the end of the first semester. Not all students were able to attend the kickoff meeting, so there was significant individual follow up by the program director to continue to match all mentees and mentors. In addition to the kickoff meeting, handbooks and guidelines were provided to all mentors and mentees in fall 2020 as a response to feedback asking for more program structure. The handbook and guidelines were intended to be resources for developing a healthy mentor-mentee relationship.

*Epic Fail*

The third initiative of the program is an event called *Epic Fail*. *Epic Fail* is an open microphone event where faculty members and students share their personal stories of failure, to dispel imposter syndrome. Having an open microphone structure with no main speaker, *Epic Fail* is considered a unique event, separate from the speaker series. This event has a goal to communicate that "Fail" stands for **F**irst **A**ttempt **i**n **L**earning and that failure is part of engineering. In fact, everyone fails, even the best in any field. It is important to emphasize that it is not only okay to fail but also a valuable way to improve by identifying ways to perform better next time. When URM students, who generally have lower self-efficacy, face failure for the first time they often talk about leaving engineering and applied sciences because they feel they do not belong. *Epic Fail* provides actionable strategies for students to implement for a seamless bounce back.

The event highlights quotes on failure from famous engineers, scientists, and innovators. While playing motivational songs in the background, *Epic Fail* starts with pre-arranged volunteers to kick off the open microphone event by sharing their failure story before the audience starts taking turns sharing their stories. The first *Epic Fail* (spring 2020) was in person and took place before the pandemic hit, and the second event (fall 2020) was virtual.

**Evaluation of the EPIC Program**

The director engaged university evaluators in early spring 2020 to develop a program evaluation plan and to help design evaluation instruments. Using the goals of the program, the evaluation team established two primary questions to be addressed in the first year of program implementation. The preliminary evaluation questions for the EPIC program are:

Q1) To what extent does the EPIC program meet its goals?

Q2) What are the areas of improvement for the program?

**Methods**

*Participants*

Participants in the evaluation included all students who were involved in any activity, including the nine seminars in the Speaker Series, the *Epic Fail* events, and/or the Mentorship Program. Both science and engineering students participated in the Speaker Series and the *Epic Fail* events, and engineering students only were involved in the Mentorship Program. Faculty and recent graduates from the engineering college, and professionals from industry who volunteered to serve as mentors in the Mentorship Program also were included in the evaluation.

*Data collection*

All participants in the program's activities were invited to complete surveys during the activities. The evaluation study proposal was reviewed by the university IRB and deemed not meeting the definition of human subject research.

Speaker Series:
After each event, students completed the surveys. Overall, 131 responses were received (students may have completed more than one survey over the course of the Speaker Series). Students were asked to rate on a scale the extent to which the seminar helped to promote a diverse and inclusive culture in the engineering college and if the speaker excited them about their future career. Students were also asked what they would like to see in future Speaker Series and what they found interesting about the seminar.

Mentorship Program:
Five students and nine mentors completed surveys after the spring Mentorship Program. Fourteen students and 22 mentors completed surveys after the fall Mentorship Program (two mentors who each mentored more than one student completed the survey for each student they mentored). Mentors were asked to rate the level of commitment they perceived from their mentee, to identify what their experience was like with their mentee, if they wanted to remain as

mentors with their mentee in future semesters, and to suggest any recommendations for improvement. Mentees were asked details about their mentoring meetings and questions such as what the experience was like overall, how supported they felt by their mentor in terms of career planning, and how good of a role model their mentor was.

*Epic Fail*:
Survey data was only collected for the fall *Epic Fail*. At the conclusion of the program, 15 students completed the survey. Students were asked to respond to a number of questions rating their perception of failure after attending the event, to rate the event overall, and to identify the most important thing they learned from the event.

**Data Analysis**

Both quantitative and qualitative data were analyzed. Quantitative responses were analyzed using descriptive statistics, including mean scores on survey Likert scales. Open-ended comments from the Mentorship Program and the *Epic Fail* activity were limited, so were summarized. Open-ended responses about the Speaker Series were analyzed using thematic analysis [49]. A single coder initially conducted the analysis of the responses, starting with a set of a priori codes that came from the development team's vision of the EPIC program. Codes were categorized by student interest in the speaker's focus on: 1. academic development (succeeding as an engineering major), 2. professional development (succeeding as an engineer), and 3. personal development (emphasis on the whole individual). As the analysis progressed, initial codes were modified, and new codes emerged to better capture student experiences. A second coder then confirmed codes, and coders came to a consensus on final codes (Table 3). To validate the accuracy of research findings, the researcher employed two strategies recommended by Creswell [50]: peer debriefing (discussions with the evaluation and program team during data collection and analysis) and consideration of discrepant information that ran counter to the themes. The data was continually reexamined during analysis as patterns and themes emerged [51].

**Results**

Speaker Series:
In surveys completed by students after the Speaker Series seminars, the weighted mean rating of the eight seminars that were rated for promoting a diverse and inclusive environment was 4.7 on a 5 point scale (Table 2). The mean rating for exciting students about their future careers was 4.3 on a 5 point scale. Participants' demographics were not collected in these surveys.

Students were asked several open-ended questions about each seminar, including what they found most interesting and what they would like to see more of in future seminars in the speaker series. These responses helped illuminate the quantitative responses provided in Table 2. There

were 105 responses to the prompt, “What did you find interesting about the seminar?” Responses appeared to shift, depending on the emphases of the speakers.

Students identified a number of aspects they felt were interesting about the Speaker Series, related to professional development as engineers. Many students identified the STEM topic and content of the seminar as engaging, particularly cutting edge topics and technology, such as conceptual coding architecture, material science and decarbonization. As one participant commented, “*My interest spiked when talking about diatoms, and the quote ‘anything you can make in a lab, nature already did.’ That really piqued my interest in nanotechnology.*”

Students also identified as interesting information speakers shared that increased their awareness of engineering, including career options in engineering, as well as how to network, advice for promotion, and what it is like to be an engineer, all topics that helped them understand how to become a professional engineer.

For many students, it was the stories that the speakers talked about their experiences during their career paths that made the talk interesting. As one student commented, “*I liked when she talked about her different career options and how diverse her options were.*” Another student commented about the panel, “*I found it interesting about the many different and unique people. It was interesting learning about the different paths that people had to get to* [the company].” For some students, they were particularly interested in hearing what it was like to be a woman or minority engineer, and/or struggles being a woman engineer in the workplace. One student was surprised to hear that “*a highly successful woman engineer still finds herself subject to disrespect and mockery from her male peer despite her successful career.*”

A number of presenters spoke of their personal development as they became engineers. Several students commented on the importance of hearing about the speaker’s culture and developing their identity as URM professionals. As one student stated about a speaker, “*I think having someone talk about their journey as a minority in STEM is very empowering.*” Another student identified that it was interesting to hear about “*the cultural perspective of a Native (American) faculty*.” Students also appreciated the candid information about having your “all”, including finding a work life balance, such as balancing family and career. As one student commented, “*I liked the part [of the talk] where the speaker really emphasized that it's okay to be yourself.*” Students also were engaged when a speaker spoke very personally about overcoming hardships in her life.

*Table 2: Participation and rating of Speaker Series seminars*

| **Spring 2020 Speaker Series** | | | | | |
|---|---|---|---|---|---|
| Date | Title of seminar | Number of participants | Number of survey responses | Promoted a diverse and inclusive environment | This speaker excited me about my future career |
| Jan. 23 *In person* | Defying Stereotypes: My Journey in Engineering | 32 | 25 | * | * |
| Feb. 9 *In person* | Native Americans in Higher Education: Expectations, Erasure, and Excellence | 13 | 10 | 4.9 | 4.2 |
| Mar. 4 *In person* | The Evolution of "Having it all" | 43 | 25 | 4.6 | 4.2 |
| Apr. 9 *Virtual* | I wasn't born with a chip, I earned it! | 47 | 14 | 4.8 | 4.6 |
| Apr. 23 *Virtual* | Build Composites Like a Girl | 17 | 5 | 4.8 | 4.8 |
| **Fall 2020 Speaker Series** | | | | | |
| Aug. 26 *Virtual* | Panel | 48 | 14 | 4.6 | 4.1 |
| Sept. 23 *Virtual* | Key Challenges to Energy System Decarbonization and Career Opportunities | 32 | 11 | 4.3 | 3.7 |
| Oct. 21 *Virtual* | How a Random Walk Through College Can Lead to a Lifetime of Science Exploration | 37 | 16 | 4.6 | 4.2 |
| Nov. 4 *Virtual* | Essential and Accidental Difficulties: Software Architecture and Models | 30 | 12 | 4.4 | 4.4 |
| **Overall** | | **299** | **132** | **4.7** | **43.3** |

*These questions were not asked at this session.

Likert scale: 5=Strongly Agree, 4=Agree, 3=Neither agree nor disagree, 2=Disagree, 1=Strongly Disagree.

*Table 3: Codes and themes emerging from the speaker series*

| Category | Codes and subcodes | Themes |
|---|---|---|
| Professional development as engineers | STEM topic and content learning | *New content and cutting edge technology piqued interest* |
| | Career awareness<br>Engineering careers<br>Networking<br>Professional advice<br>What it is like to be an engineer | *Increasing awareness for how to become a professional engineer* |
| | Professional experiences<br>Journey to career<br>Challenges in the workplace<br>Workplace diversity | *Stories illuminate experiences on career paths* |
| Personal development | Personal story<br>Culture/identity<br>Work/life balance<br>Evolution | *Personal and professional identity* |
| Academic development | Academic advice<br>Academic motivation<br>Resources/programming for underrepresented minorities | *Supports for completing degrees* |

Students commented least on aspects of academic development for completing engineering degrees as interesting. One student said the speaker provided motivation. Several identified advice that speakers provided was important. Students commented on the importance of learning about resources and programs for underrepresented students, from one speaker, who emphasized these services in the talk. Several students discussed not only the content of the talk, but also the style of the speakers. They particularly commented on speakers who were able to connect with students and were inspirational or motivational in their style.

There were 69 responses to the prompt “What would you like to see more in the future Engineering Seminars?” A number of students responded that they would like more of the same as already provided in the Speaker Series. Others responded that they would like seminars on different engineering fields such as environmental fields or aerospace engineering, more information on real world topics. Others would like more personal experiences and examples of role models. Some commented that they would like more information on careers, what it is like to be an engineer, or advice about skills needed to become an engineer. Several students stated they would like more interactive presentations.

Mentorship Program:
During the time period evaluated, the program had two cohorts of mentees. Table 4 shows the number of mentors and mentees for each cohort. Within the first cohort of mentees (spring 2020), out of eleven mentees, five were female, five were male, and one was transgender. Four were White, three were Hispanic/Latinx, and four were Multiracial. The second cohort of mentees (fall 2020) consisted of 28 mentees, with eleven identifying as White, six as Hispanic/Latinx, ten as Multiracial, and one as Black/African American. Eleven were female and seventeen were male.

*Table 4: Participation in the Mentorship program*

| | **Spring 2020** | **Fall 2020** |
|---|---|---|
| Number of mentors | 11 | 25 |
| Number of mentees | 11 | 28 |
| **Total Matches** | **11** | **28** |

*Mentors:*
Out of the eleven mentors in spring 2020, nine responded to the survey request. At the end of the semester seven of the nine had met with their mentee.

Mentors had met with their mentees one to four times for 15 to 45 minutes per meeting. The average amount of time that mentors and mentees met was approximately 69 minutes overall. Meetings were conducted in a variety of ways, including face-to-face, via email (as a check-in), a video conferencing platform like Zoom, or by phone. All mentors and mentees had met at least one time face-to-face. Mentors identified that mentees seemed somewhat committed to participation, with the identified level of commitment to the mentoring program 3.3 on a 5 point scale. Seven of the nine mentors identified that they would like to stay with their current mentee, including the two who had not yet met with their mentee. Six of the nine mentors had positive experiences. As one mentor commented about the experience with the student, "*(It was) very positive. He found it very useful and was encouraged to hear that I would continue to be his mentor next semester*." One mentor identified that mentoring was especially useful during the pandemic.

> I think the switch to virtual meetings allowed me to go over how this pandemic is affecting how we work in industry and gave him a little reassurance that engineering is still a worthwhile career to pursue. I was happy that he had questions to ask me every time we met and was interested in what day-to-day engineering looked like. I look forward to what next year brings and am excited to continue being a mentor in the [EPIC] program.

Of the mentors that were not as positive, one said the mentee was only looking for a recommendation for an internship, and another said the mentee "*didn't have anything for me*" so they "*never really got to know each other*".

Mentors identified several suggestions for improvement, including more structure/guidance for the meetings, starting the semester with a group meeting with icebreakers, instead of starting with a "cold call", and student reporting requirements.

In the fall of 2020, seventeen mentor respondents had met with their mentee, from one to five times, ranging from 15 minute to one hour sessions. The average time met was approximately 121 minutes. Meetings were primarily held through Zoom or a similar video platform, but several were held by phone, or face-to-face.

Thirteen mentors identified positive experiences, including providing help to find an internship, insight and encouragement. Other areas of help included providing support or a "*steadying hand*" to a struggling student, helping students identify goals and planning for the future, and strategies for how to succeed in challenging times. One mentor identified that a friendship had developed between themselves and the student. Three mentors identified that the student was not consistent or not responsive. As one commented, "*I was not sure of how best to help as (the) student wasn't sure what they wanted out of (the) program.*"

Fall mentors identified a few recommendations, including having students identify their expectations and goals and then revisit these items at each meeting, providing small group mentoring for shy or anxious students, or more structure to the sessions, such as providing optional questions, activities, or topics to help guide conversations. Several mentors suggested that the program should hold a group meeting or social gathering at the start of the semester to develop community. Some respondents were unsure of the procedures for connecting with mentees, including how to contact mentees.

*Mentees:*
In the spring of 2020, all five mentees who responded to the survey were very positive about their experiences, and the support provided by the mentor as a role model, to complete their degree, and for career planning (Table 5). As one student commented about the doors they felt were opened from participation:

> My experience has been more than I could have ever hoped for. I am extremely grateful this program exists for students like me to participate in and receive such important mentorship. I have been offered two paid internship positions this summer and it would not have been possible without this program.

All students wanted to continue with their mentor in the fall of 2020.

*Table 5: Mean scores for respective questions on the survey for mentees*

| | **Spring 2020** | **Fall 2020** |
|---|---|---|
| *Number of Respondents* | *5* | *14* |
| My mentor made me feel that I can complete the BS in Engineering program | 5 | 4.6 |
| My mentor supported me with career planning | 5 | 4.5 |
| How committed do you feel your mentor was toward the program? | 5 | 4.8 |
| My mentor was a good role model | 5 | 4.7 |
| To what extent do you feel you get supported by the EPIC program? | 4.6 | 4.4 |

Likert Scale: 5=Strongly agree, 4=Agree, 3=Neither agree nor disagree, 2=Disagree, 1=Strongly disagree

In the fall of 2020 eleven of the fourteen respondents had met with their mentors. Students rated various aspects of the mentoring experience positively (Table 5), including support to complete their degree, support for career planning, and support provided by their mentor as a role model. All students wanted to continue with their mentor in the spring of 2021. Several commented that it was particularly helpful during COVID-19 and the online classes to have someone with whom to talk. "*This program helped me survive this weird semester online and I really appreciated this opportunity to gain not only a mentor but also a friend.*" One student described how the mentor pushed them to go to career fairs. One student provided details about all of the ways the mentor had helped with both current school work and for professional development:

> She offered me advice on current group projects and time management. She recommended books she used while she was a project manager that could be helpful to me. And she helped me present myself better through mock interviews and guiding me through creating a good resume. She also encouraged me to pursue a project I had in mind, helped me develop a prototype, and is currently reaching out to the CEO of an electric plane company who she is friends with so he can assist me too.

Students from both semesters had a few recommendations, including that the mentors should be responsible for reaching out, and there should be more time to meet the mentors participating. One student suggested that it was important for new mentees to be specific about their goals and their purpose for participating in the program during their elevator pitches. The student commented, "*I brought up how I was interested in being a project manager for engineers later in my career and that helped me connect with (the mentor), who is a recently retired project*

*manager*." Other suggestions included getting more students involved, building in social activities such as bowling or skating, or providing more organization.

*Epic Fail*:
No data were collected at the conclusion of the first *Epic Fail* event in spring 2020. In fall 2020, a survey was administered at the end of the fall *Epic Fail* with fifteen students responding. Of those who reported demographics, eight were male, and six were female, five identified as first-generation college students, and six identified as underrepresented minorities. Students identified that the *Epic Fail* seminar increased their understanding of the role of failure and belonging and perseverance in their field (Table 7). Students rated the event above average, 4.3 on a 5 point scale.

*Table 6: Epic Fail Events*

| | **Date** | **Number of Participants (during live event)** |
|---|---|---|
| *Epic Fail* | Mar. 2020 | 11 |
| *Epic Fail* and RECOVERY | Oct. 2020 | 32 |

*Table 7: After attending Epic Fail (Oct. 2020), N=15*

| I belong in my field | It is normal to fail in my field | I can learn from failure | I can persevere through failure | I can succeed in my field, even if I fail at times |
|---|---|---|---|---|
| 4.0 | 4.5 | 4.7 | 4.3 | 4.3 |

Likert Scale: 1=Much less than before, 2=Slightly less than before, 3=About the same, 4=Slightly more than before, 5=Much more than before

Students were asked what the most important thing they had learned from attending *Epic Fail*. Students identified that failure is normal and should not be feared, but rather is part of the learning process. Students also identified that failure comes from pushing yourself. As one student commented that they learned, "*I should allow myself to fail, otherwise I am holding myself back.*" Students also found failure stories from peers and faculty "*empowering and inspiring...I've already become familiar with growth mindsets and the like, but I was more so impressed with the ability of others to come forward with their failures.*" Another student also commented that it was important to realize that many have faced challenges. "*Just learning of others' experiences really helps let me know that I am not alone in the hardships I face and have to overcome.*"

Students were asked to suggest changes to improve the *Epic Fail* event. One student suggested lengthening the event time. A number of others suggested providing more time for interaction through a Q and A session and time for a discussion or for sharing.

**Discussion**

The intent of this evaluation was to determine if the EPIC program is meeting its goals through the implementation of its three initiatives, the Speaker Series, Mentorship Program, and *Epic Fail*, and make recommendations for improvement for future iteratives. Results from the speaker series showed that in general students were quite positive about the speakers, they appreciated seeing female role models, different careers, and research areas. Some speakers were outspoken about their own obstacles/struggles, which was noted as motivating. Ratings on the Speaker Series for creating an inclusive environment were consistently high ($\bar{X}$=4.7). Similarly, students rated it high in building excitement for their future engineering career ($\bar{X}$=4.3). Qualitative feedback included descriptions such as "*empowering*" and that it is "*okay to be yourself*". These initial findings suggest that the Speaker Series is supporting students' sense of belonging in the field as well as building their self-efficacy. The feedback recommended to keep diversifying invited speakers and their disciplines. Coding of responses supports the need for more content related to academic development and to provide examples of what speakers would do if they were struggling academically, such as going to tutoring sessions and office hours. The program should work with the speakers to make the seminars more engaging by using discussion prompts, more Q and A, and polls. The program could also benefit from choosing a consistent day and time combination for all Speaker Series to take place.

For the Mentorship Program, generally both mentors and mentees reported having positive experiences when there was a connection made between the assigned pairs. Some mentors appreciated being able to provide support to students during the pandemic and felt positive about being able to connect their mentee to internships and glimpses into the day-to-day of an engineering professional. Mentees who provided feedback were all positive about the Mentorship Program. When asked if their mentor made them feel confident in their ability to complete a baccalaureate in engineering, the average score was 4.8/5 and the average score for their mentor being a good role model was 4.9/5. This data supports that, at least for those students who responded, the mentorship experience positively influenced their confidence in their ability to successfully complete their degree. Moreover, based on findings in the literature, identifying mentors as good role models likely increased their self-efficacy and sense of belonging in engineering. The analysis from the first-year Mentorship Program feedback yielded that the program could benefit from assigning additional reporting responsibilities to the mentees other than the end of semester surveys. According to the director, one challenge in coordinating the Mentorship Program was that some students signed up initially, but never followed through despite personal contact from the mentors or the program's student worker. There was confusion

about who was to reach out to whom first, which was addressed in the introduction email as being the responsibility of the mentor. One creative solution to this problem could be group mentoring for shy or introverted students to initiate the connection, followed by individual mentoring meetings.

Moreover, survey results demonstrated that the mentorship program could use more structure. Previous experience with successful mentorship programs suggests a variety of ways to provide more guidance in a mentorship program. Mentors may be asked to complete a one-hour training session prior to becoming a mentor during which details of the handbook are covered, potential goals and objectives are outlined for the first few mentor-mentee meetings, and materials are reviewed that may help to reach those goals. Mentees may also be required to attend a short orientation to the program in order to be assigned to a mentor. During the orientation they would hear about the benefits of being mentored, receive a preview of potential mentors, hear of successful mentor-mentee experiences from past cohorts, and review the expectations for their participation. Expectations of both mentors and mentees could be reiterated in a signed agreement of participation and in the initial email communication that connects mentors and mentees. To continue to provide support, both mentors and mentees may be connected via a communication platform, such as Slack, where cross-collaboration and the sharing of ideas can occur between groups.

The feedback specific to the *Epic Fail* event revealed that students felt a slight increase in their belonging in their field and ability to persevere in the face of failure after attending. Qualitative data supported this in that some respondents used words like "*empowering*" and "*inspirational*" and they commented on feeling like they "*...aren't alone in the hardships [they] have to face.*" Together, the results support that *Epic Fail* has a positive influence on students' sense of belonging. Moving forward, participants would like more time devoted for discussion.

Initial results of the evaluation indicate that EPIC has been successful at making progress towards its goals of increasing self-efficacy and developing a sense of belonging. However, one must consider the number of students reached by EPIC in the early stages of implementation. With such a small portion of the college's students participating (<2%), are these efforts going to make a noticeable difference in the college's struggle with retention, particularly with URMs? The unforeseen impacts of COVID certainly played a huge role in the program's reach, but it is unknown if a significantly larger percentage of students will become active participants in the future. For EPIC to make a noticeable difference in retention for the college, an exploration of ways to get more students, faculty, administration, alumni, and industry partners involved is recommended. With that, if a more significant number of students join, how will that impact the quality of the programming with limited faculty and staff support? A question to consider when thinking of this is, "How does one compare quantity versus quality of the experiences created by the EPIC program?" A similar question was asked by Haynes et al. [52] for mentor-mentee

relationships for junior URM faculty and emeriti engineering faculty. Although the majority (70%) of their mentees met with their mentors less than once per month, they rated the quality of the mentoring experience very close to excellent (3.67/4). As the program grows, it may mean fewer, higher quality interactions and experiences through EPIC to reach the program goals. Alternatively, it may be fair to argue that instead of a 0.20 FTE and one part-time student worker, the program could require a full-time employee and multiple student workers in the future to move the needle on retention of students, and more importantly URMs, in the discipline.

**Limitations**

There are a number of limitations in this study. The EPIC program was implemented in the context of a medium sized university in the rural southwest. The results of the evaluation may not generalize to similar minority serving programs in engineering. As this program has only recently been implemented, sample sizes for feedback are relatively small for the Mentoring Program and *Epic Fail*. Long term data identifying student outcomes, such as retention to graduation, are not yet available. Moreover, feedback was completed on a voluntary basis and self-reported. Data may be skewed depending on those who opted to complete the surveys. Additionally, considerations were not made regarding the extent of student participation in various EPIC initiatives. It is possible that attendance at multiple events or participation in more than one initiative would have a different impact on student self-efficacy, sense of belonging, and/or retention than attendance at an isolated event.

**Conclusions and Future Work**

The purpose of the evaluation was to understand to what extent the EPIC program was meeting its goals and to identify areas for improvement. The initial evaluation of the program indicated that the initiatives put in place are working toward establishing a sense of belonging and self-efficacy in students. Students appreciated the inclusive environment being created. These initial results will be used to further refine the program, and to form the basis of adapting the new contexts for the program's main initiatives as the team continues to work toward establishing success for all students in engineering by providing an inclusive environment.

The program director will continue to implement and improve program initiatives, as ongoing feedback and reflection warrants. There are plans to continue to diversify the content focus of speakers invited to present in the Speaker Series. The level of interest students expressed in career development initiated a conversation between the program and a local engineering company to launch a professional development workshop series. The hope is to adopt more structure for the Mentorship Program and grow the numbers of mentors and mentees. The *Epic Fail* will continue to occur each semester and expand its reach by extending the invitation to partner universities and community colleges. All in all, the benefits of collaboration with other

campus programs are clear and the program director will continue to capitalize on these relationships in the future by further developing cross-listed activities. Additionally, the program realizes the advantage of synchronous and asynchronous virtual events to expand the ability of those at a distance and/or with schedule conflicts to participate. The plan is to continue to do so, but also provide opportunities for hybrid and in-person participation for students on-campus, as conditions warrant.

To address some of the limitations identified, future work may include other forms of data collection, including but not limited to focus groups with those who leave EPIC, collection of identifying information to review levels of participation, or comparative analysis of persistence between participants and matched non-participants. The next phases of this project will be 1) to cross-analyze retention data and 2) to identify a sample population of students to invite for in-depth interviews about their experience in the program. To determine the long-term impact of the EPIC program, evaluators would need to conduct a longitudinal study through the URM students' progression and post-graduation.

Overall, the evaluation of EPIC identified positive program results, thus suggesting that other programs with a limited budget may implement similar strategies for underrepresented groups within engineering colleges in order to improve the culture in engineering programs. In turn, the URM students may show an improved sense of belonging, self-efficacy, and retention.

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