

## **Board 388: S-STEM: Creating Retention and Engagement for Academically Talented Engineers—Lessons Learned**

### **Dr. Indira Chatterjee, University of Nevada, Reno**

Indira Chatterjee received her M.S. in Physics from Case Western Reserve University, Cleveland, Ohio in 1977 and Ph.D. in Electrical Engineering from the University of Utah, Salt Lake City, Utah in 1981. Indira is currently an Associate Dean in the College of Engineering and Professor of Electrical and Biomedical Engineering at the University of Nevada, Reno.

### **Miss Kelsey Scalero, University of Nevada, Reno**

Kelsey is a doctoral student in the School of Engineering Education at the University of Nevada, Reno. There she completed her Bachelor's and is working on her Master of Science in mechanical engineering. Her research focuses are on undergraduate engine

### **Dr. Ann-Marie Vollstedt, University of Nevada, Reno**

Ann-Marie Vollstedt is a teaching assistant professor for the College of Engineering at the University of Nevada, Reno (UNR). Dr. Vollstedt completed her dissertation at UNR, which focused on exploring the use of statistical process control methods to assess course changes in order to increase student learning in engineering. Dr. Vollstedt teaches courses in engineering design as well as statics and runs the Engineering Freshmen Intensive Training Program. She is the recipient of the Paul and Judy Bible Teaching Excellence Award, F. Donald Tibbitt's Distinguished Teaching Award, The Nevada Women's Fun Woman of Achievement Award, and the UNR College of Engineering Excellence Award.

### **Dr. Julia M. Williams, Rose-Hulman Institute of Technology**

Dr. Julia M. Williams is Professor of English at Rose-Hulman Institute of Technology. Her research areas include technical communication, assessment, accreditation, and the development of change management strategies for faculty and staff.

### **Dr. Adam Kirn, University of Nevada, Reno**

Adam Kirn is an Associate Professor of Engineering Education at University of Nevada, Reno. His research focuses on the interactions between engineering cultures, student motivation, and their learning experiences. His projects involve the study of studen

# **S-STEM: Creating Retention and Engagement for Academically Talented Engineers – lessons learned**

## **INTRODUCTION**

This paper discusses the lessons learned and findings from formative assessment of the first four years of a five-year National Science Foundation S-STEM project entitled “Creating Retention and Engagement for Academically Talented Engineers (CREATE)”. The project is located in the College of Engineering of a large western land-grant university and has retained 26 of the original 32 students (referred to as scholars) who were selected to be part of two cohorts of 16 each. The scholars were selected from a pool of applicants based on academic talent and financial need. Six new scholars replaced the ones who left, with a current total of 32 scholars in the program. Current scholars identify as 21 male, 11 female, 18 white, 8 Hispanic, 1 Black, and 5 Asian. Program numbers mirror similar enrollment trends to the College with the following exceptions: higher female and students of color enrolled. The first cohort of sixteen scholars have completed seven semesters at the university and the second cohort of sixteen scholars have completed five semesters at the university. When retention percentages are compared to the general population in the College of Engineering (includes full-time and part-time students; data obtained from Institutional Analysis), CREATE shows much better retention. Cohort 1 is 93.8% while the general is 85.8%. Cohort 2 is 94.1% while the general is 73%.

## **LESSONS LEARNED**

After formative evaluation on four years of running the CREATE program, and based on qualitative data collected during focus groups conducted every semester, as well as a site visit by the external project evaluator, we have identified findings and lessons learned to date:

***Program persistence:*** The two program cohorts began one year apart, with the second cohort starting during COVID-impacted operations and instructional modes. Our cohort persistence data indicates that 1) retention of students in both cohorts are both in the range of 94%, although 2) broader persistence numbers for the College of Engineering dropped from 86% to 73% over this same period. This suggests that the CREATE program has successfully mitigated potential negative impacts that remote instruction and other pandemic-related impacts may have had on student success.

***Theme seminars and support services:*** CREATE has contributed to development of scholars as engineers via the information they have learned at the theme seminars that are required of the CREATE scholars. Based on faculty mentor meeting reports, all the scholars seem happy with the program and the support services provided. They felt that CREATE has been offering them opportunities that will make them successful in their degree attainment and career goals. Over the four years of running this program, these seminars have remained useful to scholars in terms of creating a sense of community and providing access to information. An important feature of the seminar topics is that they were selected to be most relevant to where scholars were in their program. Focus group data was also used to design future seminars as scholars identified specific areas they wanted exposure to, such as goal setting and an industry panel.

***Peer and faculty mentors:*** Based on the input we have obtained from the focus groups, the scholars said they greatly benefited from their interactions with their faculty and peer mentors. However, for cohort 1, we also see that there has been a decrease in the value of the peer mentor relationship and a growth in valuing the faculty mentor relationship. Scholars are now perceiving the benefits

of interacting with their CREATE faculty mentors especially for guidance on internships, undergraduate research, job opportunities, and graduate school. As cohort 1 peer mentors are now on the same graduation trajectory as their mentees, during the fall 2022 semester, peer mentoring was discontinued for cohort 1 and more focus has been placed on faculty mentoring. CREATE peer mentors were vital to the scholars during the first two years, but the mentorship program would benefit from some small changes: (i) CREATE could have provided more training to the peer mentors on how to support scholars' personal challenges; (ii) CREATE could have assigned fewer scholar mentees to their peer mentors; (iii) Matching scholars' majors to peer mentor majors and updating the questions that peer mentors asked their mentees were also suggested by mentors and mentees.

**Goal Setting:** Scholars' goals have become more defined in the later years through a mentoring process that asks scholars about their goals and examines progress toward those goals. The emphasis on goals was initiated through focus group data in which scholars described lacking clarity for future goals and being unsure in how to start thinking about and setting them. After implementing a goals workshop, a goal survey has been administered every semester and its results used in faculty mentoring meetings. In the focus groups several scholars mentioned that these were very helpful in that they made them think deeply about their goals and how to achieve them.

**Undergraduate research opportunities:** Undergraduate research funded by the CREATE program has been very well received by both scholars and their faculty research mentors. A total of sixteen scholars were placed in laboratories of engineering professors who indicated interest in giving them a research experience. An evaluation was conducted on scholars' performance and all research mentors deemed that their scholars had participated satisfactorily. Some scholars have decided to pursue graduate school based on these experiences.

**Career and graduate school guidance:** CREATE may have given information on careers and graduate school a bit too early in the program to the second cohort and hence sequencing the timing of theme seminars could have been improved. However, many scholars from both cohorts have garnered internships. A survey was conducted by the PI team on participation in internships, undergraduate research, and other jobs, both on campus and outside. Fourteen scholars reported having industry internships during summer 2022, and six during fall 2022.

**Intrusive advising:** is being conducted by College of Engineering Director for Student Success and scholars say this is helpful in keeping them academically on track.

**Engineering Education Research:** The mixed methods engineering educational research study that is part of the CREATE program has involved collecting quantitative survey and qualitative focus group data every semester and has resulted in several publications/presentations [1 – 5].

Specific impacts to date on the field of engineering education research are as follows:

- a. Recognition and relationship to engineering identity: Results from the project indicate that within the first two years, scholars narrowed down whose recognition of them as engineers or potential engineers mattered to them. This was based on the source's knowledge of engineering and experience in the field. Also, those scholars whose family did not have an understanding of what engineers do seemed to value that their family thought of them as engineers. This contribution towards understanding how students value recognition sources can lead to redesign of educational environments that support engineering identity development.
- b. Aspects of the pandemic-related remote engineering education environment that either support or fail to support undergraduate engineering identity development

were studied via the project focus groups. Scholars identified both the role of physical spaces and social interactions as being influential in development of engineering identity. Our results speak to the existing literature on remote engineering education with the added new perspective of identity development.

- c. We are exploring how scholars' performance/competence beliefs change as related to development of engineering identity. This will lead to design of engineering educational environments that are conducive to engineering identity development.
- d. The combined results from our work help point to the ways engineering curriculum can support and sustain identity development throughout the time it takes students to graduate.
- e. We are exploring how scholars' engineering interests change and how they make related enrollment decisions. This allows us to understand how to best support students as they develop individual engineering identities and to understand when certain changes happen so future support can be timely.
- f. We are exploring how cohort scholars' access and use social capital. Preliminary work highlights that membership in the cohort and relationship with the faculty and peer mentors act as expressive capital or emotional support. Access to instrumental capital or resources seems to be accelerated through involvement in CREATE.

## **CONCLUSIONS**

The qualitative data gathered to date via focus groups at the end of each semester are strongly indicating that the CREATE program has had a strong influence on the educational experience of the scholars who have been retained in the CREATE program and their degree programs. The opportunities and resources presented to the scholars via the theme seminars, and postings in Web Campus on engineering career fairs, internships, industry panels, research opportunities, K-12 outreach opportunities, student clubs, engineering seminars, study abroad opportunities, etc. have been deemed to be very helpful in enriching the scholars' educational experiences. In addition, the goals workshop, and follow-up goals survey each have been deemed very helpful in enabling scholars to think deeply about their goals and what they are doing to pursue those goals. The co-curricular activities are definitely emerging as an important aspect of the scholars' engineering educational experience. Scholars have specifically said that if it were not for CREATE making these opportunities and resources available to them, they would not have known about them or sought them out. In addition, the intrusive advising and tutoring provided by CREATE has helped scholars academically stay on track. Meetings with peer and faculty mentors have also been mentioned as being very helpful.

## **ACKNOWLEDGEMENTS**

The authors acknowledge funding from the National Science Foundation S-STEM program, grant number DUE-1833738. The Institutional Review Board of the University of Nevada, Reno has approved all procedures. They also wish to thank members of the management team, Ivy Chin, Joe Bozsik, and Marrison Markee for their invaluable participation in the project.

## REFERENCES

1. K. Scalaro, I. Chatterjee, A-M. Vollstedt, J.L. Lacombe and A. Kirn, “A two-step model for the interpretation of meaningful recognition”, Proceedings of the 2021 ASEE Annual Virtual Conference, July 26-29, 2021.
2. K. Scalaro, I. Chatterjee, A-M. Vollstedt, J.L. Lacombe, A. Kirn, “Is this the real life? Exploring how virtual learning environments influence engineering identity”, Proceedings of the Frontiers of Engineering Conference, 2021, October 13-16, 2021, Lincoln, Nebraska.
3. K. Scalaro, I. Chatterjee, A-M. Vollstedt, J.L. Lacombe, A. Kirn, “From knowledge to doing: Changes in performance/competence beliefs of developing engineers”, Proceedings of the 2022 ASEE Conference & Exposition, June 26 – 29, 2022, Minneapolis, MN.
4. K. Scalaro, I. Chatterjee, A-M. Vollstedt, J.L. Lacombe, A. Kirn, “Engineering interests dynamic major pathways”, Proceedings of the 2023 ASEE Conference & Exposition, June 24 – 28, 2023, Baltimore, MD.
5. K. Steinhorst, R. Young, K. Scalaro, I. Chatterjee, A-M. Vollstedt, J. C. LaCombe, and A. Kirn, “Creating social capital: Developing resources in a cohort program”, abstract submitted to the 2023 ASEE Conference & Exposition, Baltimore, MD, June 2023.