BOARD # 319: Academic Persistence and Graduation of S-STEM Scholars at MSOE and Their Career Pathways into STEM Workforce

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Dr. Subha Kumpaty, a Professor of Mechanical Engineering, has led several initiatives involving undergraduate students, such as Research Experiences for Undergraduates, International Research Experiences for Students and S-STEM. He has been the Principal Investigator of REU, IRES and S-STEM grants, all funded by the National Science Foundation This work is part of the S-STEM grant funded by the National Science Foundation (Grant No. DUE-2027632).

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Mohammad Mahinfalah earned his Ph.D. from Iowa State University in 1988 and is a distinguished educator and a fellow of ASME. He is currently a professor and program director of Mater of Science in Engineering at the Milwaukee School of Engineering (MSOE). Mahinfalah has more than 30 years of experience with the impact of composites, solid mechanics, and experimental mechanics. He has been recognized for his teaching excellence by three different universities. Prior to joining the faculty at MSOE, Mahinfalah served as a faculty member at North Dakota State University (NDSU) for 19 years.

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Dr. Jan Fertig is a professor in the Humanities, Social Science, and Communication Department at the Milwaukee School of Engineering (MSOE), where she has taught sociology, psychology, and addictions for over 20 years. She was recently awarded MSOE's prestigious Karl O. Werwath Applied Research Award for her ongoing research on diversity in engineering education and currently collects data as Co-Principal Investigator on the National Science Foundation-Funded S-STEM Grant (Grant No. DUE-2027632).

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Judith Eroe retired in 2022 after 35 years at Grand Canyon University. She taught German and ESL before becoming the Executive Director of Assessment. She continues to work as an Assessment Mentor for the Higher Learning Commission, as well as an External Evaluator for the Milwaukee School of Engineering's NSF grant REU and S-STEM Scholar programs.

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Introduction

DUE-2027632, the first NSF S-STEM grant to Milwaukee School of Engineering (MSOE), *Scholarships to Support Retention, Academic Success, and Career Pathways in Mechanical Engineering* (October 2020- September 2025) is in its final year supporting 19 engineering undergraduate students with four-year scholarships. The project provides financial, academic, and engineering identity and self-efficacy support through scholarships, faculty advisor mentoring and academic advice, academic coach interaction to support goal setting and holistic growth, peer mentoring and study table interactions, industry tours and seminars/webinars, quarterly kickoff workshops to address the needs of each cohort, career enhancement support through summer internship and research experiences, and an annual meeting with presentations by each scholar on their summer experiences along with various review sessions by faculty advisors and the STEM team preparing students for the new school year.

By the fourth year of the grant (September 2024), ten scholars have graduated and this paper discusses salient features of their academic success and career pathway. Another graduated in December 2024. Most of the remaining eight scholars are poised for successful completion in Spring 2025. Of the 19 STEM scholars, 63% are from underrepresented minorities, and 32% are women. The most interesting note is 53% of the cohort are from states other than Wisconsin and the neighboring Illinois. This paper showcases the high-impact practices that enabled growth of STEM identity, academic persistence and graduation. Salient observations and lessons learned are provided as pointers for other educators seeking to invest in the academic success and career enhancement of undergraduate STEM population. Both quantitative and qualitative results show the successful implementation of evidence-based strategies, the academic persistence of S-STEM scholars and their career transition into STEM workforce.

Table 1 provides a quick overview of the placement of 11 scholars in engineering positions and some unique experiences they have had during the academic program. Internships and research opportunities are discussed in subsequent sections along with specific observations and lessons.

Table 1. List of S-STEM Scholars and their Placement in STEM fields upon Graduation

Scholars	Graduation Date	Internships	Research Opportunities	Current Placement
Scholar 1 ED	May 2022	MSOE Raider Center for Academic Success	Additive Manufacturing research at MSOE (REU) led to ASME publication	Provisur Technologies
*Scholar 2 KM	May 2023	Johnson Controls	MSOE Fluid Power Institute Research Project at Stellenbosch University, South Africa	Johnson Controls
Scholar 3 AW	May 2024	Ingeteam	Georgia Tech Advanced Manufacturing REU	Ingeteam
Scholar 4 NK	May 2024	AGM Technology, Clarios	Rochester Institute of Technology REU Purdue Univ REU	Clarios- Li-Ion Mechanical team
Scholar 5 CB	May 2024	Beach Works		Provisur Technologies
Scholar 6 SD	May 2024	Midwest Engineered Systems		Midwest Engineered Systems

Scholar 7 UT	May 2024		Summer research at Univ of South Florida	Serac, Inc.
Scholar 8 SM	May 2024	Viking Masek Robotics and Automation	Summer Research at Univ of South Florida	Viking Masek Robotics and Automation
Scholar 9 BJ	May 2024	Thermo Systems	REU at Marquette University	**Graduate School** MSOE Fluid Power
Scholar 10 CR (completed in 3 years)	May 2024			**Graduate School** Marquette Univ MSME
Scholar 11 IC	December 2024	Global Power Components		Global Power Components

*Study Abroad: Lübeck University of Applied Sciences

Mentoring

Mentoring is key to growth and development of an individual, providing professional and psychological support and is personal and reciprocal in nature [1-3]. It fosters a sense of belonging in STEM that is integral to academic and career success and is widely used by S-STEM programs nationally [4]. Scholar 1 was a junior and when he approached to help the STEM program towards the end of the academic year, he was recruited for summer REU on another grant from NSF. The work resulted in ASME publication at its international mechanical engineering congress. He was recruited as a STEM scholar during his senior year and was a great mentor to the cohorts. And once peer mentoring was enabled by the success coach and the entire STEM administration, the first cohort was able to help the second cohort both from group to group and from one to another. S-STEM cohorts participated in weekly study groups; tutoring and mentoring by peers increases students' metacognitive skills, as was experienced in our STEM program. Comments on one-on-one meetings with faculty advisors have always been affirming their critical value.

"I was motivated to make the most of school and since the faculty adviser meetings, I have greatly improved academically and mentally".

"The meetings with faculty adviser helped me to stay motivated to do better in my academics and stay focused during online classes".

Undergraduate Research Experiences

Engaging undergraduates through research has been one of the long standing high-impact practices identified in the literature [5] which promotes communication, teamwork and leadership skills [6]. Kumpaty et al. [7] had established collaboration, synergy, progression and perseverance as key ingredients for successful undergraduate research. Advising of REU students has resulted in many publications with student authorship; cited samples are one from the 2024 National Conference on Undergraduate Research [8], one Scholar 1 coauthored [9], and one from S-STEM grant that had an international research experience in which Scholar 2 participated [10]. Scholar 2 was willing to go due to prior experience of study abroad in Lubeck, Germany while most scholars were unwilling to step outside of the United States.

Participation in Research Experiences for Undergraduates (REU) program has occurred for our STEM scholars at Georgia Tech (Scholar 3), Purdue University (Scholar 4), University of South Florida (Scholars 7 and 8), Rochester Institute of Technology (Scholar 4), and Marquette University (Scholar 9).

Internships and Jobs

Internships are an avenue for work-based learning and are found to produce self-regulation, self-realization and self-direction in the participants [11]. There is a lot of research on internships to be designed with careful attention as mentored learning spaces for effectiveness and satisfaction [12]. It is typical students would like internship as a stepping stone for future employment. In the case of most STEM scholars, we found internships were preferred over research experiences.

Scholar 8, who overcame many familial challenges and persisted in her academic pursuit, graduated with honors and was hired full-time at Viking Masek Robotics and Automation, the company she had been interning for two years. The object lesson from this example to the remaining STEM scholars and the STEM administration is that internships performed well often lead to full-time positions. In fact, this was a reality for six scholars of the 11 listed in Table 1.

Another remarkable observation is the geographical diversity in STEM occupation. Scholar 3 is from Georgia and Scholar 5 is from Arkansas, and they are working and settling in Wisconsin upon graduation from MSOE. The S-STEM scholars at MSOE are not all WI students but are from various states, and they are flourishing in WI job market as well.

Graduate School
Scholar 9 has grown through this program quite steadily. He overcame early struggles with study habits, time management, and exam preparation and completed the degree program with maturity and great experiences including REU at Marquette and internship at Thermo Systems. He is in graduate study pursuing master of science in engineering at MSOE since Fall 2024 and working as a graduate assistant at MSOE Fluid Power Institute. Scholar 10 completed his BS in record time requiring STEM scholarship only for three years and started his graduate study in mechanical engineering at Marquette University in Fall 2024. He worked closely with Dr. Mahinfalah, S-STEM PI and ME Program Director to strategically arrange his coursework in the midst of the quarter-to-semester system conversion and amazingly completed his degree within 3 years.

Study Abroad
Besides Scholar 2, two more scholars (Scholars 12 and 13) in the current cohort have participated in Study Abroad at Lübeck University of Applied Sciences. They spent their junior year in Germany and will complete their senior year at MSOE. When they graduate, the receive a diploma from abroad as well as they complete a final year thesis for submission to Lübeck University of Applied Sciences. These scholars participated in S-STEM activities over MS Teams while stationed abroad.

Current cohort – Remaining 7 scholars
Table 2 provides certain features of the remaining scholars currently attending the University.

Table 2. STEM Scholars currently in the program

Scholar	Features
Scholar 12	Study Abroad
Scholar 13	Internship at Federal Manufacturing Study Abroad
Scholar 14	Industrial Engineering Major Internship at Blattner Energy; Internship at GE Health Care
Scholar 15	Internship at Komatsu Mining
Scholar 16	Internship at Chief Enterprises; Internship at Beachworks
Scholar 17	Fluid Power Vehicle Challenge (winner)
Scholar 18	Changed major to Architectural engineering and construction management; so graduation delayed
Scholar 19	Food processing intern at Johnsonville Junior; late entry into STEM programs; senior in 2025-26

The persistence record of these cohorts is attributed to the fact that scholars are growing in their engineering identity and dedicated S-STEM personnel are providing guidance and encouragement to the scholars to not only complete the degree but also move into STEM workforce.

Qualtrics Survey Data and Results
Several results of Likert scale responses on events are provided (one sample below). The scale was set giving 5 for Strongly Agree (Strongly Disagree-1, Moderately Disagree -2, Neutral-3, Moderately Agree-4, and Strongly Agree-5).

KOMATSU CORPORATION TOUR
The event was relevant to my career goals. 3.85
The event gave me tools that will enhance my overall academic success. 3.31
I'd recommend this event to other ME students. 4.08

On the Komatsu Corporation tour, one student wrote, *"The visit was a fun and unique experience. I have never actually visited a company like that before, and it really helped me understand what a mechanical engineer does in the field".*

The research results on ME persistence have been shared among the stakeholders and engineering educators. Results have been disseminated in peer reviewed papers published in ASME and ASEE proceedings and at an AAC&U conference [13-17].

External Evaluator's Summary: The S-STEM project at the Milwaukee School of Engineering continues to offer a robust and rigorous opportunity for an underrepresented population to matriculate, retain, and persist in a rewarding and productive program of study and future career. The advantages extend from the individual to the greater society. The project outcomes are translatable to other disciplines and populations, informing achievement and success. The Year 4 Annual Report gives evidence of these accomplishments and lays the groundwork for the final year.

Conclusion
The S-STEM project is impacting financially disadvantaged students, providing them social mobility upon completion of the degree. Eleven who have graduated so far are in STEM careers, two in graduate school and nine in industry. Excellence in diversity and inclusion is demonstrated by the group's composition. High-impact practices in a strongly mentored environment are showing positive results in self-efficacy and preparation of a solid STEM workforce.

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