The Future of
Engineering Education
2024 Annual Conference & Exposition

Oregon Convention Center
Portland, OR . June 23 - 26, 2024

ASEE

Paper ID #43377

Board 264: Enhancing Sense of Belonging among Engineering and Artificial Intelligence Students: First Insights from the NSF S-STEM Grant in Community College

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I hold a Bachelor's degree in Aerospace and Mechanical Engineering from ESTACA, France, followed by a Master's degree in Mechanical Engineering at Polytechnic Montreal, QC, Canada. My Master's research focused on the innovative design and testing of a dynamic frame tailored for spine surgeries.

With a background enriched by five years of service as a Research Assistant at the orthopedic research laboratory in Sacre-Coeur Hospital in Montreal, I contributed to biomechanical investigations pertaining to prosthesis advancements for the hip, shoulder, and elbow.

Since 2018, I served as an engineering faculty at Chandler-Gilbert Community College. In this role, I have been delivering comprehensive instruction across a spectrum of courses including Introduction to Engineering, Engineering's Societal Impacts, Statics, Dynamics, and Computer-Aided Design (CAD), thus fostering a dynamic learning environment for aspiring engineers.

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Erika DeMartini is an aspiring professional in the field of Artificial Intelligence (AI) and Machine Learning (ML), currently pursuing undergraduate studies focused on these disciplines. During their academic journey, she has been actively engaged in research endeavors, exploring various facets of AI and mathematical modeling. Currently, Erika serves as a Grant Coordinator for an NSF-funded scholarship program at Chandler-Gilbert Community College, facilitating opportunities for aspiring engineers and AI professionals.

Title: Enhancing Sense of Belonging and Academic Integration among Engineering and Artificial Intelligence Students: First Insights from the NSF S-STEM Grant

Context

Chandler-Gilbert Community College (CGCC) is a 2-year institution serving 12,000 students (registered in varying certificates, AS and AAS degree programs) located in Arizona, and is one of 10 in the Maricopa County Community College District (MCCCD). The engineering program was created in 2001 with approximately 20 students enrolled in this program. Today, 512 students are enrolled in the Associates of Science (AS) and Associates of Applied Science (AAS) degree programs in engineering as of Spring 2024. The Artificial Intelligence and Machine Learning (AIM) program was created in 2020 and 61 students are enrolled in the program as of Spring 2024. In 2021, Arizona became the 24th state to allow community colleges to expand program offerings to bachelor-level programs (SENATE BILL 1453: Community colleges; four-year degrees, 2021). CGCC has been approved by MCCCD to offer our first Bachelor's degree in Artificial Intelligence and Machine Learning scheduled to launch in the Fall 2025.

The National Sciences Foundation (NSF) awarded a second track S-STEM grant to CGCC to support engineering, and artificial intelligence students called Scholarships, Mentoring, and Professional Support to Improve Engineering & Artificial Intelligence Student Success at Community Colleges. The grant program started in Fall 2023 with a cohort of six students, continued in Spring 2024 with 14 recipients and will serve at least 48 students until 2028. This grant, entitled Reaching Engineering and Artificial Intelligence Career Heights (REACH), empowers students with scholarships, personalized academic mentoring, and industry-oriented activities.

A sense of belonging in college involves students feeling embraced, connected, and included within the college environment, where they are valued, acknowledged, and supported by peers, teachers, and staff. (Ovink, 2024) A higher sense of belonging is associated with higher grades and the students are more likely to stay in college. (Walton, 2007) Also, students' sense of belonging plays a factor in their mental health, retention, and completion and encourages connection in their program of study. (Allen, 2022)

At the University of Maryland, Professor Gurganus in collaboration with the psychology department developed a survey that includes 19 measurable items to assess Science Identity, Expectations and Goals, Academic Integration, and Sense of Belonging to the program and the college. The surveys were completed by 60 students, including 26 S-STEM recipients. The results show that S-STEM students have a significantly larger sense of belonging to the mechanical engineering program and the Baltimore campus. S-STEM students seem to have a stronger sense of being able to integrate academically more easily. No significant differences were noted for science/engineering Identity or Expectations and goals. (Gurganus, 2019)

This preliminary study delves into the sense of belonging to the STEM field, engineering and AIM programs, CGCC, and the academic integration of the S-STEM REACH recipients compared to their peers.

Methodology

An online survey was submitted to CGCC students across six courses: three engineering courses, one AIM course, one chemistry course, and one physics course. At least one REACH student was enrolled in at least one of the six courses. The survey adapted from the University of Maryland S-STEM survey (Gurganus, 2019) was comprised of 20 questions gathering demographic and academic data (gender, race/ethnicity, program, and attending semester), categorized into sciences identity, expectations and goals, academic integration, sense of belonging to the program, and sense of belonging to the campus. Unpaired t-tests, with significance set at $p \leq 0.05$, were utilized to compare the responses of five REACH students with 58 of their peers.

Following are the questions organized by categories:

Demographic and Academic

- Are you a REACH recipient?
- What is your gender
- What is your race/ethnicity?
- Which Semester are you at Chandler-Gilbert Community College?

Sciences identity
- I have a strong sense of belonging to the community of engineering or AI
- I have come to think of myself as an 'engineer or AI scientist'
- I feel like I belong in the field of engineering or AI
- The daily work of an engineer or AI scientist is appealing to me

Expectations and Goals

- I am confident that I will achieve my career goal
- I am confident that I will achieve my academic goal
- I expect to feel comfortable going to the faculty if I have a problem

Academic Integration

- Understand what your professors expect of you academically
- Develop effective study skills
- Adjust to the academic demands of college
- Manage your time effectively
- Develop close friendships with other students

Sense of belonging with the program

- I feel a sense of belonging with STEM-oriented program, organization or community at Chandler-Gilbert Community College (e.g. SHPE, SWE, NSBE, etc.).
- I feel a sense of belonging to a STEM major at Chandler-Gilbert Community College
- I feel a sense of belonging to the Physical Sciences and Engineering Division at Chandler-Gilbert Community College

Sense of belonging to the college

- I feel a sense of belonging to Chandler-Gilbert Community College

- I feel that I am a member of the Chandler-Gilbert Community College campus
- I feel comfortable on Chandler-Gilbert Community College campus
- I would choose Chandler-Gilbert Community College over again
- Chandler-Gilbert Community College is supportive to me

Results

Sixty-three students opted to complete the survey, comprising five REACH students and 58 of their student peers. Students are enrolled in AAS, Engineering Technology (1 REACH, 1 peer), AAS, Artificial Intelligence and Machine Learning (2 REACH, 3 peers), AS, Emphasis in Engineering (2 REACH, 30 peers), and 24 were not enrolled in one of those degrees.

Table 1: Academic degrees of the students

	Students Surveyed by Degree	
	REACH	Peer
AAS, Engineering Technology	1	1
AAS, Artificial Intelligence and Machine Learning	2	3
AS, Emphasis in Engineering	2	30
Undecided	0	24
Total	5	58

Twenty females (2 REACH, 19 peers), 41 males (3 REACH, 38 peers), and one binary student (peer) in their first to sixth semester at CGCC filled out the survey. Even if the amount of students is ten times larger for the peers than for the REACH recipients, the repartition of men/women is similar in both populations (REACH 60%/40% vs Peers 67%/32%). Among those total students, 7 identified as Asian (peers), 2 as black or African American (peers), 11 as Hispanic or Latino (2 REACH, 9 peers), 39 as White (3 REACH, 36 peers), and 4 as Other (peers).

Figures 1 and 2: Gender and Ethnicities of the students
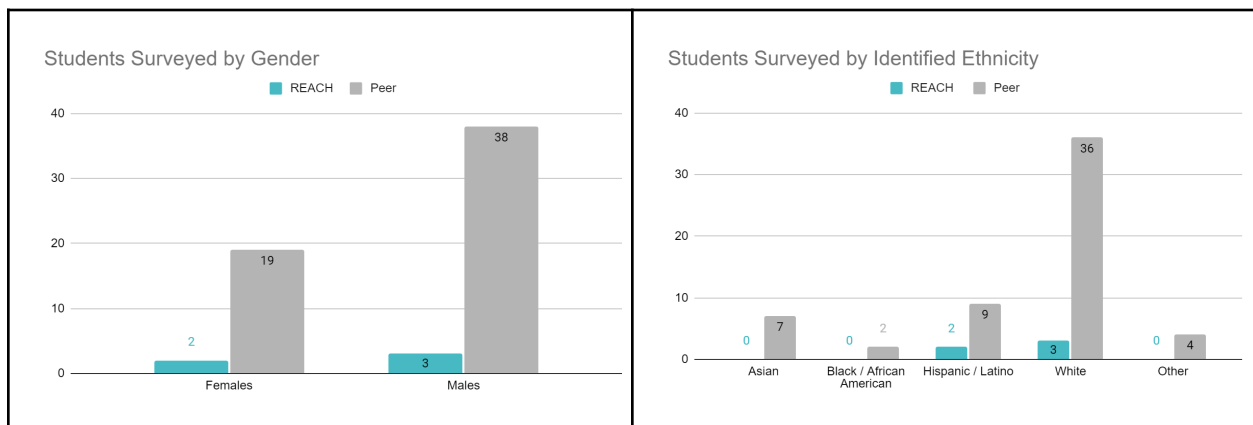
Sciences Identity

In the category of Sciences Identity, REACH students demonstrated a significantly stronger sense of belonging compared to their peers. Specifically, REACH recipients feel a stronger sense of belonging to their disciplines (Engineering or Artificial Intelligence and Machine learning). S-STEM students and the work as an engineer or AI specialist is more appealing to them.

Table 2: Sciences identity scores

	REACH Scholars	Peers	p
I have a strong sense of belonging to the community of engineering or AI	4.40	3.47	*0.017
I have come to think of myself as an 'engineer or AI scientist'	3.80	3.22	0.095
I feel like I belong in the field of engineering or AI	4.60	3.71	*0.032
The daily work of an engineer or AI scientist is appealing to me	5.00	3.98	*0.011

No significant difference was noted for the science identity answers between men and women.

Expectations and Goals

S-STEM scholars and their peers are similarly confident in achieving their academic and career goals.

Table 3: Expectations and Goals scores

	REACH Scholars	Peers	p
I am confident that I will achieve my career goal	4.40	4.36	0.454
I am confident that I will achieve my academic goal	4.80	4.34	0.091
I expect to feel comfortable going to the faculty if I have a problem	4.60	4.16	0.155

No significant difference was noted in the expectations and goals answers between men and women.

Academic Integration

Concerning academic integration, REACH students identified areas that require attention. Notably, they significantly understand less what professors expect from them. They also show difficulties developing effective study skills, adjusting to the academic demands, and managing their time effectively. Academic Integration is the only category where REACH students scored less than their peers.

Table 4: Academic Integration scores

	REACH Scholars	Peers	p
Understand what your professors expect of you academically	1.20	2.00	*0.025
Develop effective study skills	2.00	2.14	0.374
Adjust to the academic demands of college	1.80	1.97	0.333
Manage your time effectively	2.20	2.21	0.493
Develop close friendships with other students	2.80	2.55	0.289

No significant difference was noted in the academic integration answers between men and women.

Sense of Belonging to Engineering and AIM

To all the questions relative to the sense of belonging to the program, there was no difference between the REACH students and their peers.

Table 5: Sense of belonging to Engineering and AIM disciplines scores

	REACH Scholars	Peers	p
I feel a sense of belonging with STEM-oriented program, organization or community at Chandler-Gilbert Community College (e.g. SHPE, SWE, NSBE, etc.).	3.80	3.34	0.172
I feel a sense of belonging to a STEM major at Chandler-Gilbert Community College	4.20	3.66	0.136
I feel a sense of belonging to the Physical Sciences and Engineering Division at Chandler-Gilbert Community College	3.80	3.17	0.129

No significant difference was noted in the sense of belonging to their disciplines' answers between men and women.

Sense of Belonging to Chandler-Gilbert Community College

To all the questions relative to the sense of belonging to the college, there was no difference between the REACH students and their peers except one. Furthermore, REACH students reported a significantly stronger sense of belonging to Chandler-Gilbert Community College compared to their peers.

Table 6: Sense of belonging to Chandler-Gilbert Community College scores

	REACH Scholars	Peers	p
I feel a sense of belonging to Chandler-Gilbert Community College	4.60	3.78	*0.046
I feel that I am a member of the Chandler-Gilbert Community College campus	4.60	3.71	0.057
I feel comfortable on Chandler-Gilbert Community College campus	4.60	4.22	0.219
I would choose Chandler-Gilbert Community College over again	4.80	4.26	0.115
Chandler-Gilbert Community College is supportive to me	4.80	4.14	0.057

Women feel significantly more comfortable on campus (women 4.6 vs men 4.1, $p=0.04$) and find CGCC more supportive of them (women 4.5 vs men 4.1, $p=0.04$).

Conclusion: The REACH initiative at CGCC has notably enhanced the sense of belonging and connection to the college among engineering and AIM students. While REACH students showed superior community affiliation, they identified areas for academic integration enhancement. In Spring 2024, online workshops focusing on study skills and time management for online learners are highly encouraged for REACH students to address these concerns. The workshops are provided at no cost to CGCC students on the platform: www.college2success.com and include: "Online Courses: Staying Motivated & Disciplined", "10 Tips For Success In Your Online Course", "Study Tips & Note-Taking Strategies". After completing one of the workshops, the students are invited to fill out an action plan that includes 4 points of reflection: Overcome challenges, Establish a schedule, Know your instructor, and Break large tasks into smaller chunks. In the next semesters, a question will be added to the survey to assess the impact of taking those workshops on the academic integration scores.

This preliminary study includes only five REACH students and 58 of their peers. The sample size is a limitation to this analysis, particularly as the scholarship program is in its early stage and data is solely available from the inaugural cohort. Even if the gender repartition is similar in both groups, a larger sample size of REACH students that is to come from subsequent cohorts is needed to confirm the impact of the S-STEM program on the sense of belonging to the Engineering and AIM disciplines. As the program expands in 2024, and until it ultimately reaches its goal of including 24 REACH students per semester, continued assessment and support mechanisms will foster a more inclusive and integrated academic environment.

References

Allen, K.-A. (2022, February 9). A Deep Dive Into the Benefits of School Belonging. Retrieved from Psychology Today: https://www.psychologytoday.com/us/blog/sense-belonging/202202/deep-dive-the-benefits-school-belonging

Gurganus, J. R. (2019). Work in Progress: NSF S-STEM Program: Recruitment, Engagement, and Retention: Energizing and Supporting Students with Diverse Backgrounds in Mechanical Engineering., (pp. Board 103 10.18260/1-2--32172). Tampa, Florida.

Ovink SM, B. W. (2024). Figuring out your place at a school like this: "Intersectionality and sense of belonging among STEM and non-STEM college students. *PLoS ONE,* 19(1).

SENATE BILL 1453: Community colleges; four-year degrees. (2021, 01 27). Retrieved from State of Arizona, Senate, Legislation: ttps://apps.azleg.gov/BillStatus/BillOverview/75663

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. Journal of Personality and Social Psychology, 92(1), 82-96