

Pipeline Development through Middle School, High School, and Community Enrichment Opportunities

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Work-in-Progress: Pipeline Development through Middle School, High School, and Community Enrichment Opportunities

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Abstract

An engineering program, in collaboration with a mathematics program in Lawton Oklahoma has developed three annual pipeline development opportunities to strengthen the link between K-12 and a university. The primary goal of these opportunities is to give Southwest Oklahoma middle school, high school, and community access to enrichment programs that increase their interest in engineering and mathematics careers and attract them to majors in engineering and mathematics. It is imperative that middle and high school students learn to apply engineering and mathematics prior to entering college. It is equally important that students feel confident and comfortable on a college campus prior to their first day of class. In addition, it is vital that middle and high school students learn about the employment opportunities within the Southwest Oklahoma Science, Technology, Engineering, and Mathematics (STEM) job market firsthand and develop strategies for success. The Oklahoma Employment Security Commission, Economic Research and Analysis Division [3], predicts that from 2008 to 2018 there will be a 15.4% growth in architecture and engineering careers and a 14.2% growth in computer and mathematical science careers. The three pipeline development opportunities to be discussed are as follows: first, the *CU Engineering and Applied Mathematics Summer Academy* for high school students, which engages students in problem solving and critical thinking through creative design; second, *It's MathE*, a middle school enrichment program that focuses on problem solving and critical thinking through teamwork and mentorship; and third, the *CU Empowering Women in Leadership and STEM Conference*, which provides an opportunity for the university and surrounding community to learn from successful industry professionals. Each program demonstrates the importance of STEM within the region, engages students at every level to reinforce their confidence as related to mathematics and engineering, and empowers them to pursue careers in mathematics and engineering at and beyond the college level.

Background

The US Department of Labor reports continued growth in the STEM field and a growing need for qualified university graduates to fill these positions. Unfortunately, many students avoid STEM majors, choosing not to go into these careers [5]. However, early intervention leads to more students choosing STEM related coursework in high school, and collaboration between the university and the community can build on that success [4]. Cameron University is a regional university based in Lawton, Oklahoma that offers an A.A.S. in Engineering and a B.A. in Mathematics. Cameron University has hosted summer academies through the Oklahoma State Regents for Higher Education since the inception of the 1989 Summer Academies in Math and Science state initiative. The first of these academies, "CU to the 21st Century," began in 1991 and since then Cameron has hosted numerous successful STEM related academies.

Enrichment Opportunities

During the CU Engineering and Applied Mathematics Summer Academy, selected high school students work in teams and apply mathematics through the engineering design process to research, design, test, and redesign a project. Since its inception in 2016, projects include

designing (i) a rocket that safely transports an egg, (ii) a windmill that can charge a cellphone, and (iii) a portable water purification system. In addition to the design competition, teams create PowerPoint presentations focused on reflection and participate in an Academy Jeopardy Competition. The academy collaborates with industry in the form of industry tours related to the content of the academy and professional talks with networking opportunities for the high school students. Along with learning engineering, mathematics, problem solving, and critical thinking skills, meant to excite and challenge participants, the academy teaches life skills that empower academy participants and make them more confident. Academy participants spend an afternoon engaged in an interactive session with a self-defense trainer. In addition, students spend a day participating in team building activities at a Ropes Course. Both activities allow students to become leaders, listeners, and engage the students in ways that are not typical for science and math based academies. Furthermore, these activities jump start students' ability and willingness to communicate effectively, which is essential for building good team dynamics. University Engineering and Mathematics majors serve as mentors throughout the academy, working alongside the high school students. Mentors are selected from first and second year engineering majors and freshman through senior mathematics majors at Cameron University. Additionally, a junior counselor program, developed in 2017, allows up to four previous summer academy attendees to serve as junior counselors for a subsequent academy.

Outreach that starts in elementary or middle school and that occurs outside of the classroom has proven benefits as an informal STEM pipeline [1]. In 2017, the *It's MathE: Middle School Enrichment Program* began. This one-day event held at the start of the fall semester aims to engage middle school students on a college campus. The day of activities includes a series of team challenges that require problem solving and critical thinking skills. An event from the 2017 program required teams to create a conveyor belt to transport an item. Using links that each team member must hold and connect, teams constructed a transport system. In this event students applied the notions of gradient, friction, and special reasoning to construct their design and accomplish the task in the quickest time possible. Teams go through design and redesign repeatedly under the mentorship of their team leaders. First and second year engineering majors, mathematics majors, and past participants of the CU Engineering and Applied Mathematics Summer Academy all serve as leaders and mentors at *It's MathE*. This mentorship establishes a connection between middle school and high school and high school and university.

The National Research Council Committee on Women in Science and Engineering recommends a variety of outreach initiatives including career days stating, "Women role models can have a significant influence on women students, particularly as they move into upper-level courses and begin thinking about career choices" [2]. In the spring semester of each year, the Engineering and Mathematics departments at Cameron University host the *CU Empowering Women in Leadership and STEM Conference*. This annual event began in 2017 and has occurred twice to date. The primary purpose for this one-day conference is to connect high school and undergraduate/graduate women, and women in the Lawton Ft. Sill community with local women in leadership positions. The conference also aims to help participants understand their full potential as leaders within their chosen fields. Topics explored include body language discernment, team building, handling difficult people, and executive leadership strategies. The conference includes a panel of women who are successful leaders in the region and across the state. This panel aims to bridge the gap between high school and university students who are

about to begin their careers, and local women who have found success in theirs. The conference ends with a networking mixer to encourage long-term connections between students and local female leaders.

Preliminary Results and Conclusions

Though there were many accomplishments during the summer academies these five are the most notable.

1. The participant group was diverse, including students from rural and urban schools, with 25% being first generation and 50% being from underrepresented groups (women and minorities).
2. During the second CU Engineering and Applied Mathematics Summer Academy the applicant pool grew from 40 in the 2016 to 80 in the 2017.
3. The academy's focus on team building and other soft skills helped the students expand their understanding of the necessary skills for both professional and personal success.
4. Every student worked successfully in their assigned group.
5. In 2016 every team successfully built and launched a rocket, and some safely transported their quail egg, and in 2017 every windmill design successfully charged a cell phone. In 2018, all teams designed a water filter system that reduced both nutrients and pathogens.

Overall the It's MathE project provided a series of learning filled experience for middle school and high school students that allowed them to apply mathematics in new and interesting ways. It's MathE hosted 89 middle school students, 48% women, 21% Native American, 20% African American, 10% Asian, 23% Hispanic, and 26% first-generation college students. The middle school enrichment and summer academy provide quality events free of charge to students in Southwest Oklahoma including typically underrepresented groups like Native Americans, African Americans, and women.

In 2018, 20% of students who enrolled in the Cameron University Engineering Program were impacted by CU enrichment programs. The data is very preliminary as it only covers three years at best; however, the goal going forward is to continue to collect data and run statistical analysis to determine the actual impact of each of these three enrichment opportunities.

References

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