

Enhancing Student Retention and Success in Computing and Engineering through the BE-TEC NSF S-STEM Program

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Abstract

Utah Valley University (UVU) was awarded a \$1.5 million National Science Foundation S-STEM grant over a six-year period to strengthen student outcomes in computer science and engineering through Leadership, Engagement, Academic Mentoring, and Preparation. The BE-TEC (Building Exceptional Talent in Engineering and Technology) scholarship program is a dynamic Track 2 initiative that supports students in Electrical Engineering, Computer Engineering, Computer Science, Computational Data Science, Software Development, and Software Engineering.

This paper presents the objectives, structure, and outcomes of the NSF BE-TEC program, highlighting its measurable impact on student success indicators such as GPA improvement, retention rates, graduation rates, and post-graduation employment or enrollment in graduate studies. The findings demonstrate that combining financial support with intentional mentoring, engagement, and experiential learning can significantly enhance student performance and persistence in computing and engineering disciplines.

Introduction

The Smith College of Engineering and Technology at UVU was awarded an S-STEM Track 2 scholarship grant to support students in Electrical Engineering, Computer Engineering, Computer Science, Computational Data Science, and Software Engineering. This program advances Utah's Engineering and Computer Science Initiative by contributing to the development of a highly skilled STEM workforce and strengthening academic programs at a large open-admissions university.

The BE-TEC scholarship program builds on the success of a previous National Science Foundation S-STEM Track 1 program [1] by:

- 1) promoting student success and degree completion through scholarships to low-income, academically promising students, beginning in their freshman year.
- 2) implementing evidence-based activities to support scholars including intentional faculty mentoring, high impact practices, and professional preparation.
- 3) advancing knowledge about evidence-based, context-specific interventions for STEM programs at primarily undergraduate institutions. BE-TEC is increasing support of financially needy students with an interest and aptitude for engineering and computing degree programs by offering an average of 23 scholarships per year over a six-year period to at least 43 unique students.

Now in its fifth year, this project is increasing graduation rates for computer science and engineering students at Utah Valley University, an open-enrollment institution, while preparing

them for continued education and success in the STEM workforce. The program accomplishes this by providing scholarships to academically talented students with financial need, along with leadership opportunities, engaged learning experiences, and mentoring. To date, 55 students who met the selection criteria have been recruited and awarded scholarships.

Computer Science and Engineering Departments

To address one of Utah's most pressing workforce needs, Utah Valley University launched three new engineering programs in Fall 2018: Electrical Engineering, Civil Engineering, and Mechanical Engineering. These new bachelor's degree programs joined UVU's existing Computer Engineering and Pre-Engineering programs within a newly established Department of Engineering. Student interest was immediate, with approximately 300 students enrolling in Fall 2018.

Prior to the creation of the Engineering Department, the Computer Engineering program was housed within UVU's Computer Science department, which offers Bachelor of Science degrees in Computer Science, Software Engineering, and Computational Data Science, as well as a Bachelor of Applied Science in Software Development and a Master of Computer Science degree. The Bachelor of Science in Computer Science program, established in 1993, was one of the first bachelor's degree programs at UVU. Its mission has been to provide a high-quality education that meets accreditation standards while equipping students with the skills needed for successful careers in computing. The Computer Science program is accredited by the Computing Accreditation Commission of ABET and currently serves approximately 988 students.

In Fall 2024, the Department of Engineering was reorganized into two separate departments: Mechanical and Civil Engineering (MCE) and Electrical and Computer Engineering (ECE). The ECE Department now serves approximately 300 students and offers ABET-accredited programs in Electrical Engineering and Computer Engineering.

BE-TEC Project Goal and Objectives

The goal of the BE-TEC project is to build on the success of a previous S-STEM program to increase the graduation and retention rates for students in Engineering and Computing at UVU and develop their potential for success in the STEM workforce by providing scholarships to academically talented students with financial need and by providing evidenced-based support and activities to include intentional faculty mentoring, engagement in high-impact practices, professional preparation, and leadership opportunities [1].

The Process objectives of the BE-TEC project are to:

1. **“Scholarship Awards** - Increase support of financially needy, but academically talented students (including students from underrepresented groups) with an interest and aptitude for engineering and computing degree programs by offering an average of 23 scholarships per year over a 6-year period to at least 43 unique students.

2. **Intentional Mentoring** - Support scholars' academic growth with faculty mentors who emphasize the use of an Individual Education and Development Plan to foster student growth and increase student outcomes for persistence, completion, and career aspirations.
3. **Engagement in High Impact Practices** - Engage scholars in high impact practices, including capstone projects, internships, and collaborative projects.
4. **Professional Preparation** - Foster professional preparation through common academic coursework, skills workshops, guest speakers and career awareness presentations, field trips to industry, and conference participation and presentation.
5. **Leadership Opportunities** - Provide leadership opportunities for all scholars within a student section of a professional organization (IEEE) or club (BE-TEC Club)". [1]

The Measurable Outcome Objectives of the BE-TEC project is:

- A. **"Graduation** - A minimum of 20 scholarship recipients will graduate with a baccalaureate degree in EE, CE, CS, or SE by the end of year six. (18 will still be enrolled)
- B. **Completion and year-to-year persistence rates of BE-TEC participants** will show an increase from the departmental baseline and a comparison cohort.
- C. **Employment in STEM Workforce** - A minimum of 95% of BS degree graduates will be employed in a STEM field or enrolled in graduate school within in 6 months after graduation.
- D. **Advance Knowledge** about the use of internships to learn relevant job skills, increase social and communication skills, and improve employment outcomes (salary & jobs in field). Two papers on the results of the program will be submitted and presented at conferences". [1]

BE-TEC Scholar Selection Criteria

Students were selected based on the following criteria:

- 1) U.S. Citizen, Permanent Resident, US nationals, or admitted refugee.
- 2) Demonstration of low-income (defined at UVU as Pell Eligible); and have unmet financial need in accordance with the Department of Education FAFSA rules.
- 3) Demonstrate academic ability or potential.
- 4) Full-time student majoring in Computer Science, Computer Engineering, Software Engineering, Electrical Engineering, or Computational Data Science.

BE-TEC Scholar Agreement

The selected BE-TEC Scholars were committed to progressing in their major by signing a contract with the institution. This contract set out their requirements to accomplish the following:

- 1) Maintain a grade point average of at least 3.0 in all classes taken.
- 2) Meet with their faculty mentor twice per semester (monthly for the first year) and create an Individual Education and Development Plan (IEDP).
- 3) Participate in common coursework to the extent possible
- 4) Attend the initial meeting and two monthly BE-TEC meetings each semester.
- 5) Participate in the IEEE student section or CE club (participants will be urged to accept leadership roles)
- 6) Complete an internship course in their junior or senior year.
- 7) Scholars will also agree to participate in ongoing project evaluation.

Scholars required out-of-class time commitments are not going to be extensive and focus on the most important activities for program coherence and student success. The most important element of the scholar contract is academic performance. Thus, there are some options and flexibility to allow the BE-TEC scholars with other responsibilities to reasonably participate in the activities.

NSF BE-TEC Scholarship Report

Fifty-five NSF BE-TEC scholars in six different STEM programs at UVU have participated in the NSF BE-TEC program up to now. Table 2 lists students from different programs that participated in the NSF BE-TEC program.

Programs	NSF Scholars
Computer Engineering	6
Computer Science	19
Software Engineering	10
Electrical Engineering	18
Computational Data Science	3
Software Development	2
Total	55

Table 2: Number of Scholars from Different Programs

To assess the four measurable outcomes of our NSF BE-TEC program, a study has been started and conducted by the institution's Business Intelligence and Research Services to compare the NSF BE-TEC students to a comparison group. The comparison group is formed by matching the NSF BE-TEC scholars with nonrecipients who are also attending during the first semester they received the scholarship. The comparison group is randomized and then matched by major, gender, age, class level (credit hours completed), first generation status, and race/ethnicity.

Scholarships were first awarded in January 2022. A total of 55 students has received scholarships. Since the beginning of this BE-TEC program on August 1, 2021, **14** BE-TEC students have received their B.S. degrees in Computer Science; **10** in Electrical Engineering; **6** in Software Engineering; **3** in Computer Engineering; and **2** in Computational Data Science; **2** in Software Development. This equates to a BE STEM degree graduation rate of **67.3%**. The BE

STEM degree graduation rate for Comparison Group, i.e., students is currently **47.3%**. The fall-to-fall semester STEM retention rate for the BE-TEC students is **75.0%**. This compares to a STEM retention rate of **57.7%** for the comparison group. The cumulative GPA for the BE-TEC scholars are **3.66 GPA**. The cumulative GPA for Comparison Group is **3.49 GPA**. Lastly, BE-TEC scholars are averaging **11.9 semesters** to obtain their BS degrees. Conversely, comparison group students are averaging **13.0 semesters** to obtain their BS degrees.

Conclusion

This paper is a presentation of the progress report of UVU's BE-TEC program which is an NSF supported S-STEM project whose goal is to enable academically talented and financially needy students to pursue college degrees in computing sciences and engineering. This program, now in its fifth year, is increasing the graduation rate for students in Computer Science and Engineering at Utah Valley University, an open enrollment university, and better preparing them for continued education and/or success in the STEM workforce by providing scholarships to academically talented students with financial need and by providing leadership opportunities, engaged learning activities, and mentoring. Overall, the BE-TEC program is an effective tool in helping to recruit, retain, and promote computer science and engineering programs.

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1. NSF Proposal Document, "Project Description – Building Exceptional Talent in Engineering and Computing (BE-TEC) at UVU", August 2021.