

A Discussion of Year 4 Activities and Outcomes of the NSF S-STEM Scholarship Program at Shepherd University

Dr. Robert Monahan, Shepherd University

Robert Monahan received his Ph.D. in Mathematics from the University of Florida in 2021. Enjoying the symmetry found in the Category of Relations, Dr. Monahan extended common notions in Functional Analysis to new notions in the Category of Relations. Most notably, the famous Open Mapping Theorem and the Closed Graph Theorem, traditionally regarded as two theorems that imply each other, were interpreted in the Category of Relations as one single theorem in which both of the classical versions can be deduced. Upon graduation, Dr. Monahan was appointed as an Assistant Professor of Mathematics at Shepherd University. Focusing heavily on teaching any and all mathematics courses at Shepherd University, Dr. Monahan has received numerous teacher-of-the-year nominations and awards, received various Open Educational Resource awards for his hand made course resources, and is Co-PI for an NSF S-STEM grant that financially and academically supports Computer Science, Mathematics, and Engineering majors at Shepherd University.

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Introduction

Shepherd University (SU) is a small, public liberal arts institution serving the eastern panhandle of West Virginia, and is the only public four-year college or university in its rural Appalachian region. Notably, over half of West Virginia's public schools are classified by the National Center for Education Statistics [1] as town or rural, and students from these areas are statistically less likely to attend college [2]. Faculty from the department of Computer Science, Mathematics, and Engineering (CME) within the college of Science, Technology, Engineering, Mathematics, and Nursing (STEM&N) received a six- year grant in the fall of 2021 from the National Science Foundation to offer scholarships (S-STEM) to academically talented CME students with financial need (S-STEM Scholars).

The S-STEM program was designed to increase the number of skilled STEM graduates by providing financial, academic, and social supports, thereby enabling qualified students to overcome some of the barriers that prevent them from meeting their educational goals. This goal was broken into four specific objectives: (1) increase enrollment and retention of CME majors; (2) improve the four-year graduation rate of CME majors; (3) increase the proportion of graduating S-STEM Scholars who immediately find employment or continue to graduate studies; and (4) enhance student support programs. These four objectives will serve as the structural outline of our analysis.

Methods

Upon receipt of the scholarship, Scholars immediately become members of an S-STEM club, a LinkedIn group, and an email list-serv. The club holds monthly socials to share conference, research, internship, and career opportunities. In addition to the monthly socials, the club sponsors presentations and workshops from academic and industry professionals – these are open to all students and, therefore, also serve as an S-STEM recruitment tool. Each summer, we sponsor a faculty-mentored eight week Summer Undergraduate Research Experience (SURE) for up to three Scholars that culminates in a undergraduate research conference presentation. Through an individual consultation, students also establish a personalized success portfolio. Their portfolio includes academic records, attendance records, and academic goals. At-risk students meet with a Co-PI individually to establish a recovery plan that encourages previously mentioned S-STEM Scholar support programs and/or utilizes broader university wide support programs such as counseling, advising, and/or career services.

Both Calculus I and Discrete Structures were specifically targeted for tutoring intervention and data collection. A pre-course and post-course survey was administered to students in these two classes, Scholars and non-Scholars alike. The surveys contain four Likert scale questions assessing students' perceived mathematical skill, confidence, and nerves, as well as how likely they were to take a math course on their own volition. The surveys also contain indicators such as tutor usage, instructor office hour usage, time spent on homework, and more. A Pratt-modified Wilcoxon Signed Rank test was performed on the four Likert scale questions (pre- vs post-) filtered by each individual indicator.

Enrollment, retention, and graduation data were retrieved from reports from the Registrar's Office as well as public data from the Academic Affairs Office. Enrollment, retention, graduation, and other academic data for the S-STEM Scholars, on the other hand, were retrieved from internal S-STEM tracking sheets: Academic spreadsheets, a pre-course survey, a post-course survey, and an annual self-report. Once a Scholar graduates, email contact is made to secure post-graduation data.

Results

Shepherd University experienced an average year-over-year enrollment change of -5.35% from F15 to F21 while the CME department experienced a change of -2.62%. From F21 to F24, however, Shepherd University experienced an average +0.07% change and the CME department experienced a -1.00% change. See Figure 1 and Figure 2 for annual cohorts.

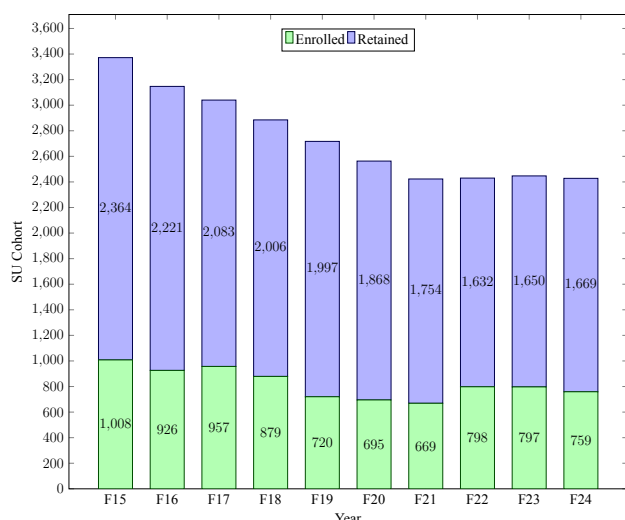


Figure 1: SU cohort from Fall 2015 to Fall 2024 split by enrolled and retained.

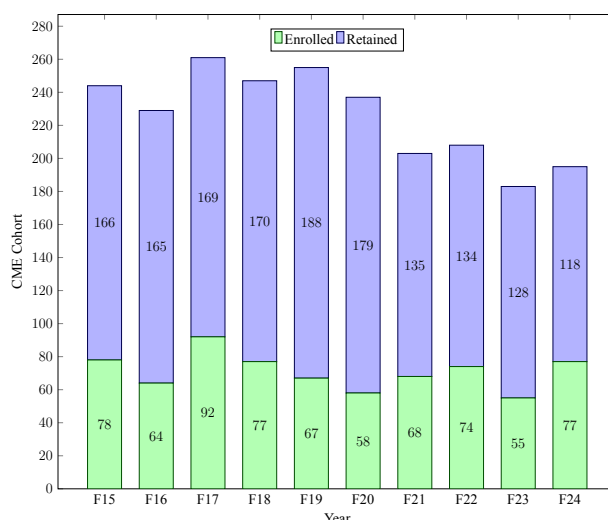


Figure 2: CME cohort from Fall 2015 to Fall 2024 split by enrolled and retained.

Figure 3 summarizes changes in the S-STEM Scholar cohort each semester. In a given semester, positive quantities above the dotted horizontal axis represent recipients that semester, while negative quantities below the dotted horizontal axis represent recipients the previous semester that were no longer recipients that semester. In F24, for example, there were 25 recipients of the S-STEM Scholarship: 13 were newly awarded, 12 were renewed (1 of which then graduated at the end of F24), 1 was a S24 recipient who lost F24 eligibility, and 1 was a S24 recipient who left Shepherd University.

The CME department's average retention rate was 57.78% from F14 to F20 and 59.39% from

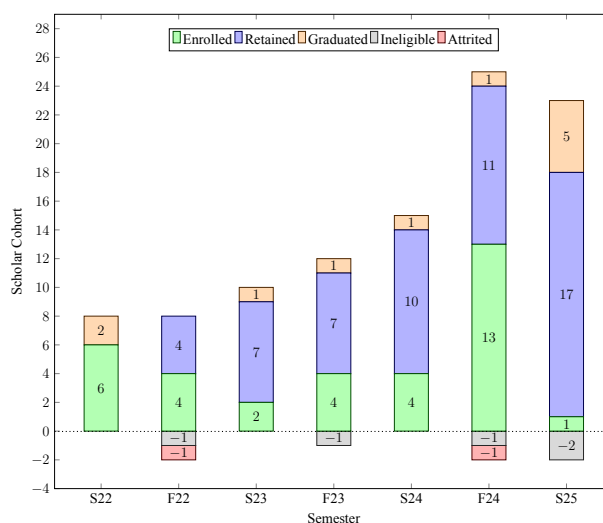


Figure 3: Scholar cohort from Spring 2022 to Spring 2025 split by enrolled, retained, graduated, ineligible, and attrited.

F21 to F23. We, however, retained 5 of the 6 (83.33%) S-STEM Scholars eligible for retention from S22 to F22; the attrited student left Shepherd University to attend seminary school instead. We retained 6 of 7 (85.71%) eligible from F22 to F23; the attrited student lost financial eligibility and subsequently left Shepherd University. We retained 9 of 10 (90%) eligible from F23 to F24; the attrited student left Shepherd University for an unknown cause. This annual comparison can be found in Figure 4. Of those 20 students counted as retained, 2 lost financial eligibility but continued to receive our non-financial S-STEM support services; 1 is still enrolled at Shepherd University and 1 has since graduated from Shepherd University.

From F16 to F20, 90 (34.09% of the full F16 to F20 cohort) students who declared a CME major graduated with any major within 4 years. Of those 90 graduates, 67 (25.38% of the full F16 to F20 cohort) graduated with a CME major. Shepherd University saw 35.51% of its F16 to F20 cohort graduate within four years, regardless of major. See Figure 5 for a summary of graduation rates by enrolled major and graduated major.

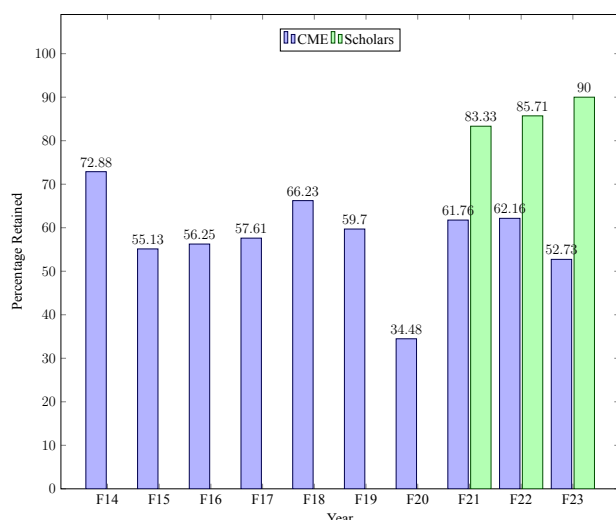


Figure 4: Percentage of CME students and Scholars from Fall 2014 to Fall 2023 who were retained from the previous fall semester.

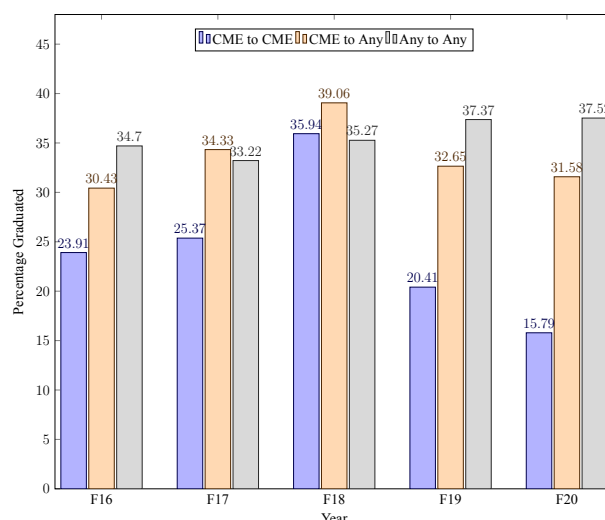


Figure 5: Percentage of SU students from Fall 2016 to Fall 2020 who graduated within 4 years split by enrolled major and graduated major.

Only 14 S-STEM Scholars could have satisfied the conditions required to declare a CME major and graduate with a CME major within four years: 1 Scholar left Shepherd University to attend seminary school, 1 Scholar lost financial eligibility but graduated from Shepherd University, and 1 Scholar lost eligibility and left Shepherd University, and the remaining 11 Scholars naturally met the four-year graduation conditions. We count this as 12 out of 14 (85.71%) S-STEM Scholars graduated within four years. Of the 12 graduated Scholars, 9 (75%) have either found a career or pursued a graduate degree related to their major, 1 (8.33%) found a career unrelated to their major, and 2 (16.67%) have neither found a career

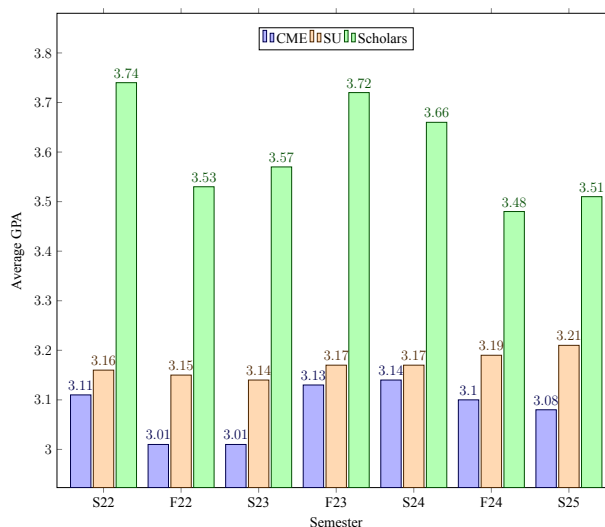


Figure 6: Average semester GPA from Spring 2022 to Spring 2025 split by CME, SU, and Scholars.

nor continued to graduate school.

From F21 to S25, the average GPA was 3.08 for CME students, 3.16 for Shepherd University students, 3.58 for Scholars. Figure 6 summarizes average GPA data each semester.

Figure 7 and Figure 8 display Likert response percentages and the Pratt-modified Wilcoxon Signed Rank test applied to each of the four reflection questions. We then ran the same test filtered by each of the 90 possible combinations of participant responses to each of the eight indicator questions. Of the 90 indicator-filtered tests, 1 combination produced a significant p -value ($Z = -2.39, p = .03$): the survey participants ($N = 9$) who selected that a “Peer Mentor” assisted them lowered their confidence rating from the pre-course survey to the post-course survey.

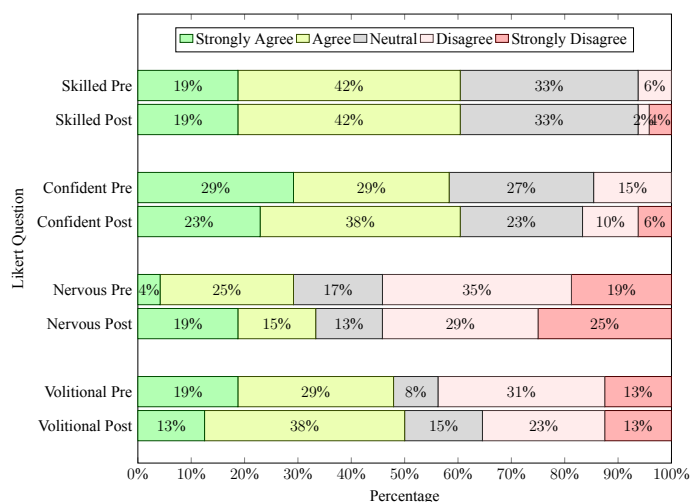


Figure 7: Percentage of responses to pre-course and post-course survey questions using a 5-point Likert scale.

Question	Pre- Median	Post- Median	Z	p
Skilled	4	4	-0.29	.83
Confident	4	4	-0.83	.41
Nervous	2	2	1.37	.21
Volitional	3	3.5	0.13	.92

Figure 8: Pre-course and post-course survey medians with the Z, p values from a Wilcoxon Signed Rank test.

Discussion

The S-STEM program at Shepherd University is growing rapidly. Our Scholars’ retention rates, graduation rates, and academic performance greatly surpasses those of the CME department and the greater Shepherd University population. This elevated impact on Student Success Metrics is also noted [3], [4], and [5] while similar post-graduation success is noted in [6].

Pre-course and post-course survey distribution was inconsistent and, therefore, produced unmatched student data. Of the matched student data, very few were actually Scholars. Furthermore, we only saw one indicator produce a suitable p -value: students that utilized a Peer Mentor ultimately lowered their mathematical confidence rating from the pre-course survey to the post-course survey. Because these particular students continued utilizing the tutoring services and noted that the Peer Mentor helped them succeed, we can more plausibly conclude that the lowered confidence rating was simply a humble correction after an ambitious pre-course survey claim. Henceforth, administering the pre-course and post-course survey consistently will produce a richer set of data for analyzing which indicators contribute to changes in Likert ratings.

Acknowledgment

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