Board 264: Endeavour S-STEM Program for First-Year Students: 3rd-Year Results

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1 Introduction

In 2012, over four million freshmen were enrolled in U.S. four-year institutions of higher education, and of those almost two million received Pell grants in their first year. Six years later only 43% of those students had obtained a bachelor's degree, 10 percentage points behind non-Pell recipients [1]. The education disparity between privileged and low-income students has slowly been widening over the years. The percentage of first-time students who obtained their bachelor's degree within six years has increased from 57% (in 2001) to 69% (in 2017) for students from families in the fourth (highest) income quartile [2]. However, for students from families in the first (lowest) income quartile, the number has remained steady at around 27%. Even for students in the second income quartile, graduation rates have only improved from 31% to 36%.

Unfortunately, this is a problem that has long plagued the American education system. In 1947, the President's Commission on Higher Education reported that "for the great majority of our boys and girls, the kind and amount of education they may hope to attain depends, not on their own abilities, but on the family or community into which they happened to be born" and that one of "the greatest barriers to equality of educational opportunity [is] the inadequacies of family income" [3]. However, the Commission also states that equal educational opportunity is a major goal of American democracy. Present day action towards that goal is the National Science Foundation (NSF) Scholarships in Science Technology Engineering and Math (S-STEM) program. Each year, new student success programs guided by educational theory and evidence-based practices are funded and developed to provide critical support to low-income postsecondary students in STEM. The Endeavour Program at the University of Houston is one of those programs. In the fall of 2018, Endeavour recruited its first cohort of STEM freshmen. Since then, two cohorts have completed the two-year program with the third set to complete the program in spring 2023. This paper presents data for what would have been the 3rd-year mark of the program. However, due to two program pauses these data are being presented in the 5th calendar year. Results presented here are associated with specific aim 1 of the full project (developing 1st- and 2nd-year cornerstone courses) and augment results reported in an earlier paper by the author [4].

2 Background

The literature on retention cites many reasons beyond academic struggles that cause students to either leave school or switch to a non-STEM major [5], [6]. While low-income students are more likely to leave for financial reasons, financial assistance is not enough to fix the leaky pipeline for less privileged students. Other barriers include a sense of not feeling welcome or not feeling a strong connection to the institution and its people. A lack of knowledge of institutional norms and policies can also hinder low-income students, especially those students who are first-

generation. Even advising that does not consider the particular hardships for low-income students can factor into a student's decision to quit pursuing a STEM career.

However, the literature also provides evidence of practices that improve the retention of low-income students. In particular, there is strong evidence of the positive impact of small learning communities and student engagement on student success measures such as performance and retention [7]. What is less understood is how student success programs impact the various dimensions of engagement, especially in the first two years of STEM. Therefore, the authors felt that an intervention was needed to specifically target multiple facets of engagement of STEM students, as well as a method to measure and analyze that engagement data over time. Those data could then assist advisors in providing better guidance for students. Failure to understand how to best support low-income students in STEM will result in the needless attrition of academically talented students who would otherwise experience upward mobility by participation in the STEM workforce. In addition, the loss of those students would perpetuate or perhaps even widen the education and income disparity already in existence.

3 Overview

The University of Houston has two very successful student success programs in STEM that have supported mostly underserved students in STEM for almost 50 years. Those programs have grown to be quite large and have supported thousands of students during their existence. However, with so many students and different program components and levels of participation, it has been difficult to determine the impact of the programs. It has also been difficult to provide financial support and targeted advising for so many students and to form class cohorts. The two programs have also been run independently in two different colleges and are very different in programming. All activities are co-curricular, and while the benefits of those activities are undeniable, they require an additional time commitment that places an additional burden on many low-income students who often have outside family obligations. Therefore, the Endeavour S-STEM Program was designed to fill a critical programming gap for students in STEM that minimized additional cognitive and time loads for students while still delivering meaningful content.

Using many of the best practices from existing university support programs, Endeavour was designed to be a course-based small learning community that provides financial, academic, professional, and personal support. The aim was to increase student engagement without adding any undue burdens to low-income students. The program consists of four one-hour courses taken in the first four semesters of college. In addition, financial assistance is provided each of those semesters in the form of scholarships. During that period, students are engaged in a curriculum that mixes technical skills, undergraduate research, professional development, personal development, team projects, and career advising. The stakes are low, the group is small (20 STEM students), and almost all activities are performed within the scheduled class time. The intent is to bring these students together to increase all aspects of engagement and make them more successful in school and eventually in a STEM career. The engagement data collected can then be analyzed to determine which, if any, aspects of engagement are good predictors of

retention and graduation. Once we develop a reliable way to track changes in student engagement levels and understand how those levels relate to success, we can use that information to design more impactful early interventions for low-income STEM students including more targeted advising strategies and student success programs.

3.1 The Endeavour S-STEM Program

The Endeavour S-STEM Program is a two-year student success program that supports students in a variety of ways so as to impact student engagement levels on multiple dimensions. Students are invited to apply during the summer before their freshman year. The invitations are sent by e-mail to all students who meet the following criteria: 1) first-time in college student, 2) admitted into a STEM college, 3) top 10% of high school class, 4) score of at least 580 on the SAT Math test or 25 on the ACT Math test, 5) Pell eligible, and 6) expected family contribution less than or equal to $5,000. Selection to the program is based on the criteria listed as well as responses to essay questions on the application. If selected, students commit to taking a one-hour Endeavour course each semester in their first two years and then receive a $2,000 scholarship for each semester that they enroll in those courses. The courses are more than community-building mechanisms. They are technical skills building courses as well. Students meet twice per week (1.5 hours each meeting) for four long semesters beginning with their first semester on campus. Three of the courses are in the same small computer lab each semester and led by the Director of the program. Through those courses the students learn programming and electrical skills, research skills, professional skills, and personal wellness skills. Each course is designed to provide early exposure to concepts that are deemed to be critical to success in STEM fields, and that will either level the playing field for low-income students or in some cases give them a professional edge. For instance, all Endeavour scholars receive two class sessions of career fair training (including résumé writing) in their first semester that is designed specifically for this program, and then are required to attend a career fair within the first two months of school. The Endeavour Program staff, in partnership with the Engineering Career Center, provide the students with padfolios, résumé paper, one-on-one advising, clothing assistance, networking opportunities, and a dedicated check-in table at the career fair. And because many students feel anxiety about participating in such a large professional event, the staff are also on hand to provide guidance, support and sometimes even make introductions to recruiters to make the students feel more at ease. Currently, no other student success program at the University of Houston offers this level of professional support to all of their students. Yet we find that with this very early exposure to career fairs, Endeavour students tend to continue to attend them throughout the rest of their time in STEM and some even obtain internships in their freshmen year. Moreover, the hands-on technical curriculum of the Endeavour courses provides students with multiple project items to include in their résumés, making them stand out from other students at their level.

Another program component designed to give scholars a leg up is a seminar with the University of Houston Tilman J. Fertitta College of Medicine admissions staff in the freshman year. Many scholars are biology majors with the intent to apply to medical school yet have no knowledge of the requirements or pathway to get there. Therefore, five members of the medical school staff

have been brought in to present information on what to do in the first year of college to get on a path to medical school. The overall goal is to provide students with that critical first connection to resources so that they do not miss out on opportunities due to a lack of knowledge or social network. Although many students tell us that it is the academic scholarship that is the reason that they join Endeavour, they say that it is the other non-financial elements of the program that make them stay. It also important to note that because low-income students often find it difficult to engage with the campus outside of class, all but a handful of activities are scheduled within the formal class time. By engaging students at various levels (institution, classroom, curriculum) the program aims to give students a larger context in which to feel a sense of relatedness and competence, and also provide a small learning community of peers with similar circumstances and goals.

4 Specific Aims

The *long-term goal* of the Endeavour S-STEM Program is to increase the number of low-income STEM graduates at the University of Houston. The *overall objective* of the program is to increase the retention of low-income students by fostering their behavioral, academic, cognitive, and affective engagement. The *central hypothesis* for the project is that participation in a small STEM learning community designed to increase engagement on multiple dimensions will improve student success outcomes for low-income students. Our hypothesis is based on data from existing programs on campus supporting underserved students. Best practices from those organizations were incorporated into the program design for Endeavour.

The research study associated with the Endeavour S-STEM Program has been designed to address three specific aims:

1. Specific Aim #1: Develop 1st- and 2nd-yr cornerstone courses that promote engagement, retention, and academic success of low-income STEM students.
    - We hypothesize that participation in these cornerstone courses will lead to higher levels of engagement compared to those who do not participate in the courses.
    - We hypothesize that participation in these cornerstone courses will lead to higher levels of academic performance and retention compared to those who do not participate in the courses.
2. Specific Aim #2: Identify the relationship between different dimensions of engagement and academic performance and retention for low-income STEM students.
    - Our hypothesis is that a multi-dimensional model of engagement will serve as a better predictor of academic performance and retention for low-income STEM students than a single-dimensional model.
3. Specific Aim #3: Develop a platform to identify warning signs of engagement that may give advisors an early indication that a student is at risk of leaving school.
    - We hypothesize that a platform displaying multi-dimensional engagement levels over time will work as a better early warning tool for advisors than tracking end-of-semester grades alone.

At the end of the S-STEM grant term, we will have developed an engaging two-year project-based curriculum in STEM including technical hands-on activities and projects. We will have also obtained insight into how different dimensions of engagement relate to student success measures. And lastly, we will have created an advising tool for monitoring and reporting engagement levels over time. These outcomes are expected to have an important impact on student success program development for first time in college (FTIC) low-income STEM students at the University of Houston, and potentially at other institutions as well.

5 Data Collection and Early Findings

This study is a work in progress and the remainder of this paper relates to preliminary data collected for the second part of specific aim 1, specifically academic performance and retention.

Institutional data for retention and cumulative GPA has been collected for the first three cohorts of the Endeavour S-STEM Program. Due to a pause in the program during the COVID-19 pandemic, the three cohorts did not start in consecutive years. No freshman cohort was recruited for the fall of 2020. Table 1 shows a timeline of the first three cohorts. Engagement data (not presented in this paper) has been collected each semester and institutional records (including GPA and retention) have collected for each completed school year.

Table 1

Time Spent in Program for Each Cohort

	2018	2019	2019	2020	2020	2021	2021	2022	2022	2023
	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Cohort 1	Year 1		Year 2							
Cohort 2			Year 1		Year 2					
Cohort 3							Year 1		Year 2	

5.1 Academic Performance

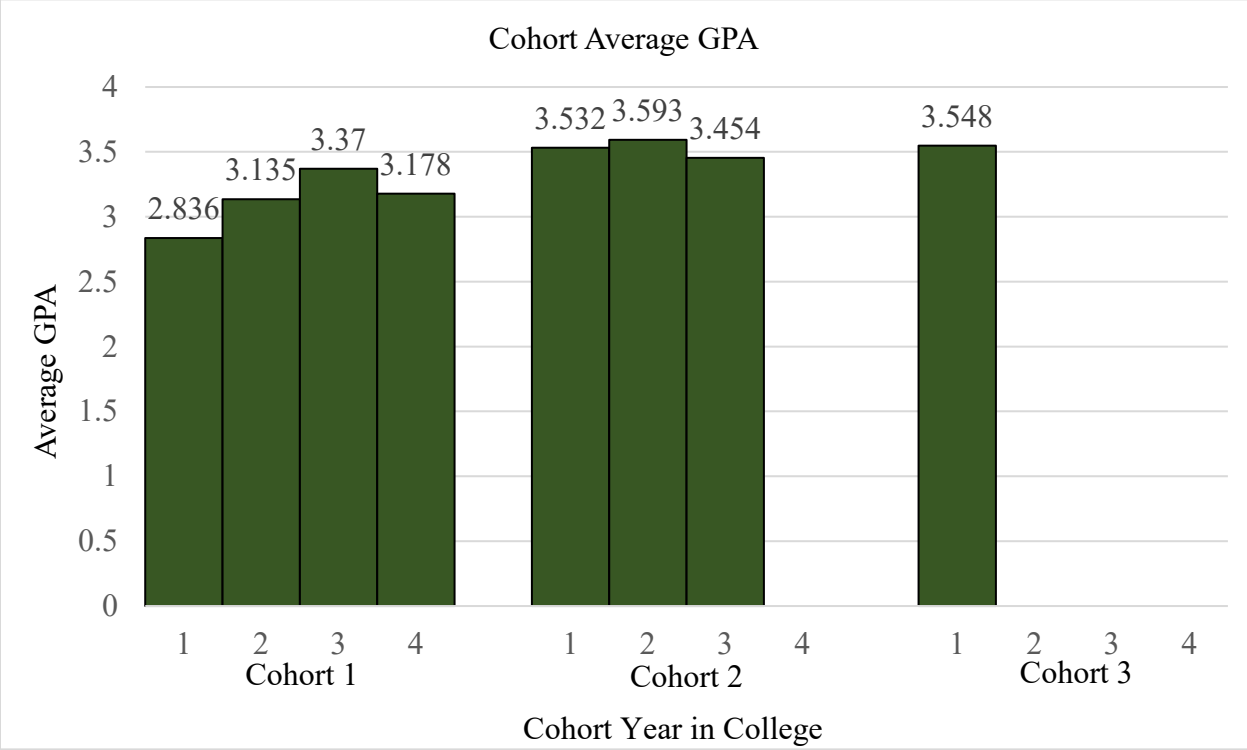
5.1.1 Academic Performance of Endeavour S-STEM Scholars Over Time

Figure 1 shows the academic performance of the program cohorts over completed years in STEM. Only students in the cohort who were retained in STEM at the end of the year were included in the calculations. Cohort 1 of the program was enrolled in fall 2018. Cohort 2 began in fall 2019, and Cohort 3 enrolled in fall 2021. (The fourth and final cohort will enroll in fall 2023.) Only years one and two are associated with participation in Endeavour. The other years are shown only for comparison. As can be seen from Figure 1, cohort GPAs stay fairly consistent over time. The first semester mean GPA for Cohort 1 was quite lower than first semester GPAs of the next two cohorts due to some outliers within that group (evident by a large standard deviation for that year of 1.12). However, the following three years show average GPAs above 3.0 for those retained in STEM. Cohorts 2 and 3 show better first semester results

(approximately 3.5) and Cohort 2 also shows that average holding steady over time. It is unclear as to why the first cohort had such a difficult start compared to later cohorts, but with such a small group (N=20) any one student struggling will have large effects on the cohort mean GPA. Another factor could be that the program evolves over time. S-STEM scholars provide valuable feedback at the end of each semester and program adjustments/additions are subsequently made. Hence, improved GPA averages with the second and third cohorts could be a result of improved programming.

Figure 1

Cumulative GPA for Each Endeavour S-STEM Cohort to Date



5.1.2 Academic Performance of Endeavour S-STEM Scholars Compared to Non-Participants

Academic performance for this study was defined as overall university GPA. Comparison groups for each cohort were created by finding all students who would have qualified for the program that year, but either did not apply or were not accepted. National Science Foundation (NSF) required that S-STEM scholars be first-time full-time students (although that requirement has since been relaxed) and U.S. citizens. NSF also requires that students be academically talented and have financial need, but organizations are allowed to form their own definitions of those labels. Endeavour considers entering freshmen to be academically talented if they were in the top 10% of their high school graduating class and scored either at least 580 on their math SAT or at least 25 on their math ACT. Financial need was defined as having an expected family

contribution (EFC) equal to or less than $5,000 and being Pell-eligible. Therefore, all students who entered the university in the same semester as the Endeavour S-STEM scholars and met all of the above requirements were placed in the comparison group, minus the scholars themselves. For Tables 2-4, only students who were retained in STEM were included in the calculations each year.

Given the lower GPAs of the first cohort, it is not surprising that Cohort 1 mean GPAs were lower than the comparison group throughout the first four years (Table 2). There was a difference of .32 GPA points between the groups. However, by junior and senior year that gap had closed to .03 and .19 GPA points respectively. Both Cohorts 2 and 3 (Tables 3-4) performed better than their comparison groups in every semester to date. Cohort 3 (Table 4) has had the best start by outperforming their comparison group by .42 GPA points in their first year.

Table 2

Endeavour Cohort 1 Overall GPA Means Compared to Similar Non-Participants

Cohort 1 *Enter Fall 2018*	Year 1 (Spring 2019)			Year 2 (Spring 2020)		
	N	Mean	SD	N	Mean	SD
Endeavour S-STEM *(retained STEM only)*	20	2.84	1.12	19	3.14	0.63
Comparison Group *(retained STEM only)*	262	3.16	0.75	205	3.34	0.48

Cohort 1 *Enter Fall 2018*	Year 3 (Spring 2021)			Year 4 (Spring 2022)		
	N	Mean	SD	N	Mean	SD
Endeavour S-STEM *(retained STEM only)*	16	3.37	0.42	15	3.18	0.44
Comparison Group *(retained STEM only)*	177	3.40	0.47	134	3.37	0.45

Table 3

Endeavour Cohort 2 Overall GPA Means Compared to Similar Non-Participants

Cohort 2 *Enter Fall 2019*	Year 1 (Spring 2020)			Year 2 (Spring 2021)			Year 3 (Spring 2022)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Endeavour S-STEM *(retained STEM only)*	19	3.53	0.25	17	3.59	0.21	16	3.45	0.30
Comparison Group *(retained STEM only)*	275	3.36	0.68	209	3.51	0.37	185	3.37	0.44

Table 4

Endeavour Cohort 3 Overall GPA Means Compared to Similar Non-Participants

Cohort 3 *Enter Fall 2021*	Year 1 (Spring 2022)		
	N	Mean	SD
Endeavour S-STEM *(retained STEM only)*	19	3.55	0.36
Comparison Group *(retained STEM only)*	158	3.13	0.80

It is important to note here that every cohort to date has been impacted by COVID-19 in either the instructional methods employed each semester or through revised university grading policies. There were major changes to instructional formats during the COVID-19 pandemic. Even though the university returned to in-person classes in the fall of 2021, instruction was required to be online for the first two weeks that semester as well as for the spring of 2022. And some professors have opted to remain online permanently while others have moved permanently to a hybrid format. Therefore, instructional methods have varied significantly throughout the program's existence. In addition, there were major changes to university grading policies. Beginning in the spring of 2020, students were given the option to either be graded on a pass/fail

basis which would *not* impact their GPA or be assigned a grade that *would* count towards their GPA. That policy was in place through spring of 2021. Students were given the option on a course-by-course basis. Gatekeeper course grades that might have significantly lowered GPAs in many cases were not included in GPA calculations those semesters. However, that same policy was in place for all students. So, although the changes complicate year-to-year comparisons, participant group to non-participant group comparisons are still valid.

5.2 Retention

5.2.1 Retention of Endeavour S-STEM Scholars

Figure 2 shows retention rates for the Endeavour S-STEM Scholars over time. Given the difficulty of STEM majors, it is not surprising to see some attrition over the years. However, it is known that some students had to leave school due to economic hardships caused by the COVID-19 pandemic. Some scholars had family members lose jobs or lose hours on the job and therefore their families lacked the finances to pay for tuition. Some students had to leave school to work and help support the family. The extent to which the pandemic was responsible for scholars leaving school is unknown since some students simply left without communicating with the program staff and did not respond to attempts to contact them. However, given the circumstances, the overall retention rates have not been greater than what would have been expected for STEM majors, and six students from Cohort 1 have already graduated with a STEM degree.

5.2.2 S-STEM Retention Compared to Non-Participants

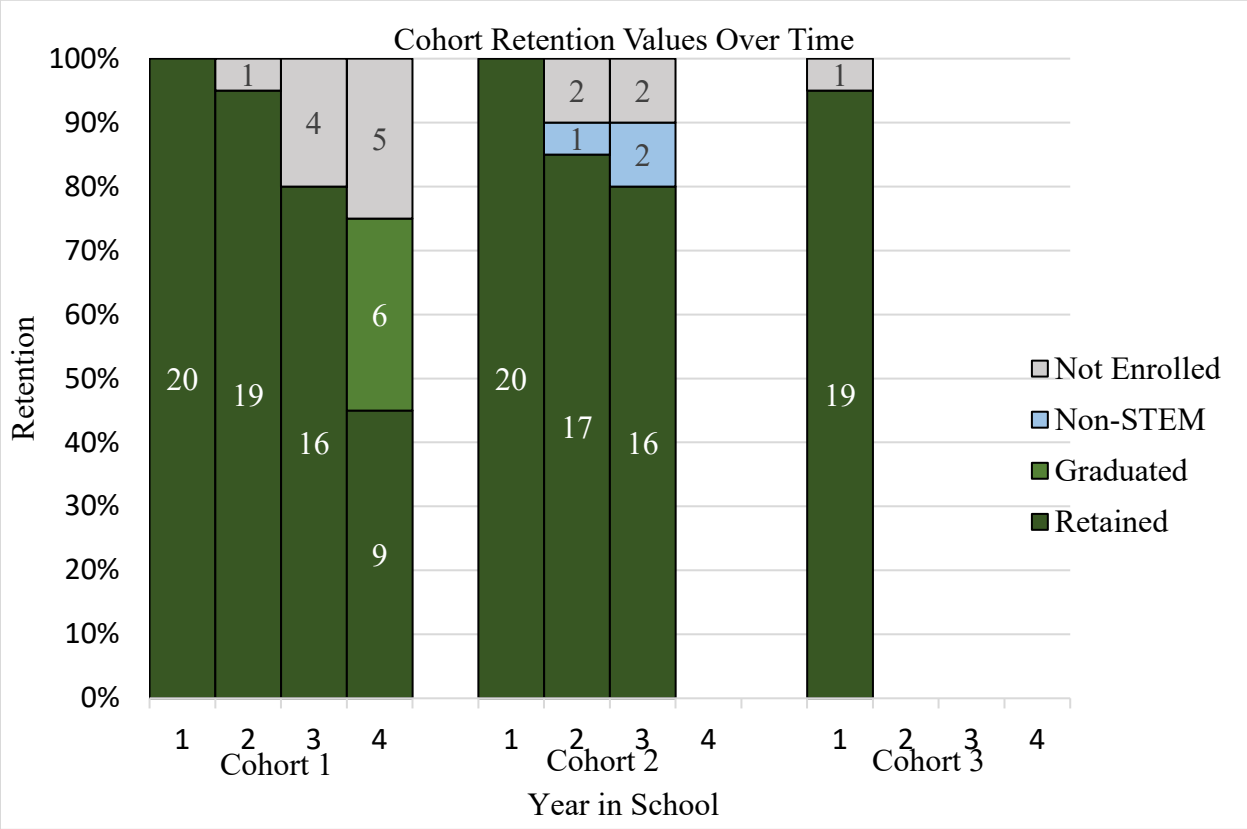
In the next several tables, retention rates for Endeavour S-STEM Scholars were compared to students from the same freshman cohort who qualified for the program but did not participate. Table 5 shows retention rates for the two years in the S-STEM program for Cohort 1 as well as the following two years to show the four-year retention rates (fall 2018 – spring 2022). Table 6 shows data for the three years that have been completed by the fall 2019 cohort, and Table 7 shows the data for the single year that students in the fall 2021 have completed. Those data are contrasted with those of the comparison group. Only students who were still enrolled in STEM majors at the end of the school year were included in these groups.

The first-year retention rate for Cohort 1 is on par with the comparison group of non-participants. However, in year two the Endeavour students were retained at a much higher rate than the comparison group (95% to 76%). Although the S-STEM program continued to see some attrition, that retention rate gap held relatively steady over the next two years. For Cohort 2 (Table 6), similar results are seen in the first year. However, once again the S-STEM group begins to separate itself in years two and three showing double-digit differences in retention rates. Cohort 3scholars (Table 7) were also retained at a high rate in the first year. However, even as the comparison group had an uncharacteristically low retention rate that year. Moreover, the comparison group was also a significantly smaller group with over 100 fewer students than the year before. Both numbers are concerning, and it is as of yet unclear why both enrollment and

retention rate are markedly down for freshmen entering college in the fall of 2021. More data in the coming years will show if that year was an anomaly or the first sign of a troubling trend.

Figure 2

Endeavour S-STEM Retention Over Time



Note: Students are in the Endeavour S-STEM Program during freshman and sophomore years only.

Table 5

Endeavour S-STEM Cohort 1 STEM Retention Rates versus Comparison Group

Cohort 1 *Enter Fall 2018*	N	Year 1 *(Spring 2019)*	Year 2 *(Spring 2020)*	Year 3 *(Spring 2021)*	Year 4 *(Spring 2022)*
Endeavour S-STEM	20	100%	95%	80%	75%
Comparison Group	276	95%	76%	64%	57%

Table 6

Endeavour S-STEM Cohort 2 STEM Retention Rates versus Comparison Group

Cohort 2 *Enter Fall 2019*	N	Year 1 *(Spring 2020)*	Year 2 *(Spring 2021)*	Year 3 *(Spring 2022)*
Endeavour S-STEM	20	100%	85%	80%
Comparison Group	293	95%	73%	64%

Table 7

Endeavour S-STEM Cohort 3 STEM Retention Rates versus Comparison Group

Cohort 3 *Enter Fall 2021*	N	Year 1 *(Spring 2022)*
Endeavour S-STEM	20	95%
Comparison Group	176	88%

Although the reason for S-STEM scholars leaving school was not always known, in many cases the students were still in good standing with the university. In other words, they left for reasons other than poor academic performance. Some scholars and their families got caught in the COVID-19 employment crisis. Some lacked the finances to fully pay for tuition regardless of employment status and did not want to reduce school courseloads or take out loans. Others who were on the cusp of leaving were almost sidelined due to transportation insecurity and medical issues. Given that the program is restricted to low-income students, these reasons were not surprising. What was surprising (and perhaps should not have been) was how sometimes very small of amounts of additional money and time can have significant impacts on the retention of low-income students as well as their performance. Each Endeavour S-STEM Scholar received a $2,000 scholarship in each of the four semesters that they participated in the program. For most, that amount was enough to close the tuition gap and would often make working off-campus unnecessary. However, having the ability to adjust the scholarship (sometimes significantly and sometimes in very small amounts) to individual financial needs might have made a difference in keeping some of the S-STEM participants in school. Unfortunately, the original program budget

only allowed for a fixed amount and only over the two-year program. It is clear now that the program could be more impactful in producing STEM graduates if there were a good amount of flexibility in the scholarship amount as well in how many years students were supported. Future program budgets and design will take these issues into account.

5.3 A Word About Engagement

The move to off-campus instruction during the COVID-19 pandemic had a significant and dramatic impact on the engagement levels of students during and after that time. There have so far been three cohorts enrolled in the Endeavour S-STEM Program and none have had a complete program experience without a COVID-19 disruption. Moreover, each cohort has been affected differently and at different points in the Endeavour Program. Endeavour S-STEM was designed to be an engagement-focused program and was severely limited in how it could engage with its students. The disruptions have made the originally planned engagement study infeasible.

However, COVID-19 was not the only obstacle in collecting engagement data. Initially, engagement data for two of the engagement dimensions (cognitive and affective) were to be collected through a validated survey. However, after conducting the survey multiple times in the first two years it was felt that the initial data failed to capture the high levels of engagement that the Endeavour staff was experiencing in and out of the classroom. Also, the researchers felt that the high frequency of the survey delivery (five times over the two-year period of the program) was leading the students to not reflect on the survey questions as deeply as was desired since they had seen the questions so many times before. Therefore, modifications were continuously being made to the original study design with the first three cohorts (e.g., a shift to focus groups as opposed to Liker-scale surveys). Although the initial survey data would still prove useful for achieving specific aim 3 (an engagement dashboard), engagement measures have since moved to more qualitative methods of data collection [8]. Work is still being done by the staff to pull in the best aspects of the quantitative and qualitative methods to measure the four engagement dimensions (academic, behavioral, cognitive, and affective). The resulting study design will be implemented with the fourth and final cohort which is expected to be enrolled in the fall of 2023. Engagement outcomes will then be reported at the end of the final two-year intervention.

6 Conclusion

The Endeavour S-STEM Program continues to evolve, and the outcomes continue to be promising for low-income STEM students. Endeavour Scholars do well academically and are retained at high levels compared to their peers. This paper has presented initial data for the first three cohorts of the program. As this project is a work in progress, data will continue to be collected and reported for the two years remaining on the NSF grant which supports the program. Although the focus of the program is related to engagement, due to COVID-19 disruptions and other unforeseen issues, consistent data collection has problematic. Although some engagement results have been published in previous papers [4, 8, 9], the intended study related to specific aim 2 of the program has not yet been possible. As the S-STEM grant term ends in spring of 2025, the research team will be working to redesign the engagement study with the hopes that a

longitudinal study will be possible for the fourth and final cohort of the Endeavour S-STEM Program.

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