

The Endeavour S-STEM Program: A Multi-College Collaboration to Increase Engagement and Retention in STEM

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Introduction

The United States has long held its position as the global leader in technological innovation and education. But that standing has been in jeopardy due to the shortage of domestic students graduating in STEM. This concern has led researchers to investigate why graduation numbers are so low and also to propose ways in which STEM retention and hence graduation can be increased. The data show that there are portions of the population which are greatly underrepresented in the STEM fields, and what the data tell us is that family income matters. Overall, only 32% of 2009 ninth graders from families in the lowest fifth of income level enrolled in college within a year after graduation, compared to 51% of those from the middle fifth and 79% of students from families in the highest income group. And of that population, the percentage of low-income students who attained a degree within 8 years was only 14%, compared to 29% for middle-income students and 60% for high-income students [1]. Moreover, low-income students are likely to be less prepared in math and science than their high-income peers coming out of high school, which makes them less likely to choose STEM as a career path [2]. Not only does this underrepresentation of low-SES graduates impact the overall numbers of STEM professionals in the U.S., but it also means that those graduates are missing out on all of the financial and professional benefits that a job in STEM offers.

To address the representation gap in STEM for low-income students, the National Science Foundation created the Scholarships in STEM (S-STEM) grant program. NSF seeks to support evidence-based initiatives that will support low-income STEM students financially and in other non-financial ways. The Endeavour Program was developed as one of those initiatives, and it provides scholarships for 80 students over their first two years in a STEM major. Knowing that the link between student engagement and academic success measures (such as retention) has been well-established in the literature (e.g.,[3]), the program was designed to create a small learning community experience for students who would be less likely to demonstrate high engagement with the university, the curriculum, their instructors, and their peers. There are many reasons why low-income students might show low-engagement levels. One reason is that a school and/or family obligation requires them to work a significant number of hours each week. It is difficult to attend football games or join a sorority when you are working 20-40 hours a week off-campus. Engagement is a luxury that many low-income students simply cannot afford. The Endeavour Program was designed to address this financial and engagement issue by supporting low-income STEM students over the first two years of college. Part of the design was to prepare students for both industry internships as well as research appointments during that time so that students would be well set up to obtain paid positions once the S-STEM scholarships were no longer available. The engagement activities were also brought right into the classroom with hands-on and team-based activities in almost every class. The projects and associated

technical skills were also selected specifically to increase the marketability of the scholars in their early college years.

The Endeavour Program was designed on the premise that a relatively small amount of financial support paired with a strong community of support could have a significant impact on a student's trajectory in STEM. Each program participant received a \$2,000 scholarship each semester that they qualified for and participated in the program (4 semesters max). In some cases, the scholarships eliminated the need to work completely. In others, the scholarships reduced the number of hours worked each week. And in a few cases, the scholarships were enough to allow the students to move to campus where they could be more engaged in campus culture.

To date only one cohort has completed the Endeavour Program. Therefore, the remainder of this paper describes the program results for the first cohort of 20 participants who entered the university with the fall 2018 freshman class. Since the program was designed to significantly impact student engagement, the engagement data for this first cohort are presented and, when possible, contrasted with a comparison group of similar peers.

Specific Aims

The purpose of this paper is to present initial quantitative and qualitative results for the first cohort of the Endeavour S-STEM Program and to show how an engagement dashboard developed in Excel was studied for possible use as an advising tool in STEM. Therefore, the specific aims for this paper are as follows:

Specific Aim 1: To report student success measures for the first cohort of the Endeavour Program compared with those of non-participants.

Specific Aim 2: To describe the methods used to track and analyze different dimensions of student engagement for the first cohort of the Endeavour Program.

Specific Aim 3: To describe both the college and program experience from the perspective of the Endeavour Program Scholars.

Methods

Population of Focus

To be eligible for the Endeavour S-STEM Program, the students must have been freshmen who demonstrated high academic achievement in high school by being in the top 10% of their graduating class and who scored either a 580 or better on the math portion of the SAT or a 25 or better on the math portion of the ACT. In addition, students must have satisfied the low-income requirement by demonstrating financial need. NSF allows some flexibility in defining low-income, and the grant investigators chose to define this term as being Pell Grant eligible and having an expected family contribution (EFC) below \$5,000 as determined from a submitted Federal Application for Federal Student Aid (FAFSA) form. In addition, NSF requires that the

scholarship recipients be first-time and full-time college students with either United States citizenship or permanent resident status.

For the first cohort of the program, all eligible students were invited to submit an application during the summer of 2018. The program staff then reviewed the applications and selected scholars based on academic achievement and professional goals. Ten students from the College of Engineering and ten students from the College of Natural Science and Mathematics (NSM) were selected for the program. Once recruited into the program, participants had to remain in good academic standing, remain enrolled in a STEM major, and be enrolled in one Endeavour S-STEM course each semester to continue to receive the S-STEM scholarships. Participants were required to take four one-hour courses over the duration of the program (one per long semester). Initially, there was some concern about requiring low-income students to enroll and pay for an additional course. The fear was that this added financial commitment would result in a wash for the students after receiving their scholarship. However, all of the participants were enrolled in a university program called “UH in 4” which caps tuition at 12 hours of courses. Therefore, adding the Endeavour course did not add to the tuition burden.

Program participants could and were encouraged to remain in the Endeavour courses even if poor academic performance resulted in disqualification from the S-STEM scholarship. The staff did not want to remove valuable academic support from an already struggling student. Although financial support ceased, other types of support remained in place and the S-STEM scholarship could be reinstated if the student regained good academic standing in a STEM major.

Data

The Endeavour Program was designed to be first and foremost an engagement program since there is strong evidence to suggest that student engagement positively impacts student success [4]. Therefore, as part of the program’s evaluation, engagement levels of the scholars were measured and used to identify any negative trends that could be a cause of concern. As most scholars would agree that engagement is a multidimensional construct, student engagement was measured on four different dimensions according to the framework developed by Appleton [5]. Descriptions of the four dimensions follow.

Academic Engagement Data

Academic engagement refers to behaviors related to the learning process. Indicators of academic engagement include grades, assignment completion rates, and progress towards a degree. These measures are those most often directly associated with student success.

Behavioral Engagement Data

Behavioral engagement indicators include class attendance, class punctuality, and extracurricular activities. These measures indicate the extent to which students adhere to university rules and norms. They are the external and observable behaviors that are clear indicators of a student’s participation in or withdrawal from the campus community. The S-STEM program was designed to impact this dimension of engagement in particular by providing low-income students with

financial resources that would eliminate the need to work off campus and hence allow them the time to be more active on campus.

Cognitive Engagement Data

Cognitive engagement measures the mental energy that students expend to go beyond what is required in school. Students who seek out additional materials for learning or persist with difficult tasks are demonstrating cognitive engagement. High levels of this measure indicate a strong investment in learning and effective problem-solving skills.

Affective Engagement Data

Affective engagement relates to the feelings of relatedness that students have with school. These data include feelings of support from teachers, peers, and family and indicate how connected students feel to the school community.

Data Collection

Over the two years that the first cohort participated in the program, academic and behavioral engagement data was collected from both institutional records (e.g., grades, progress, DFW counts) and through advising surveys. The advising surveys were administered in person by college advisors each semester in the first year of the program. However, there was a concern about how comfortable and honest a student would be completing a survey while being watched, so the survey was moved to an online format after that. The students were then asked to complete the form within a given timeframe.

Cognitive and affective engagement measures were collected via the Student Engagement Instrument (SEI) developed by Appleton, et al. [6]. The SEI consists of 35 items divided into six categories. Three categories correspond to affective engagement (teacher-student relationships, peer support at school, and family support for learning), and three categories correspond to cognitive engagement (control and relevance of schoolwork, future aspirations and goals, and intrinsic motivation). The survey was given to students each semester during the two-year program so that trends in the engagement levels could be analyzed.

In addition, affective engagement data was also collected via class reflection papers at the end of each semester in the third and fourth semester of the program. The third-semester reflection paper assignment had 12 prompts which asked students to discuss their reasons for applying, their expectations for the program, and their perceived role in the program. The fourth-semester reflection paper was more open-ended and asked students to reflect on their overall experience in the Endeavour Program and also to describe how they felt that the pandemic had impacted their college experience. The reflection papers had no page limit but had a minimum length requirement of two pages.

Data Analysis

Descriptive Statistics

The means and standard deviations of student GPAs and progress towards a degree (in units of course hours) were calculated for both the S-STEM scholars as well as a comparison group which included students who qualified for the program but did not participate. Retention numbers were also calculated for each group. For this study, students were considered to be retained if they were enrolled in a STEM major at the end of the program term. Only the first cohort was considered in this paper since it was the only group to have completed the entire program at the time of writing.

All engagement data collected was also entered in an Excel file and displayed in a dashboard developed by the authors to show engagement trends for each scholar as well as comparison data between scholars.

Inferential Statistics

Student GPAs and academic progress (total completed hours) were compared between the program participants and a comparison group of similar and retained STEM students from the same freshman cohort. A two-tailed t-test was used to compare the means.

Grounded theory drove the qualitative coding process for the reflection papers. This study used Dedoose software to initially code data. The themes were then drawn from those codes and are presented in the findings.

Results

Specific Aim 1: Report student success measures for the first cohort of the Endeavour Program compared with those of non-participants.

Retention, GPAs, and total hours completed toward a major were analyzed separately using a comparison group of peers with similar characteristics. All of these measures are indicators of academic engagement. The results of the analyses are described in the following sections.

Retention

Overall retention numbers for the students in the first cohort of the Endeavour Program were very positive. Two students of the original 20 scholars left the program in the second semester for reasons unknown. Neither responded to requests for follow-up interviews so we can only surmise that they felt that the program was not a good fit for them. Of those two students, one is still in good academic standing in a STEM major and the other is no longer enrolled due to academic suspension. One other student in the first cohort left the program after the third semester as the result of academic suspension (Table 1). For the original 20 students in the first cohort, the overall college retention rate was 90% (18 are still enrolled at the university). For the 17 students who participated in the program for the full four semesters, the retention rate in

STEM (students still enrolled in the College of Engineering, College of Technology, or the College of Natural Science and Mathematics) was 100%.

Table 1 also shows that in the comparison group of students who met the program requirements but did not participate in the Endeavour Program, the overall retention rate was 87.6%. However, the retention rate in STEM was only 70.4%.

Table 1

Participant and Non-Participant Retention Results for Spring 2020

Intervention Experience	Retained in STEM Major		Retained in Non-STEM Major		Not Retained		Total n
	n	%	n	%	n	%	
No Intervention	238	(70.4%)	58	(17.2%)	42	(12.4%)	338
Partial Completion of Intervention	1	(33.3%)	0	(0%)	2	(66.7%)	3
Completion of Intervention	17	(100.0%)	0	(0%)	0	(0.0%)	17
Total	256	(71.5%)	58	(16.2%)	44	(12.3%)	358

GPA and Academic Progress

For the purpose of comparing academic performance between the program participants and the comparison group, only students in the comparison group who were still enrolled in a STEM major after the term of the intervention (fall 2018 – spring 2020) were included. Omitting the students who were no longer enrolled in STEM was done to avoid comparing the academic performance of students who were taking significantly different classes with regard to math and science. The results of the comparison are shown in Table 2.

Regarding cumulative GPA, no statistically significant difference was found ($t(252) = 1.02$, $p = .310$, $r = .255$) between the program participants ($M = 3.250$, $SD = 0.429$) and the non-participants ($M = 3.378$, $SD = 0.494$). In addition, no statistical difference was found between participants and non-participants in number of hours completed toward GPA, $t(252) = -.514$, $p = .610$, $r = -.129$.

Engagement Dashboard

As part of the Endeavour Program evaluation and research study, four types of engagement data were collected from participants at various points throughout the two years (four long semesters) of the program. Understanding when and in what ways to intervene was not always apparent by

simply looking at the student numbers over time. Therefore, the engagement dashboard was developed as a way to compile all of the collected data and to provide an easy-to-read student snapshot of engagement with red flags clearly highlighted. The dashboard separated out each dimension of engagement in table form and also showed color-coded trends for each dimension. The dashboard was not developed before the first cohort of the program completed the program but was incorporated afterwards to determine if this type of numerical and visual representation could have been used to identify semesters when students were at greater retention and academic risk. With the benefit of hindsight, it could be determined if this tool could have prevented some academic pitfalls. In that case, it would make it a powerful new tool for advising future cohorts.

Table 2

GPA and Hours Toward GPA Results for STEM Non-Participants versus Participants

Measure	Retained in STEM		Retained in STEM		t(DF)	p	r
	Participants (4 semesters)		Non-Participants (0 semesters)				
	M	SD	M	SD			
GPA	3.250	0.440	3.375	0.490	1.02 (252)	0.310	0.255
Hours	58.82	10.92	57.55	9.730	-.514 (252)	0.610	-0.129

Specific Aim 2: Describe the methods used to track and analyze different dimensions of student engagement for the first cohort of the Endeavour Program.

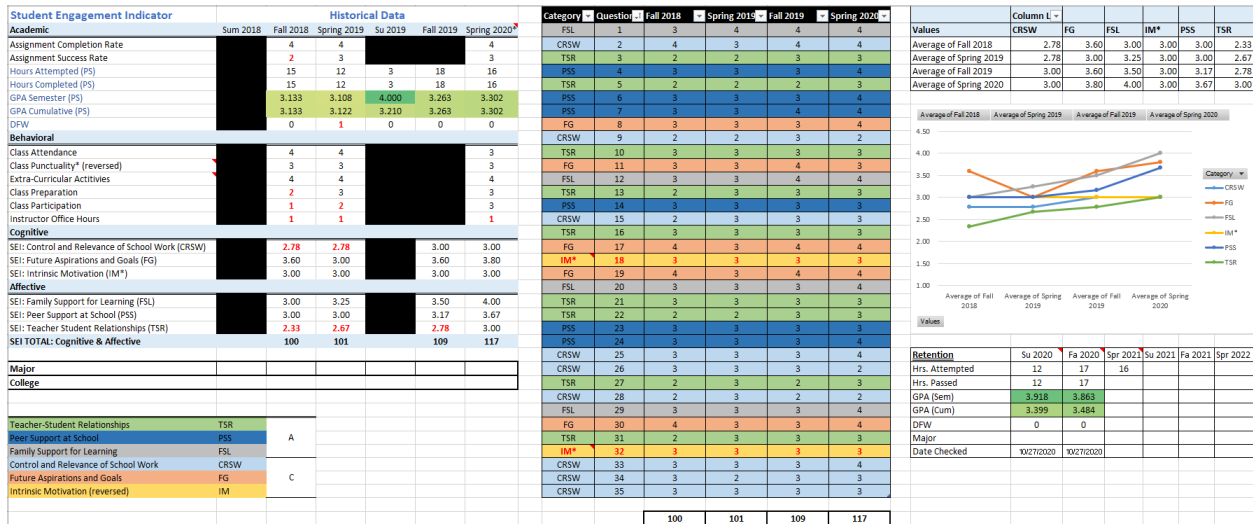
The dashboard consisted of multiple areas which compiled the student engagement data in various forms (Figure 1). One area of the dashboard (upper left) showed a summary of all of the engagement indicators in table form with areas of concern highlighted in bold red numbers. That table was separated into the four engagement dimensions measured (academic, behavioral, cognitive, and affective). Some of the data was collected from institutional data, some from advising surveys/meetings, and some from the Student Engagement Instrument (SEI) surveys. The dashboard provided a way to compile the data from all of those sources to show an overall picture of each category.

Table 3 shows a close-up pattern of the academic engagement measures (which include indicators such as grades and progress). Patterns of green boxes in the GPA columns showed that at least GPA-wise students were performing well. However, deviations from the overall pattern were also easily detected by warmer colors in that area. Table 3 shows how one semester with a dramatic drop in GPA could be easily detected, thereby prompting additional advising sessions. Other red flags in that area show assignment completion rates and grades as self-reported by students on a 4-point Likert scale. Any number below three would alert program advisors to

possible issues. Total hours completed as well as DFW counts were also included in this section to determine if students were attempting too many hours given their GPA history or if they were not making progress in their major. All of that information combined gave the overall level of a student's academic engagement, which without seeing in one place would be difficult to determine.

Below the academic engagement table was a second table listing the behavioral engagement indicators for the student (Table 4). All of the data in this portion of the table were from an academic advising survey given to the students. These numbers were also based on a four-point Likert scale. Once again, any number below 3 was flagged as a cause for concern. For the case shown, the student had become more socially engaged on campus (extra-curricular activities) at the end of the program but showed an overall decline in class engagement. Trends such as these could have been used to guide academic advising sessions and provided a much richer picture for advisors beyond simply considering grades and hours completed.

Figure 1
Overall Layout of the Dashboard for One Student



Although the intent of the NSF S-STEM program is to increase the graduation rate of low-income students in part by eliminating the need to work, some students had to or chose to work a significant number of hours outside of school. High work demands are a major distraction from school and could severely impact behavioral engagement. Data related to student work hours could have provided important context to the behavioral indicators. Therefore, these data will be included in the dashboard for the next cohorts.

The next two tables included below the behavioral indicators were the cognitive and affective engagement scores from the Student Engagement Instrument (SEI) [6]. The SEI is a 4-point Likert scale survey that was given to the participants each semester in the program. The scores for each category of the SEI were displayed as well as the total SEI score (Table 5). The red

highlighting in this table again shows areas of possible concern. In the example shown, the data show a negative pattern of feelings regarding parental support. An advisor seeing this trend would be able to more appropriately guide advising sessions. Moreover, this table format helped to distinguish this dimension of engagement from those related to support at school, which could be an important distinction that may have been missed if the different categories had not been tracked separately.

Table 3

Academic Engagement Indicators as Shown on the Dashboard

Academic	Sum 2018	Fall 2018	Spring 2019	Su 2019	Fall 2019	Spring 2020*
Assignment Completion Rate		3	4			3
Assignment Success Rate (Grades)		4	3			2
Hours Total Attempted (PS)		17	19	0	17	14
Hours Total Completed (PS)		17	19	0	17	10
GPA (Semester)		3.883	3.473	N/A	3.529	2.801
GPA (Cumulative)		3.883	3.667	3.667	3.622	3.492
DFW; NCR Count		0	0	0	0	1

Note: Black portions of the table indicate that no data was collected for that measure in that semester. Scores in the top two rows are based on a 4-point Likert scale in which low scores indicated negative behaviors.

Table 4

Behavioral Engagement Indicators as Shown on the Dashboard

Behavioral	Sum 2018	Fall 2018	Spring 2019	Su 2019	Fall 2019	Spring 2020*
Class Attendance		4	4			3
Class Punctuality* (reversed)		3	2			2
Extra-Curricular Activities		2	2			4
Class Preparation		3	4			2
Class Participation		3	4			2
Instructor Office Hours		1	1			1

Note: Black portions of the table indicate that no data was collected for that measure in that semester. Scores are based on a 4-point Likert scale in which low scores indicated negative behaviors.

In addition to the averages for each category, the total SEI score was displayed at the bottom of the table to give a quick snapshot of overall cognitive and affective engagement and how those measures changed over time.

A pivot table and chart were included on the right side of the dashboard interface to show semester results and trends in just the SEI responses. Both the pivot table and chart were derived

from the collected SEI data shown as the colorful section in the center portion of Figure 1. The pivot table showed just the averages of each SEI category over time (Table 6) and the chart (Figure 2) showed the same data in graphic form. The chart was color-coded to the data table to make trends in each SEI category easy to visualize. Figure 2 shows a student whose engagement levels in most dimensions held steady over the course of the program. However, there was a dramatic decline in intrinsic motivation (IM) over time which was made apparent through the chart. This drop correlated with changes of in-class behavior with this student. Had the chart been used by advisors at the time of the first drop, this particular issue could have been discussed during advising sessions and perhaps assistance provided to bring the scores back up. Once again, it is noted that the observed negative trend in IM would have been missed by considering engagement to be a single construct. The many different dimensions being studied provide a much deeper understanding of the overall student experience during these critical first semesters.

Table 5

Cognitive and Affective Engagement Indicators as Shown on the Dashboard

	Sum	Fall	Spring	Su	Fall	Spring
Cognitive	2018	2018	2019	2019	2019	2020*
SEI: Control and Relevance of School Work (CRSW)		3.44	2.44		2.67	3.22
SEI: Future Aspirations and Goals (FG)		2.60	3.40		3.60	2.60
SEI: Intrinsic Motivation (IM*)		4.00	4.00		4.00	3.50
Affective						
SEI: Family Support for Learning (FSL)		2.00	1.50		2.25	2.75
SEI: Peer Support at School (PSS)		3.33	2.83		3.33	3.83
SEI: Teacher Student Relationships (TSR)		3.22	2.33		2.44	3.22
SEI TOTAL: Cognitive & Affective		109	91		101	112

Note: Black portions of the table indicate that no data was collected for that measure in that semester. Scores are based on a 4-point Likert scale in which low scores indicated negative behaviors.

One last area of interest in the dashboard interface is a table with post-program retention and academic data (Table 7 and bottom right of Figure 1). These data will continue to be collected for past participants throughout the term of the grant.

SEI Comparison Data

In addition to the engagement dashboard, a table showing how each program participant ranked on the SEI for a single semester was created (Table 8). This table and the related figure (Figure 3) were modeled after a large study and advising program created for a large urban K-12 school district [5]. The percentile ranking shown in the table immediately identified the students in the cohort that had the lowest engagement scores for that semester. The data was also displayed in graphical form to see how students compared in overall engagement as well as in the different SEI categories (Figure 3). A future version of the engagement dashboard will also include a similar chart which will show changes in the SEI category averages between semesters for each student.

Table 6

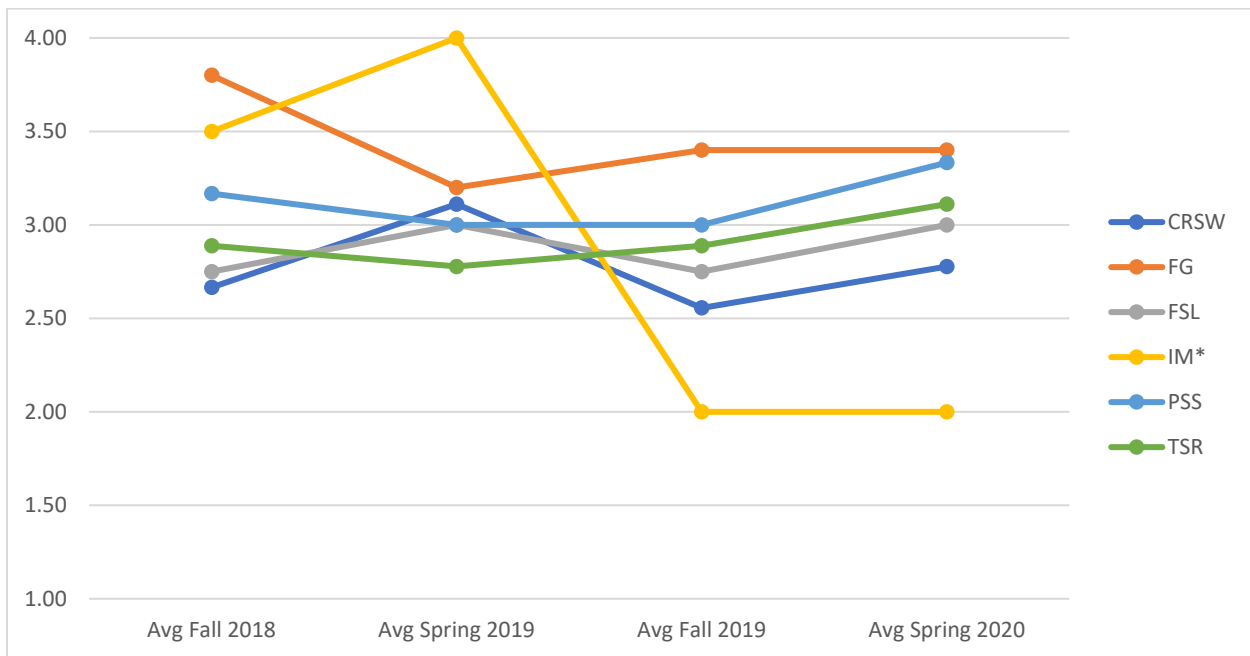
Compilation of SEI Scores in Table Form for One Student

SEI Results by Category & Semester	Column Labels					
Values	CRSW	FG	FSL	IM*	PSS	TSR
Avg Fall 2018	2.67	3.80	2.75	3.50	3.17	2.89
Avg Spring 2019	3.11	3.20	3.00	4.00	3.00	2.78
Avg Fall 2019	2.56	3.40	2.75	2.00	3.00	2.89
Avg Spring 2020	2.78	3.40	3.00	2.00	3.33	3.11

Note: CRSW = Control and Relevance of School Work; FG = Future Aspirations and Goals; FSL = Family Support for Learning; IM = Intrinsic Motivation (items are reverse coded, so responses have been inverted before being entered); PSS = Peer Support at School; TSR = Teacher Student Relationships.*

Figure 2

Compilation of SEI Scores in Chart Form for One Student



Note: CRSW = Control and Relevance of School Work; FG = Future Aspirations and Goals; FSL = Family Support for Learning; IM = Intrinsic Motivation (items are reverse coded, so responses have been inverted before being entered); PSS = Peer Support at School; TSR = Teacher Student Relationships.*

Table 7

Post-Program Academic Engagement Measures Tracked Through Graduation

<u>Retention</u>	Su 2020*	Fa 2020*	Spr 2021*	Su 2021	Fa 2021	Spr 2022
Hrs. Attempted	12	16	17			
Hrs. Passed	12	16				
GPA (Sem)	3.917	3.864				
GPA (Cum)	3.398	3.485				
DFW, NCR Count	0	0				

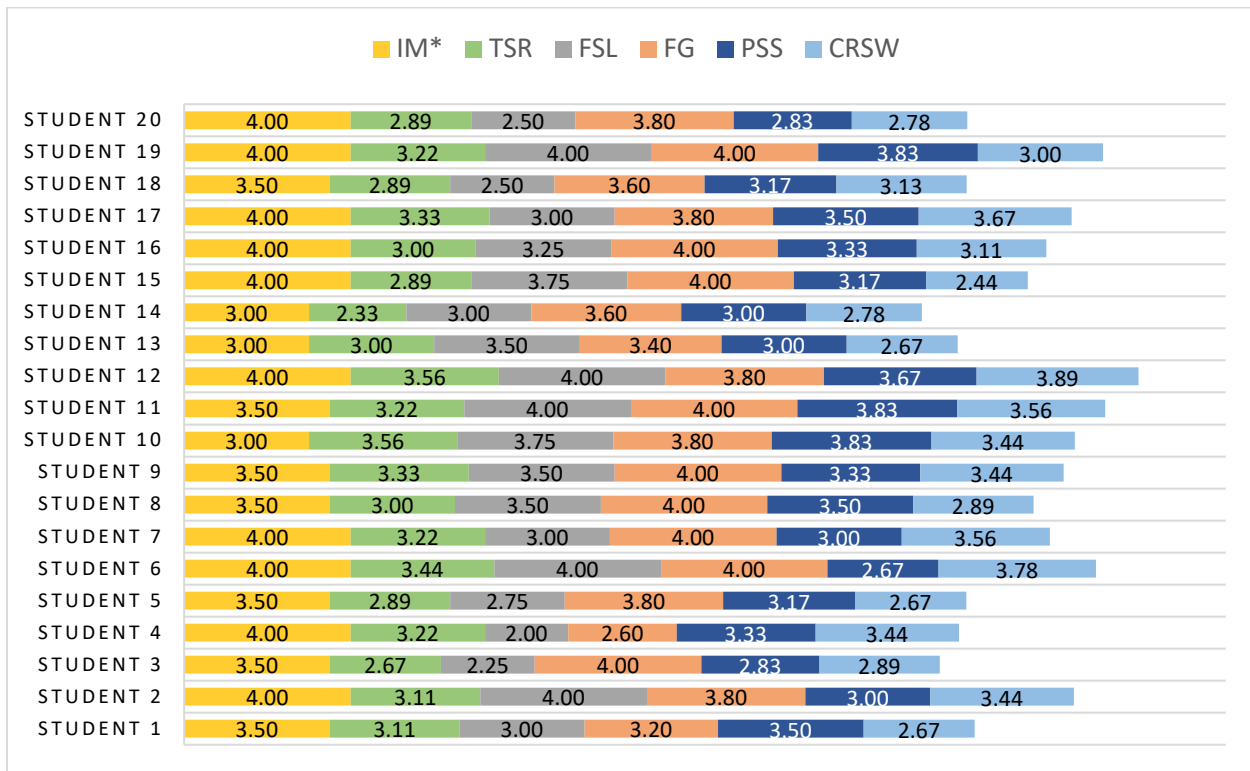
Table 8

Program Participant SEI Rankings for a Single Semester

Student	IM*	TSR	FSL	FG	PSS	CRSW	SEI Mean	Percentile
Student 1	3.50	3.11	3.00	3.20	3.50	2.67	3.16	Middle 80%
Student 2	4.00	3.11	4.00	3.80	3.00	3.44	3.56	Middle 80%
Student 3	3.50	2.67	2.25	4.00	2.83	2.89	3.02	Lowest 10%
Student 4	4.00	3.22	2.00	2.60	3.33	3.44	3.10	Middle 80%
Student 5	3.50	2.89	2.75	3.80	3.17	2.67	3.13	Middle 80%
Student 6	4.00	3.44	4.00	4.00	2.67	3.78	3.65	Middle 80%
Student 7	4.00	3.22	3.00	4.00	3.00	3.56	3.46	Middle 80%
Student 8	3.50	3.00	3.50	4.00	3.50	2.89	3.40	Middle 80%
Student 9	3.50	3.33	3.50	4.00	3.33	3.44	3.52	Middle 80%
Student 10	3.00	3.56	3.75	3.80	3.83	3.44	3.56	Middle 80%
Student 11	3.50	3.22	4.00	4.00	3.83	3.56	3.69	Highest 10%
Student 12	4.00	3.56	4.00	3.80	3.67	3.89	3.82	Highest 10%
Student 13	3.00	3.00	3.50	3.40	3.00	2.67	3.09	Middle 80%
Student 14	3.00	2.33	3.00	3.60	3.00	2.78	2.95	Lowest 10%
Student 15	4.00	2.89	3.75	4.00	3.17	2.44	3.38	Middle 80%
Student 16	4.00	3.00	3.25	4.00	3.33	3.11	3.45	Middle 80%
Student 17	4.00	3.33	3.00	3.80	3.50	3.67	3.55	Middle 80%
Student 18	3.50	2.89	2.50	3.60	3.17	3.13	3.13	Middle 80%
Student 19	4.00	3.22	4.00	4.00	3.83	3.00	3.68	Middle 80%
Student 20	4.00	2.89	2.50	3.80	2.83	2.78	3.13	Middle 80%

Figure 3

SEI Category Averages for All Program Participants in a Single Semester



Specific Aim 3: Describe both the college and program experience from the perspective of the Endeavour Program Scholars.

At the end of both semesters in the second year, the program participants were asked to submit reflection papers regarding their experience in the Endeavour Program. Some specific prompts were included (e.g., “Why did you decide to join the Endeavour Program?”) as well some more open-ended prompts (e.g., “What does it mean to be part of the Endeavour community?”).

In the qualitative analysis of the student reflection papers, three themes emerged from coding: 1) forming and growing social networks, 2) growing in possible self, and 3) finding resources to find success. Each is discussed in turn in the following subsections.

Forming and Growing Social Networks

Students described the role participation in S-STEM had in helping them develop and expand their networks of support. This observation was particularly true during the Spring 2020 semester marred by COVID 19. One student captures well this thematic sentiment.

During this horrible pandemic, one of the groups that I keep in contact the most is actually our research team under Dr. X. By holding regular zoom meetings and checking each other's work, we are able to make the assignments less challenging and more enjoyable. Often times, we are off topics by having sports, politics, entertainment, and other miscellaneous discussions. However, each person in our group is reliable, responsible, and have adequate input in our group's project. I guess our teamwork is seamless because we comprehend each other's strengths and weaknesses. For example, someone from Engineering college would do the engineering aspect (like MATLAB) of the research while NSM students would help take care of data collection and perform stats on the project. From this research, I actually learned a little more about MATLAB simulations from my friends in Engineering college, which was really cool.

Participants identified several specific ways in which networks constructed as a function of participation influenced their college experience. For some, the benefits were technical. "This community has led to the advancement of my studies, with respect to the 2-bit calculator, the image processing project, and the big research project at the end of sophomore year. This has given me an advantage over my peers because most Sophomores do not complete the tasks that Endeavour has led us to complete." For others, these networks became broader sources of support and assistance.

The community itself became a network for us students to rely on each other when we needed help. Coming into college, I believe is not always comforting since our high school friends moved to other colleges; leaving most students alone to find new friendships. However, I don't believe I had the time to feel lonely thanks to this community. I was able to make friends who not only support me in school, but support me emotionally as a person, in other words, actual friends who care about me as a person.

Most prominently, though, participants in the program developed deep and lasting friendships and collegueships which they saw as beneficial well beyond the time of the program itself. Three different students' voices capture this sentiment clearly.

I have honestly developed a good relationship with two of the people that are in the s-stem course. I am so close to one of them that I want to see her [at] my wedding or baby shower. I am a person that easily feels bad when I ask a stupid question, or I just don't want to ask it because I'm afraid that I would be viewed as unintelligent. Some people think that I am so blunt with everything that I say. Yes, I'm a blunt person, but only with the things that I want to be with. The questions I may ask that are dumb, are not necessarily due the fact that I can't figure it out, but more with the fact that I didn't get all the information. In a sense, I grew up with the idea that I can't be that stupid, perhaps a little, but not too much. When I'm with one of these members, I feel like I can let my guard down. In a sense, it makes me feel accepted even though I can make a lot of errors or be dumb in some situations. I can truly show all my thoughts and concerns to this person without worrying that I'll be less of a person. I think that with all the members I

have developed a cordial relationship of acquaintances; but with these two people that I'm talking about, well I can those two real friends. (Student A)

I have learned that it is okay to make friends in college. I did not expect to make so many these last two years especially because of my introverted personality. I prefer to struggle on my own and get through everything by myself but some of the current friends forced themselves into my life and I appreciate it. They are funny, cool, and good people at heart. (Student B)

I did not expect to make many new friends through my college years. I expected semester friends however with this two-year program, many of the cohort members have become close friends of mine that I hope to keep.

Growing in Possible Self

Students also identified the role of the program in helping them envision possible selves. For some, that expanded trajectory was skills-based.

The biggest benefit from the program were the projects. Although I personally believe that I was not too good at them, I finished them well. Also, when I went to an interview for an internship, the interviewer actually asked about one of the projects. For our final project, we did image processing with MATLAB to identify the right Potato [Head]. I put that on my resume and it obviously caught his eye because it was not related to the job but he still talked a little bit about it. I feel like that gave me a slight advantage above the other candidates.

Similarly, another student describes:

My expectations when I joined was that the program would make it easier for me to start in my discipline. I was expecting that we would be programming and learning about electronic components, and maybe even do a project or two. My expectations were almost exactly how the program turned out. I say almost since we obviously did robots and learned about electronics as the course describes, but more importantly, we also got professional development, networking, and research experience from the guest speakers, assignments, and the required events (such as career fair), which was a lot more than I had expected (although I really wished we did some more electronics and programming in our current sophomore class, but that's just a personal thought).

For others, the evolution of their understanding of capacity pushed into career trajectories. "I absolutely would not have had the knowledge of nor the courage to apply for the Houston Early Research Experience Summer 2019 if it weren't for S-STEM. A good chunk of my resume would not have existed if not for the skills that S-STEM helped me to develop." Another student offers, "Being an S-STEM scholar completely widened this viewpoint of mine and changed my perceptions for the better and to be more inclusive. In turn, I am now more aware of how else I can better expand my career as a student and the paths that I can choose to invest myself in."

Finally, for many, the program offered an opportunity to think more broadly about who they were and had capacity to be in whole.

This program completely changed college for me. In the fall, I'll be moving onto my junior year. My first semester here at UH in which I won't be attending an S-STEM class or even be a current S-STEM scholar. However, instead of feeling as if this crutch of mine has been taken away, my emotions are in the polar opposite of this spectrum. I am looking forward to it. Above everything, S-STEM armed me with the confidence to continue and fully maximize the remainder of my time here at the University of Houston as an undergrad. It has also equipped me with the courage to envision myself in pursuing academia, a route that I never thought I could ever picture myself pursuing or think I had a shot at. Lastly, my time in S-STEM has encouraged me to open the doors to others the way they were opened up for me.

Finding Resources to Find Success

Funding associated with the program served as the consistent initial motivator for almost all participants. For some, the scholarship funding was a fundamental gateway to learning, as represented by one student.

When I first heard of the S-STEM program, the main thing that drew me to want to join was the money. That was not the only thing that drew me to join but, it was a big factor. From a young age, I knew I would have to work for everything I wanted including an education. I wanted to go to a university and the only way possible from what my parents told me was by getting good grades in school and working outside of school. I have been working since the age of 14 however, with this scholarship and others, I have been able to take off working for over a year now, allowing me the best opportunity to be successful in school and explore many of my career interests.

More completely, students described how essential the scholarship was in allowing them to more fully engage in all that the college experience could provide. Scholarship funding "lifted burdens" that then provided space to engage in career and technical building activities likely to meaningfully advance their career possibilities.

One student writes:

I think the financial help would be the most important because without it, it would put a lot of students in the position of keeping track of their college life with having to worry about how they're going to pay to keep doing what they're doing. With financial help, there would be a huge burden lifted and most of what a student would have to worry about is either studying for a test or how to apply for internships or jobs, instead of working external jobs or taking extra loans that will probably bite them in the ass in the future. Honestly, the financial help is a godsend.

Similarly, another student offers:

Another big part of Endeavour is the financial support that it gave me. It allowed me to live on campus for my freshman and sophomore year. Living on campus is an amazing experience, for me, because I can always go to events and spend more time with my friends. It also allowed me more time in my studies because I did not have to dedicate my time each day to a commute from home to school, which was really helpful to me. This program also supported me in my career development. It encouraged me to go to career fairs and talk to recruiters, and it taught me how to promote myself. It also helped me in my time management skills, too, with respect to the time management workshop, I learned how to manage my time better and to plan out my week ahead of schedule, I know it may seem simple, but it really helped, because that is how I am able to complete assignments quicker.

Beyond only financial supports, participants identified the role of a supportive faculty and academic infrastructure in providing resources in support of their success. On the front line, having a college advisor specifically assigned to the program served as a key touchpoint for students. “Receiving help from your own college advisor is also a huge plus, especially after Endeavour and the Challenger Program merged. In my opinion, Mrs. Floyd does an awesome job at notifying us of different opportunities that are available on campus like the Emergency Financial Aid Grant. She, and the other advisors, also understand how challenging the college course load, so she will be frank...” Similarly, students identified the program’s director as a lynchpin to their success. “Dr. D held this program together through the ups and downs with admirable grace, efficiency, and honesty. From the very beginning, Dr. D established an open relationship with us especially when the matter is on the current and future state of [Endeavour] S-STEM. With every curveball the program faced, Dr. D informed us immediately and opened the floor for suggestions, questions, and opinions. She valued our voices and wanted to hear all that we had to say. It never felt as if there were matters being swept under the rug or being kept under wraps because everything was out in the open.” The presence of expert faculty and staff who also infused genuine care and concern for students created comfortable conditions that allowed students to vulnerably seek help ultimately maximizing their likelihood for success.

Participants also learned through the program the importance of and opportunities to tap into resources aimed at building emotional capacity. As one student notes, “No matter what degree we’re in, we’re all struggling.” The curricular attention to the whole learner shown through in importance for many. Another student writes that “It has given us information about how to cope with any anxiety or stress. Although it might not seem helpful, I guess just the idea of hearing someone say its [sic] okay to be overwhelmed and if you need anybody there is people willing to listen to you is comforting.” As similarly described by a different student, “The exposure to career and mental health services...Dr. D works tirelessly to break the taboo around this early on in our time as a student has been so beneficial.” In short, students in the program learned the important skill of struggling successfully. “It also helped me face new tasks that I didn’t fully understand and get through them by asking for help when I needed it or just looking at what I did wrong. This program taught me how to balance my lifestyle with homework and social activities. It’s something I’ve always needed to work on and I’m still struggling to perfect it. It’s helped me

get in the right direction and realize that I haven't been putting in as much effort as I need to be in my classes.”

Conclusion

Interpretation of Findings

Regarding the academic measures of GPA and total hours, the data show no significant difference between the program participant group and the comparison group of similar peers. However, the retention rate in STEM for the participants was markedly higher with 100% of the participants completing the program being retained in STEM. But these quantitative results do not show the real impact that is being made through the Endeavour Program. Through class reflection papers, the participants began to provide a richer description of the program experience. A theme of access began to emerge: access to institutional resources, access to research and design opportunities, access to professional development opportunities, access to personal development opportunities, and access to outreach opportunities. These are resources and opportunities which low-income students often find difficult to locate because they lack the social and professional networks on campus to help them navigate the academic waters. Many affluent students already have campus experiences when they arrive, or have parents or mentors that can guide them through the typical obstacles. For low-income students, having to navigate the complex system that is a university becomes an unnecessary distraction from the goal of graduation. Moreover, we found that many of our students were unaware of the academic, professional, and financial expectations placed on them. They simply arrived on campus with no plan and almost always with no social network to support them when the struggles became overwhelming. The Endeavour Program was always meant to be an *experience* program. It was believed that if these students were immersed in engaging group experiences, they could form a community that would support them both during and after the formal program term. The quantitative data show that these students are almost all persisting and continuing to pursue careers in STEM. Yet it is the qualitative data that show the extent to which the program participants have formed personal and professional networks. The theme of friendship is common in their responses, and many feel that they would have struggled through the first year(s) alone without the program. The participants also say that they wish to build even larger and stronger networks by joining the different cohorts and extending the program beyond the second year. In this sense, the Endeavour Program has succeeded in building the community of scholars that it sought to create. And viewing this cohort through the lens of our engagement dashboard demonstrated promise in detecting early warning signs that if ignored could result in poor academic performance. Therefore, an updated version of the dashboard will be used with the next cohorts throughout the program as a way to personalize advising. And as more engagement data is collected, the dashboard will continue to be updated to better support advisors. Ways to incorporate some of the qualitative data into the dashboard may also be investigated. Regardless, it is clear that more forms of qualitative data collection (e.g., interviews) need to be added to the data set to pinpoint the most significant impacts of the

program, the relationship between the specific engagement measures and student success, as well as how the program can be improved.

Challenges and Lessons Learned

Not all surveys were given to the participants during each semester (as can be seen from the black boxes in the dashboard tables). Sometimes this was done to prevent test fatigue. Sometimes this was due to scheduling problems with advisors during a given semester. And sometimes it was simply an oversight. But for the engagement dashboard to be a truly effective tool for advising, it is important that trends across all semesters of the program be shown. To this end, the data collection plan will be updated so that all surveys will be conducted each semester for future cohorts. In addition, the program staff will be working with the Math Department to administer the SEI to all incoming freshmen. Doing so will provide a large comparison group for the SEI data already being collected from the participants.

One major challenge experienced with this first cohort is one that probably most researchers can relate to at this time. As everyone has experienced major interruptions with the COVID-19 pandemic, the Endeavour Program was no exception. Half-way through the last semester of the first cohort term, the University of Houston switched to an online format of instruction as did most universities across the country. This second year of the program was to be the research experience year for the cohort. (The first year was a design experience.) The unexpected departure of a staff member who was to direct the undergraduate research year left the remaining staff with little time to develop a new plan for the second year of the program. Therefore, the third semester of the program had to be quickly redesigned and there was a large delay in getting students teamed up with faculty mentors and research projects. Well into the fourth semester the students were beginning to finally make progress even with a very compressed timeline. However, the transition to online learning after spring break ceased all research activities for the students making it a not-so-engaging end to an engagement program. Although the staff does not expect to endure another global pandemic in the span of this grant, the sudden changes brought on by the pandemic do remind us how disproportionately low-income students are impacted by such changes. Future program designs should bear in mind temporary disruptions and have a plan to keep students engaged during those times. Many of the huge gains in community building seen in the first year were severely impacted by the move off campus. And although it is hard to know how one could have prepared for such an unprecedented event, moving forward, the program needs to develop an alternate curriculum for some type of disruption.

Even without the move to online learning, there was an insufficient lack of interaction between the two cohorts which was made clear by the student feedback. The program was designed to have four independent cohorts. But as the students took on the identity of the program, the sophomores were eager to mentor the freshmen and the freshmen were eager to know who comprised the rest of the Endeavour family. Unfortunately, due to the program pause caused by the pandemic, the program will reset again in the fall of 2021 with only one cohort in the pipeline. Therefore, there will be no sophomore class to mentor the incoming freshmen. But the staff will do their best to

encourage the program veterans to assist with future activities and will modify the current curriculum to bring the two remaining cohorts together on more occasions.

As mentioned earlier, enthusiasm dropped significantly moving into the second year due to the fact that working on research projects did not have the same day-to-day energy and structure of the first-year design projects. Hence, the staff will be revisiting the structure of the second-year research experience to try to bring that same level of class interaction and hands-on learning to the second year that was so successful in building a community in the first year.

The program participants also indicated that they wanted to engage more with each other outside of an academic environment and spend time with the staff in a more casual setting. So more social events will be added to the program to bring active cohorts, staff, and program veterans into one unified Endeavour community. Specifically, these events should increase the students' affective engagement and potentially positively impact their overall college experience as well as their academic success measures.

Significance of the Study

Although there is an abundance of research related to school engagement, the bulk of the research studies presented in the literature have been conducted in K-12 settings (e.g., [3]). The results from this study contribute to the knowledge of how engagement plays a role in student success at the college level. Moreover, this study shows how a richer and clearer picture of engagement can be produced by measuring engagement as a multi-dimensional construct. Also, the development of the engagement dashboard provides an example of how a detailed and very informative tool can be created using a standard application such as Excel. Anyone with a decent knowledge of Excel can use this template, which is based on previous research [6], to customize a powerful advising tool.

Limitations

As with any research study, there are limitations to the findings that should be noted. One such limitation is a change in grading policies in the spring of 2020 due to COVID-19. Students in that semester were given the option to forego a letter grade in all of their classes and accept a No Credit instead. Students used this policy not only for failing grades, but also for passing grades that would negatively affect their GPA. Therefore, any analysis related to GPA would be affected by the inconsistent use of this policy. Analysis of GPAs over time will also be affected since the spring 2020 grades may be inflated due to the policy.

In addition, because the program participant group is so small (20 total and 17 who completed the program), any parameters derived from the data are highly susceptible to outliers. This fact should be kept in mind when using these parameters to evaluate educational significance.

Another limitation of the study is that there was no comparison group for the SEI data. Although patterns of engagement can be analyzed for each participant and between participants, there is currently no way to know if those trends were typical of their peers or if they would have been

statistically good predictors for student success. However, the intent of the Endeavour staff is to add an SEI comparison group for future program cohorts.

Future Work

As the University of Houston makes plans to return to campus in the fall of 2021, the Endeavour staff will begin to recruit the third freshman cohort of scholars. Two new sets of data will be added to the study for those cohorts along with the current cohort (Cohort 2) which is set to complete the program in spring of 2021. Each cohort will be impacted differently by the COVID-19 pandemic. The program staff will be looking at how the engagement patterns of each cohort are affected given the type and duration of campus restrictions due to COVID-19.

Human Subjects

The research methods for this study have been approved by the University of Houston Internal Review Board (IRB ID: STUDY00000716).

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Keywords

Student Engagement, Student Engagement Instrument (SEI), NSF S-STEM, STEM Retention

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