Session XXXX

Endeavour S-STEM: Supporting High-Achieving Underserved Students in STEM

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Abstract
Students from underserved populations face many obstacles in their endeavor to obtain a bachelor's degree in STEM. The challenges are not only financial, but also academic and social. These students often arrive on college campuses lacking adequate support structures to help them navigate a very rigorous and sometimes confusing curriculum in an unfamiliar environment. Therefore, support programs designed to assist these students should address not only their financial needs, but also other gaps in their professional knowledge, academic preparedness and social support structures. The goal of the Endeavour S-STEM Program at the University of Houston has been to investigate the impact of a holistic approach to student support for STEM undergraduates across two colleges. Support services in both the College of Engineering and the College of Natural Science and Mathematics (NSM) have been enhanced and shared to financially support as well as academically and socially engage students who may be at an increased risk with regard to retention. Early findings from the Endeavour Program suggest the initial efforts are staving off typically expected patterns of struggle. Data show that the participants that the Endeavour Program was designed to support (i.e., students with demonstrable risk factors) have statistically indistinguishable outcomes from their peers. This early evidence supports the hypothesis that participating in these programs will increase the level of student engagement and hence student performance and persistence putting them on a path to graduation in STEM. While these findings are positive, the results point to further work that remains to be done.

Introduction
In the United States, first-time full-time (FTFT) college students who entered a 4-year degree-granting institution in 2015 were retained at a rate of 81% (95% for selective schools). However, for that same academic year, the 6-year graduation rate (150% of "normal time") was only 60% (Mcfarland et al., 2018). Among students seeking bachelor's degrees in STEM, just over one half remain in STEM after six years (Chen, National Center for Education Statistics, & R. T. I. International, 2013). For underrepresented minorities (URMs), the picture looks even bleaker. In 2014, URMs were over 30% of the working-age population in the United States (National Science Foundation & National Center for Science and Engineering Statistics, 2017). However, just a few years later African American students were earning only 4% of the engineering degrees and less than 12% of degrees in each of the science and mathematics fields. At that same time Hispanics

accounted for only 10% of the engineering degrees and less than 15% of science and mathematics degrees.

For URM students from low-income families, the financial hardships create an additional drag on retention rates. Students from low-income families often find that their family financial obligations as well as other income-related obstacles (e.g., transportation security, social capital) create a strong pull to an educational off-ramp even when those students demonstrate high academic ability. And predictably the lower end of the spectrum gets hit the hardest. While students at public institutions who receive only subsidized loans (no Pell Grants) graduate at almost the same rate (59%) of the overall student population in six years (60%), students who receive Pell Grants graduate at a rate of only 44%. For FTFT undergraduates from families with an annual income of $30,000 or less, the average *cost of attendance (COA)* and *net price* for a public institution are $20,000 and $10,000 respectively. Therefore, a family making $30,000 a year is being asked to find an additional 33% of their annual income to send one child to a public four-year institution for one year. For private institutions, the financial obstacle becomes almost insurmountable. The average cost of attendance is $28,000 per year and the average net price (after grants and scholarships have been applied) is $21,000 (Ginder, Kelly-Reid, & Mann, 2018). This amount equals 75% of the family's yearly income, an inconceivable sacrifice for any family.

And while the financial challenges for low-income students are significant, money alone does not eliminate all retention risks for these students. Other issues such as lack of knowledge of institutional processes and available support services, stereotype threat, lack of reliable transportation, mental health issues, and insufficient academic preparedness all contribute to low retention rates. Therefore, programs which aim to make a significant impact on the retention and graduation rates of low-income students in STEM must think about the student educational experience on campus more holistically. Money is simply not enough to make the problems go away.

There is a wealth of education literature supporting the positive relationship between engagement and academic achievement (e.g., Christenson, Reschly, & Wylie, 2012). Institutions wanting to increase the student success rates on their campuses should then consider focusing a significant amount of resources on activities that increase student engagement. However, it has been noted that engagement is often a luxury that low-income students cannot afford (Kezar, Walpole, & Perna, 2015). Engagement requires time. And as low-income students often try to balance the forces of having to work to pay for school and also taking a large number of hours to receive tuition breaks, finding time to engage at any level on campus becomes for many an impossibility.

The Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) program at the National Science Foundation (NSF) was created to address this issue of time. The S-STEM program provides funds to universities across the nation to financially support underserved students through STEM scholarships. Endeavour is one of these supported programs. By providing scholarships for low-income STEM students, the Endeavour S-STEM Program alleviates some of the financial pressure to work in non-STEM related jobs (usually off-campus). For some students this support is sufficient to allow them to quit working entirely. This reduction in working hours allows students to more fully engage with the university through the many academic, professional, and social activities provided by the Endeavour Program as well as its partner programs on campus. Ongoing research by the authors seeks to determine if this financial assistance combined with the program activities and support can significantly reduce the negative impact of risk-factors for low-income students in STEM.

The Endeavour S-STEM Program

The UH Endeavour Program is a two-year STEM engagement program funded through an NSF S-STEM grant (NSF No. 1742579). Managed through the Department of Electrical and Computer Engineering, the program financially supports cohorts of 20 STEM students. Low-income students who demonstrate high academic potential in high school and on standardized tests are recruited before their freshman year and selected based on need, previous academic achievement, and application survey responses. The first cohort of students was selected in the summer of 2018. Twenty students were selected from both the College of Engineering (10 students) and the College of Natural Science and Mathematics (10 students) and completed their first year of college in the spring of 2019. Although the Endeavour program was designed to increase student engagement on four dimensions (academic, behavioral, cognitive, and affective), this paper presents early results of only two types of student engagement (academic and behavioral) from the first cohort.

The goal of the Endeavour S-STEM Program at the University of Houston is to positively impact the retention and graduation rates of high-achieving low-income students in four cohorts in STEM over five years. Towards that end, program elements have been designed and utilized to provide a holistic approach to student support for STEM undergraduates across two colleges. Services in both the College of Engineering and the College of Natural Science and Mathematics have been enhanced and shared to financially support as well as academically and socially engage students who may be at an increased risk with regard to retention.

Given the research supporting engagement as an effective means of improving student achievement, and hence retention, the Endeavour Program has focused on significantly increasing the engagement levels of the program participants. Although different motivation frameworks will often use different terminology to describe distinct aspects of engagement, most converge around three to four themes including elements of outward academic behaviors, cognitive processes, and emotional connections. The framework adopted in this study is the four-dimensional perspective outlined by Appleton (2012) which are 1) academic engagement, 2) behavioral engagement, 3) cognitive engagement, and 4) affective engagement. The Endeavour Program as a whole addresses all four elements of Appleton's framework. *Academic engagement* refers to behaviors which have the purpose of high academic achievement (e.g., attaining good grades, completing assignments, and accruing hours towards graduation). *Behavioral engagement* is defined as behaviors that demonstrate a respect for or adherence to school policies and norms (e.g., attending classes, being on time). *Cognitive engagement* refers to behaviors that demonstrate effort and an investment in learning. These are behaviors that show students going beyond what is required (e.g., seeking to improve work, seeking challenging work, and staying on task). And finally, *affective engagement* (sometimes called emotional engagement) is a measure of the emotional attachment and identification with the school at different organizational levels. In this context, the school includes both peers and staff as well as the actual academic work. All four types of engagement have been shown to be related to student achievement and therefore retention. Each of the four types of engagement has been measured independently, and it has been shown that students can score high on one measure and low on another. However, the components tend to be highly correlated, and therefore any one student is likely to score high (or low) on multiple engagement dimensions at any given time (Finn & Zimmer, 2012). In order to have the greatest impact on student engagement, student success programs that aim to improve student achievement should be designed with elements of the intervention to address all four of the engagement dimensions simultaneously, since raising engagement on one dimension is likely to be linked to an increase in engagement on another. With this multi-dimensional goal in mind, the Endeavour S-STEM Program brought together a set of proven support services and programs from across the campus. Each element of the program was intentionally incorporated to impact one or more of the four dimensions of engagement outlined above and was based on evidence-supported practices.

Through this program each participant receives a $2,000 scholarship per semester for the first two years (freshman, sophomore) of school. This amount is typical of the unmet need of the program participants each semester. Since the students must demonstrate high academic achievement to qualify for an S-STEM scholarship, most of the participants already have sizeable financial aid packages available to them for school. The support that the S-STEM scholarship provides typically pays all or most of the tuition balance and allows the student to work fewer hours (or none at all) giving them more time to participate in program activities.

As far as program expectations, participants are required to take a one-hour course each semester in the first two years of college. The first year is a hands-on project-based robotics curriculum, while the second year is an undergraduate research experience with a faculty mentor. The mandatory weekly class meetings are a significant part of the engagement intervention as the effectiveness of project-based learning and undergraduate research experiences in increasing engagement has been well-established in the STEM education literature.

Another major component is the community-building through the program's small learning community (SLC). The mandatory courses are designed to be highly engaging, low stress, and have a strong emphasis on program identity. Only the program participants are allowed to take these courses. There are no sections offered for other students. Students are also strongly encouraged to support each other in and out of class. Since the program has all of the characteristics deemed to be essential to a SLC (student teams, teacher teams, collaboration on curriculum, a separate space within the school, a distinctive focus, student autonomy, and flexibility) (Anderman & Weber, 2009), it is not surprising that many friendships and study groups have formed through these courses.

And finally, the program enlists the services of other campus and off-campus support groups such as Counseling and Psychological Services (CAPS), the Engineering Career Center (ECC), industry speakers and advisors, and the engineering library services. The program has also partnered with other well-established student success programs on campus such as the Scholars Enrichment Program in NSM (SEP) which provides academic workshops, the Program for Mastery in Engineering Studies (PROMES) which provides outreach opportunities, and the Challenger Program (university-wide first-generation program) which provides academic tracking and advising. With all of this support, the expectation is that the performance and retention of the non-participant comparison group will be matched or surpassed by the program participants (scholars) despite their increased risk factors.

First-Year Results

Of the four engagement types, academic and behavioral are the most directly observable and are the two presented in this paper. The remaining engagement dimensions (cognitive and affective) are not as easily observable and are typically measured though self-reported surveys or interviews. Data are currently being collected on those two dimensions and those findings will be reported in future publications.

Academic Engagement

Initial data was collected for two measures of academic engagement through university student records: 1) first-year GPA, and 2) semester hours attempted. Students included: S-STEM (n=20 in fall and spring) and non-participant (n=1276) FTFT STEM majors.

Table 1: First-Year Academic Engagement Indicators for FTFT Program Participants and Comparison Group, 2018-2019

	Endeavour S-STEM	FTIC STEM Majors
Fall 2018		
	(n=20)	(n=1276)
Mean units taken (sd)	16.2 (1.8)	15.1 (1.6)
Mean semester GPA (sd)	3.02 (0.7)	3.09 (0.9)
Spring 2019		
	(n=20)	(n=1238)
Mean units taken (sd)	16.3 (2.2)	15.2 (2.0)
Mean semester GPA (sd)	2.60 (1.2)	2.87 (1.0)

For the 2018 fall semester, the number of credit hours attempted by the program participants was similar to the non-participant comparison group. The mean GPA for the participant group was also quite similar between groups for that semester. Those same measures for the participant group during the spring 2019 semester were also on par with the non-participant group. For both fall 2018 and spring 2019, differences between the two groups in semester GPA were not statistically significant ($t=-.333$, $p=.74$ for fall and $t=-1.14$, $p=.25$ for spring).

Behavioral Engagement

Behavioral engagement data was collected via a written survey instrument administered during a mandatory advising session with college academic advisors. The students filled out the surveys with the advisors and then discussed the answers. The academic advisors then worked with each student on a plan to address any problem areas. The survey questions are shown below in Table 2. The table compares mean values for each question between the participants' first and second semester. The results show that with respect to behavioral engagement, participants remained stable (all on a Likert scale of 1-4) between the fall and spring semesters.

Table 2: First-Year Behavioral Engagement Indicators for FTFT Program Participants, 2018-2019 (Likert Scale range = 1-4)

	Fall	Spring
Likert Scale: 1=Never, 2=Rarely, 3=Most of the Time, 4=Always		
1. How regularly are you attending class?	3.6	3.6
2. How often are you late for classes?	1.9	2.5
5. How often are you completing your class assignments?	3.5	3.3
Likert Scale: 1=Not at All Prepared, 2=Not Very Prepared, 3=Somewhat Prepared, 4=Very Prepared		
3. How prepared are you for class?	2.9	3.4
Likert Scale: 1=Not at All, 2=Not Much, 3=Somewhat, 4=Very Much		
4. How much do you participate in discussions?	2.7	2.9
Likert Scale: 1=Most Ds & Fs, 2=Mostly Cs, 3=Mostly Bs, 4=Mostly As		
6. What are your grades so far on assignments and exams?	3.4	3.2
Likert Scale: 1=0 Times per Week, 2=1 Time per Week, 3=2 Times per Week, 4= >2 Times per Week		
7. How often do you visit professors during office hours?	1.1	1.2
8. How often do you attend student organization events (per week)?	1.8	1.7
9. How often do you participate in other extra-curricular activities?	1.8	1.8
Likert Scale: 1=0 Hours, 2=1-10 Hours, 3=11-20 Hours, 4= >20 Hours		
10. How many hours are you working per week?	1.3	1.7

One point of concern is Question 10 which relates to the number of hours worked during each week. Given the goal of the NSF S-STEM initiative, an increase in the number of hours worked by participants is an unexpected and undesirable trend. The logical assumption would be that if the program provided more financial aid to these students then they could stop working altogether. However, two things were discovered with some follow-up work. First, many students would not be able to receive more money from the program because they were already receiving aid at the university-calculated cost of attendance (COA). Once a student's aid package hits the COA, if we provide them with more aid over the COA then the state assistance that they had received is refunded to the state in that same amount and the student net gain is zero. Therefore, higher S-STEM scholarships are usually not a remedy. Also, many students who did have their tuition fully covered were still expected by their families to work to pay for other expenses. Therefore, more scholarships would not necessarily eliminate a student's need to work. However, the Endeavour Program includes both professional development and research experience elements. The expectation is that students will be able to leverage this training to obtain paid internships and research opportunities before their junior year and will then use that income to pay for tuition and other expenses eliminating the need for non-STEM jobs. Regardless, this measure will be monitored closely by the program staff in future semesters.

Summary and Conclusions

The early findings from the Endeavour Program suggest the efforts are staving off typically expected patterns of struggle. Said differently, findings represented in Table 1 indicate that participants that the program was designed to support (i.e., students with demonstrable risk factors) have statistically indistinguishable outcomes from their peers. While this finding is positive, Table 2 also represents that further work remains to be done.

As work continues, attention needs to be paid to the ways in which students receive support, including through social, academic, and professional activities. This early evidence supports the hypothesis that participating in these programs will increase the level of student engagement and hence student performance and persistence putting them on a path to graduation in STEM. But further research is needed to meaningfully assess this assumption. Broadly, this work stands to influence the recruitment and retention of science and engineering undergraduates and give insight into broadening participation in STEM. The investigators project that this work will aid in the design of transferable interventions that other universities can model.

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Key Words
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