ASSETS: Fostering a community of engineering transfer students - best practices and beyond

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***Abstract*—This Research-to-Practice full paper presents findings from the ASSETS program – a comprehensive support ecosystem developed to improve retention and reduce time to graduation for engineering transfer students. ASSETS builds on the momentum established by two statewide initiatives in Tennessee that place transfer students at the forefront: (1) Tennessee Promise – a nationally recognized scholarship program launched in 2015 that provides last-dollar scholarships for low-income students to attend any state community college, and (2) Tennessee Reconnect – a last-dollar grant established in 2018 that allows adults who do not have an associate degree to attend a community or technical college tuition-free. With over 100,000 students enrolled in these programs to date, the number of students transferring to four-year institutions is expected to increase exponentially in the coming years.**

Historically, transfer students have been at higher risk of attrition due to known academic and social barriers. This is especially true for the Engineering disciplines. In an effort to address these obstacles, we have developed the Academic Intervention, Social Supports, and Scholarships for Engineering Transfer Students (ASSETS) program. In its third year of operation, with 35 enrolled ASSETS scholars, the program is well underway. Among our findings, we have recognized the critical importance of nurturing a community of transfer students that emphasizes equity, diversity, and inclusion. Establishing such a community involves more than just adopting established best practices. It requires a shift in mindset on behalf of the student regarding what is required to succeed, as well as on the part of faculty on what is expected of incoming students.

This paper presents the findings and outcomes of the ASSETS program towards providing support to and enhancing the success of engineering transfer students.

Keywords—Engineering transfer students, institutional barriers, cohort learning

I. Introduction

Traditionally, higher education has focused its efforts and resources in educating "college ready" students. More recently, higher education institutions are enrolling an increasing number of students who do not fit this "traditional" model. Many of these students are underserved, underrepresented, first generation college students from outside the traditional age group. These "non-traditional" students are more likely to be less "college ready" due to contextual factors and institutional barriers that hinder successful matriculation.

According to the Organization for Economic Cooperation and Development (OECD), more than a third of US students who begin a post-secondary degree never graduate [1]. As academic institutions, our purpose is to serve our communities and our responsibility goes beyond merely enrolling students. We must also work to ensure these students successfully graduate and are prepared for careers. This shift in mindset, from enrollment toward matriculation, necessitates that educators assume a larger responsibility for how students learn. It is no longer appropriate to focus only on the "college ready" students, but rather to focus on how to prepare all students to become successful within our programs [2].

In light of this, many institutions are retooling their educational infrastructure to become "student-ready". Simply defined, "student-ready" institutions are those that develop programs and faculty ready to teach a diverse group of students, develop and measure learning outcomes to improve performance, and adapt practices and organizational structures to ensure that all students succeed [3].

A. Tennessee State Initiatives Affecting Transfer Students

In 2015, the state of Tennessee launched Tennessee Promise to provide open access to high school students at two-year community colleges. Tennessee Promise is a last-dollar grant, i.e., it can be used to pay the remaining balance of tuition and

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mandatory fees after other state and federal financial aid have been applied. Rapid enrollment increases are expected at 4-year institutions in the very near future, as Tennessee Promise students transfer and complete their final two years to earn a four-year degree.

Based on the success of Tennessee Promise for high school students, the state of Tennessee created the Tennessee Reconnect grant. Tennessee Reconnect is also a last-dollar grant. The Tennessee Reconnect grant is available for eligible adults who want to pursue an associate degree, technical degree, or technical diploma at a Tennessee community college or technical college.

For those students wanting to use Tennessee Reconnect to obtain an associate degree, the Reconnect grant can be used at one of the 13 Tennessee community colleges and at 2 four-year institutions to pay for tuition while earning a two-year associate degree. There are also 7 additional Tennessee four-year universities that are working with these associate degree programs to encourage transferring the appropriate course credits into a bachelor's degree programs. UTC is one of those 7 four-year public Tennessee universities participating. There are also 24 independent four-year colleges and universities that are participating in the Tennessee Reconnect grant program; and, there are 27 TCAT (Tennessee Colleges of Applied Technology) programs that are also participating in the grant providing a wide range of one to two year technical /occupational education programs with high employment placement rates. This grant pays the remaining balance after other state financial aid and Pell grants have been applied towards tuition and mandatory fees at the community college. At a four-year institution, the Tennessee Reconnect grant will not be last-dollar, meaning it will not cover all tuition and fees. The amount of funding you may receive will be based on the average amount of tuition and fees at a community college. The ASSETS program at the University of Tennessee Chattanooga (UTC) is designed to address the challenges that these students and the institution are expected to face. The ASSETS program provides guidance and support to transfer students who enter UTC from community colleges across the state.

Another Tennessee educational program that has been developed and legislatively passed into a well-defined established bridge from a two-year associates degree into a four-year bachelor's degree programs is The Tennessee Transfer Pathway (TTP**).** This program ensures courses taken at state community colleges transfer credit to other state-funded colleges and universities. In this pathway, general education, math, science and pre-major courses are defined for each pathway to a specific bachelor's degree. For all engineering disciplines in Tennessee, this pathway defines the necessary general education courses, specific mathematics courses in calculus, linear algebra and differential equations, specific science courses in calculus-based physics 1 & 2, and general chemistry, along with any foundation engineering courses, like statics & dynamics. However, the TTP path in engineering does not account for all the courses in the first two years of an engineering bachelor's degree, so TTP students aren't automatically a third-year engineering student. This is due to the varying abilities of the state's community colleges to offer the entire content of foundational engineering courses that occur in the first two-years of a bachelor's degree in engineering.

Because of their proximity to Chattanooga, students living in northwest Georgia are also eligible for reduced tuition to Tennessee institutions, so students transferring from Dalton State and other colleges in north Georgia is common. UTC has leveraged these state-wide initiatives and the proximity of the university to Chattanooga State to further collaborate to improve the transfer process between the two institutions. UTC recently signed a Dual Admissions agreement with Chattanooga State, in which students apply for admission simultaneously at both campuses while pursuing an associate's degree at Chattanooga State and are guaranteed admission to UTC once they earn an associate's degree. Moreover, Chattanooga State has established an Associate's of Applied Science in Applied Science for General Engineering, which has been accredited by the Applied Science Accreditation Commission of ABET and aligns with curricula for the four engineering degree programs at UTC in chemical, civil, electrical, and mechanical engineering. This close relationship is hereafter referred to as the "UTC-Chattanooga State Transfer Model."

B. Barriers to Learning for Transfer Students

Transfer students, many of whom are non-traditional students, face unique barriers to success. Most students transferring from community colleges to 4-year institutions experience "transfer shock," manifested in a lower grade point average (GPA) their first semester at the receiving institution [4-6]. Community colleges typically offer smaller classes that foster individualized attention from faculty and come at a much smaller cost while universities are notorious for larger classes, decreased attention from faculty, and a higher price tag. The adjustment from this two-year environment to the demanding, sometimes isolating, four-year environment most impacts STEM transfers and is exacerbated by the fact that transfer students are often passed over for support, in favor of first-year students, as they are assumed to have already acclimated to the college environment. Transfer students, however, struggle more with social integration than non-transfers. Further, transfer students often have preconceived ideas (frequently false) about four-year institutions which can hinder students from communicating concerns to faculty and administrative staff.

An additional factor that magnifies the shock of transitioning to a four-year institution is entering a curriculum that is likely to be disconnected from the community college curriculum. When curricular mapping is misaligned, students face academic challenges such as not receiving full credit for all their community college courses which may extend the time required for degree completion [7,8]. Engineering transfer students often arrive at 4-year institutions lacking prerequisite courses to take junior-level (or major-specific) courses, therefore they accumulate additional credit hours that extend time to graduation.

Degree pathways with imperfect curricular mapping and credit transfer policies among institutions is a significant barrier for transfer students across the nation. This barrier is frequently paired with poor advising and guidance on courses to take and a lack of information regarding transfer policies. The State of Tennessee has made efforts to mitigate this barrier with the

enactment of the TTP (described above). Currently, UTC has TTP agreements for mechanical, civil, and electrical engineering degree paths; however, a path for chemical engineering is still lacking. Moreover, these paths are not tailored to UTC's unique requirements and critical prerequisite courses needed to complete the 4-year engineering degree that are not offered at the colleges due to a lack of faculty, a common problem, and other institutional barriers. Therefore, transfer students must take an additional 1-2 semesters of courses before they begin junior-level coursework, which increases the time to graduation. Chattanooga State students following the general engineering transfer pathway, described above, fare much better.

However, this degree path is unique to the students in the Chattanooga State Community College General Engineering program that was developed with the assistance of faculty from the College of Engineering & Computer Science at The University of Tennessee at Chattanooga (UTC), so most other transfer students around the state are more familiar with the state-wide TTP bridge plan. In coping with this transfer shock and the development of targeted supports, UTC transfer students have fallen prey more easily to difficult junior-level engineering courses that supply the fundamental knowledge for remaining courses. Based on input from UTC's engineering faculty, these difficult gateway courses include: Mechanics of Materials (Civil); Circuits I and II (Electrical); Fluid Mechanics and Lab, Process Controls and Lab (Chemical); and Thermodynamics II, Fluid Mechanics, and Heat Transfer (Mechanical).

Transfer students tend to be more career minded [9]; however, like traditional students, a clear pathway to a career is often not well communicated. To ensure students are linked to careers following graduation, the College of Engineering & Computer Science (CECS) will provide exposure to professionals as guest speakers and at job fairs, industry tours, and/or other events through the year. Also, transfer students will be introduced to the Handshake software system, an internship and entry level job opportunity environment, managed out of our College's Student Success Center.

The characteristics of the transfer student population tend to be similar across institutions. Many are ethnic minorities, low-income, and of nontraditional college-age [6]; they face economic hardship, demands of employment, and therefore have little chance to develop a sense of community with their peers, faculty and degree program. The UTC ASSETS participants shared many of these same characteristics (Table 1). Sense of community is vital for persistence in college generally [10], and particularly important in science, technology, engineering and math disciplines given the demands of the curriculum [11]. To mitigate these known barriers faced by many community college transfer students, the UTC Engineering program has designed a comprehensive support system that incorporates financial, community, mentoring, academic, and career support. So, the goal of the UTC CECS ASSETS program is to improve retention and reduce time to graduation for engineering transfer students, who often take as many as three to four years to graduate UTC following their transfer, and provide them an environment for both personal and professional growth as a student.

Table 1. At-risk criteria for ASSETS students (Total # students enrolled in program = 35).

	Cohort 1	***Cohort 2***	***Cohort 3***	**Total**
Failed College Course	5	5	2	12 (34%)
Employed outside college	9	9	7	25 (71%)
Avg hours work/week	20	20	17	19 avg.
1st Gen College Student	5	5	7	17 (49%)
Attend Ed Disadv HS	5	2	2	9 (26%)
Rural Background	4	1	0	5 (14%)
Family Commitments	3	4	3	10 (29%)
Avg. years since HS	6	9	9	8 avg.

II. THE ASSETS MODEL

Driven by research and the lessons learned from UTC and other STEM programs [9, 12-14], evidence-based strategies have been adapted to create a comprehensive support ecosystem to ensure transfer students persist through UTC and graduate with an engineering degree within three years of their transfer date. Additionally, research strongly promotes the development of partnerships with feeder community colleges [15-19]. Therefore, the ASSETS model includes an Advisory Board consisting of representatives from UTC's primary feeder schools. The Advisory Board meets with the project team twice per year to help guide project implementation to ensure the needs of transfer students are effectively addressed and to lay the foundation for a future regional alliance.

UTC's ASSETS model (Figure 1) addresses common transfer-related issues through the following evidence-based strategies: (1) providing financial support; (2) establishing a transfer learning community; (3) providing faculty and peer mentorship; (4) offering a summer boot camp and peer tutoring;

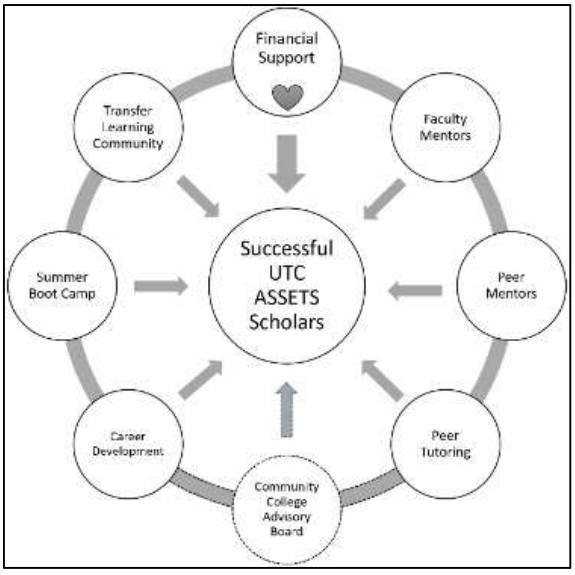

Figure 1. UTC ASSETS comprehensive support system for engineering transfer students

and (5) providing career development opportunities. Evaluation of the program is centered around *three primary research questions*: (i) Which activities reduce transfer shock? (ii) Does the boot camp improve academic performance and matriculation among transfer students? and (iii) Which activities most improve post-graduation employment? Additional details on the ASSETS model can be found in our prior work [20].

III. METHODOLOGY

In this study, an integrated approach was utilized to measure programmatic effectiveness, attitudinal shifts, and student performance outcomes (i.e. student GPA, time to graduate), as defined by the research questions. The integration of performance measurement into the overall programmatic evaluation was achieved by grounding the study in the core tools and methods that are essential to both: Program logic models; research design; statistical analysis, and validity [21]. Utilizing an integrated approach supported both an "Evaluation for Knowledge" [22] and a "Development Evaluation" [23, 24] mindset. The findings presented in this paper provide a deeper understanding of the various factors underlying the identified problems, and the "fit" between these factors and the ASSETS' program model which was designed to address them [21, 22]. Additionally, this study seeks to address the ongoing organizational learning in complex settings that the research questions identify [21, 23, 24].

Educational research and evaluation often involve non-experimental research designs that do not have the benefit of matching comparison groups and/or controlled "non-participant" environments. Therefore, triangulation of data becomes increasingly important. Establishing a concurrence of evidence, themes, viewpoints and/or data from a variety of sources and data collection methodologies is one strategy that was used in this study to increase the confidence in evaluation findings [4]. Incorporating both quantitative and qualitative measures supports data triangulation. Quantitative measures include activity participation tracking, periodic mentor check-ins, and repeated measures surveys. Qualitative measures include focus groups of all participants (students, peer mentors, faculty) and open-ended survey responses from non-ASSETS and ASSETS participants, and UTC faculty. Ethical research practices are followed and compliance maintained via institutional review board.

This study utilized a time series research design, tracking program related variables over time and documenting changes in those variables. It is important to note that this research design is not equipped to determine a direct causal relationship between the assessed outcomes and the programmatic interventions. However, it is appropriate to track differences in outcome variables before and after changes in a program's structure or activities have been implemented [21].

Participants: The ASSETS program includes a total of 35 transfer student participants (aka ASSETS Scholars) admitted as three cohorts, who were intentionally selected to participate in the program according to the National Science Foundation's (NSF's) admissions parameters (Table 2). For investigation associated with the research questions of academic performance and persistence and time to graduation, a non-ASSETS transfer student comparison group, with 129 students, was identified.

Table 2. ASSETS student demographics (Total # students enrolled in program = 35).

	Cohort 1	*Cohort 2*	*Cohort 3*	**Total**
Concentration				
Chemical	0	1	1	2 (6%)
Civil	1	5	5	11 (31%)
Electrical	3	5	1	9 (26%)
Mechanical	6	3	4	13 (37%)
Gender				
Female	1	7	5	13 (37%)
Male	9	7	6	22 (63%)
Race/Ethnicity				
White	8	10	9	27 (77%)
Black	1	0	0	1 (3%)
Asian	0	3	1	4 (11%)
Hispanic	0	1	0	1 (3%)
Native American	0	0	1	1 (3%)
Two or More	1	0	0	1 (3%)

The method for determining comparison group membership was based upon: a) the identification of students who had transferred to UTC during the same timeframe, b) students who had transferred directly from a Community College, and c) students who had declared one of the four Engineering concentrations identified in the grant (i.e. Civil, Chemical, Electrical, Mechanical). See Table 3 for the stratified sample based on admission for ASSETS program.

IV. RESEARCH FINDINGS

A. Integration of Best Practices

Financial Support: Seventy-one percent of ASSETS Scholars (n=25) identify as being employed outside of school, working an average of 20 hours per week. Financial support is critical for Scholars to be able to engage in the academic program without distraction. As a result of the tuition support, 76% (n=19) of employed ASSETS scholars were able to decrease the number of work hours per week.

When asked to identify the "most effective support strategy" of the ASSETS program, 100% of ASSETS Scholars either "agreed" or "strongly agreed" that receiving tuition support enabled them to be successful academically. As one student stated, "Without the tuition assistance, I would be overwhelmed with student debt which would force me to shift my priorities from education to employment".

Transfer Learning Community (TLC): ASSETS Scholars arrive at UTC from many different regional Community Colleges. Twenty-six of the ASSETS Scholars (74%) transferred from Chattanooga State Community College. The remaining 26% transferred from one of four other institutions: Cleveland State, Motlow State, or Pellissippi State Community Colleges in Tennessee, and Dalton State College in Georgia. By

Table 3. Cohort comparison for ASSETS students versus non-ASSETS transfer student comparison group.

	ASSETS Y or N			Total
		NO	*YES*	
Admit Term	Fall 2017	0	1	1
	Fall 2018[1]	30	5	35
	Fall 2019[2]	41	13	54
	Fall 2020[3]	19	11	30
	Spring 2018[1]	13	2	15
	Spring 2019[2]	13	0	14
	Spring 2020[3]	9	0	9
	Summer 2018[1]	2	2	4
	Summer 2019[2]	2	0	2
	Summer 2020[3]	0	1	1

**1=Students identified as Cohort 1; 2=Students identified as Cohort 2; 3= Students identified as Cohort 3*

**Y=yes, enrolled in the ASSETS program, N=non-enrolled comparison transfer student group.*

developing a cohort approach to the learning community, each group of Scholars has immediate access to a peer community. One student stated, "Activities during the ASSETS cohort class [TLC] during the first semester helped quite a bit. The relationships I've developed with cohorts and faculty has beenwonderful and I feel supported through both". Another noted, "Being around other transfer students helps bring the realization that nobody is alone, but rather experiencing similar "transfer" difficulties". Finally, "[ASSETS] gave me a "ready-made" community at UTC where I was able to ask peers questions. It also allowed me to get to know my professors more quickly and become comfortable enough to ask questions".

Mentoring: ASSETS Scholars constantly identify the opportunity to build connections with faculty, outside of the classroom, as an essential element to achieving academic persistence and success, with one student stating, "The guidance from the mentors have proved to be invaluable in my academic and professional career". Another scholar indicated that, "ASSETS has allowed me access to faculty mentors that would be otherwise not available to the common CECS student. This has been beneficial for me so that I can talk out my difficulties and find the right resources/get advice on how I could solve these problems". Ninety-one percent of ASSETS Scholars (N=32) participated in an Academic Environment survey, the purpose of which was to gather perception data from ASSETS Scholars regarding the academic culture and climate at UTC. When asked "*What does an engineering transfer student need to be successful at UTC?*", faculty connections and mentoring was most frequently identified. Respondents indicated that, "the ability to get to know the faculty", "the opportunities for open communication with faculty", and "access to information regarding academic and social supports that a mentor can provide", fostered "connections with faculty [that] really helps with the transition". One respondent simply stated, "A supportive and positive faculty mentor, it has been the best experience so far".

The ASSETS faculty mentorship program has enabled faculty to develop an awareness and deeper understanding of the unique challenges transfer students face and the additional academic supports that may be needed to support their success. UTC engineering faculty were asked to participate in the Academic Environment survey as well. One hundred percent of ASSETS mentors "agreed" or "strongly agreed" that, as a result of their training and experiences as an ASSETS Mentor they, "*appreciate the importance of transfer students feeling like they are part of the academic community*", with 100% "agreeing" or "strongly agreeing" that they "*engage in open and candid conversation with their mentee*". Eighty percent indicated they are now able to identify the risk factors and academic struggles that are unique to transfer students.

Of the UTC Engineering faculty survey respondents who were not ASSETS mentors, 57% agreed that they provide support for students transferring into the UTC environment, with only 42% indicating that they provide "*additional resources or help to support transfer students*". When asked what they believe a transfer student needs to be successful in UTC's Engineering program, one faculty respondent stated, "How do I know what they need to be successful? I do not differentiate between transfer and non-transfer students. The expectations for the class and how I help them is no different than that of a non-transfer student."

Academic Support: Academic support resources available to ASSETS program scholars include peer tutoring through the CECS peer-to-peer tutoring program, faculty mentor coaching and tutoring, UTC Student Support Services, and a Summer Boot Camp held for incoming cohorts to ease the transition from community college to university life and to boost academic abilities. To inform programmatic evaluation and improvement, ASSETS Scholars are asked to participate in an on-going program effectiveness survey at the conclusion of each semester. The survey response rate (97%) indicates the participation by most ASSETS Scholars during the semesters in which they were enrolled. Only 15% (n=5) of survey respondents indicated that they had attended peer, faculty, or some other form of tutoring. When asked to identify the activities that scholars felt were the MOST effective in supporting their academic success, only one respondent identified "tutoring". "Attending professional and workforce development activities" was identified as the MOST effective ASSETS support activity by 56% of respondents, with 18% identifying "Participation in the TLC1 Seminar Course". When asked to identify what ASSETS support activities were the LEAST effective in supporting their academic success, 58% of respondents identified "Peer Mentoring/Communication", with 35% of respondents identifying the "TLC2 seminar course".

Summer Boot Camp experiences were not identified, by survey respondents, as either the MOST or LEAST effective support strategy. One reason for this seemingly ambivalent attitude could be due to the type and focus of the academic support activities and modules offered. As one student stated, "It would have been more beneficial if the activities presented applied directly to my engineering degree (i.e. Electrical, Chemical, Civil, Mechanical), maybe divide participants by concentration"? Another participant expressed the benefits of the community building aspect of the experience, but felt the academic support was not applicable stating, "Boot Camp was fun and provided a way to connect with students and ease the transition, but it did not have any effect in supporting me academically".

Professional/Workforce Development: The professional and workforce development activities, exposures, and networks that the ASSETS program provides, enabled graduating ASSETS Scholars to access a robust curriculum-to-work force pipeline. Of the seventeen ASSETS Scholars (50%) who have successfully completed their program of study and graduated, 15 (88%) were employed upon graduation. One scholar was accepted into a graduate program, and one was seeking employment at the time of graduation. All indicated that they were employed in Engineering or STEM related fields, with eight (57%) indicating the type of employer as "corporate". The remaining graduates indicated being employed by either a national level government agency (28%) or by state level government agencies (15%).

Graduates identified a variety of long-term professional goals including, obtaining a PE license (33%) or continuing their education either in a graduate Engineering or Master of Business Administration program (27%). Others indicated an interest in pursuing a career in research and/or teaching in Higher Education (14%). Non-profit work, mission work helping developing countries with infrastructure, and development of renewable energies were also identified as long-term professional goals. As a result of the ASSETS program, graduates indicated an increased awareness of the variety of educational and employment opportunities available beyond program completion.

Overall Value of ASSETS Programmatic Components: One hundred percent of ASSETS scholars (N=34*), indicate that, "YES", they would recommend the ASSETS Scholars program to other engineering transfer students. When asked to identify the strength(s) of the program, open-ended responses included, "[ASSETS] definitely helped me in so many ways socially, academically, and mentally to transition to UTC"; "The comradery ASSETS developed for transfer students…it was like we were in an exclusive club and looked forward to seeing each other"; "The ASSETS program really allows for students transferring into [UTC] to be able to focus on what counts, school"; "The funding was greatly appreciated, it can be daunting to go college, especially when transferring in from a [school] with a lower level of difficulty, and having to continue to support yourself [by working]"; "This program allows for a much easier transition, and in turn probably increased [my] success"; "[ASSETS] made it easier to transition [into UTC] because the professors already had an idea of who you were, and [it] opened up communication with them and other students".

* *one student withdrew after the first semester for personal reasons*

B. Student Performance Outcome Measures

Comparison of ASSET Scholars to Non-ASSETS Transfer Student Comparison Group*:* In comparing the overall differences between ASSETS (N=35) scholars and students in the non-ASSETS transfer student comparison group (N=129), the average UTC Institutional GPA (GPA for courses completed at UTC) for ASSETS scholars was 3.351 (*SD*= .5378), as compared to the comparison group (non-ASSETS students) average Institutional GPA of 2.993 (*SD*= .6261). There was homogeneity of variances, as assessed by Levene's test for equality of variances (p = .743). A significant statistical difference was observed $t(162) = 3.083$, p = .002 (95% *CI*, 0.1286 to 0.5867). This indicates that ASSET Scholars demonstrated a statistically significant higher Institutional GPA as compared to the non-ASSET scholars. There was no significant difference between the number of Institutional Credit Hours earned at UTC between ASSETS versus Non-ASSETS transfer students. This indicates that independent of the number of credit hour earned, ASSETS students appear to have a higher Institutional GPA versus the non-ASSETS transfer students.

When comparing the differences between the Non-ASSETS students' transfer GPA (GPA of courses completed OUTSIDE of UTC), (M = 3.2353, SD = .4673) to their UTC Institutional GPA (M = 2.9934, SD = .6261), a significant difference was observed $t(128) = -5.023$, p = .001 (95% *CI*, -.3373 to -.1467). There was no significant difference between ASSETS Scholars' transfer GPA as compared to their UTC institutional GPA. This indicates that non-ASSETS transfer students experienced a drop in GPA following transfer to UTC, while ASSETS Scholars did not experience a significant drop in their GPA following transfer.

In terms of overall credit hours earned (transfer hours plus institutional hours), ASSETS Scholars' number of credit hours (M = 142.75, SD = 47.36) were compared to non-ASSETS transfer students' number of credit hours (M = 119.96, SD= 33.87). Homogeneity of variances was violated per Levene's test for equality of variances (p = .015) and the adjustment was made to the t-test statistic. A significant difference was detected $t(43.867) = 2.667$, p = .011 (95% *CI*, 5.5635 to 40.003).

Comparison of ASSET Scholars to a Random Sample of Non-ASSET Transfer Students: To further explore student performance outcome measures, this study utilized the same ASSETS Scholar sample (N=35), took the existing full sample of non-ASSETS transfer students (N=129), and generated a random sample of 35 non-ASSETS transfer students from the total 129 utilizing randomized ranked based assignment generation (Bootstrapping). This bootstrapped non-ASSETS sample was then compared to the ASSET Scholars' group to see if similar trends held constant. The average UTC Institutional GPA for ASSETS Scholars was 3.351 (*SD*= .5378) as compared to randomly sampled non-ASSETS transfer students' Institutional GPA of 2.868 (*SD*= .7981). There was homogeneity of variances, as assessed by Levene's test for equality of variances (p = .236). A significant statistical difference was observed $t(68) = 2.967$, p = .004 (95% *CI*, 0.1580 to 0.8072). This replicates the finding that ASSET Scholars demonstrated a higher Institutional GPA as compared to the non-ASSET transfer students.

There was no significant difference between the Institutional credit hours earned between the ASSETS Scholars versus the Non-ASSETS transfer students. This indicates that independent of the number of credit hours earned, students appear to have a higher Institutional GPA within the ASSETS Scholars group versus the non-ASSET transfer students bootstrapped sample group.

Moreover, in utilizing the same samples, comparing the differences between the non-ASSETS transfer students' transfer GPA (M = 3.115, SD = .4805) to their UTC Institutional GPA (M = 2.8683, SD = .7981), a significant difference was observed $t(34) = 2.288$, p = .028 (95% *CI*, .0276 to .4657). This replicates

the finding that non-ASSET transfer students demonstrated a significant decrease in GPA from their transfer GPA to the UTC institutional GPA. We also replicated the finding of no significant difference between the ASSETS Scholars' transfer GPA compared to UTC institutional GPA. This provides further trend evidence that non-ASSETS students experienced a drop in GPA following transfer, while ASSETS Scholars did not experience a significant drop in GPA following transfer.

We further examined if there was a statistically significant difference in the number of overall completed hours between ASSETS Scholars versus the Non-ASSETS transfer students, utilizing the same randomized sampling strategy, and found no significant difference on Mann-Whitney U analysis. This is likely due to an inherently small effect or correlated error as observed utilizing projected data replicated modeling and an interocular assessment and would require a much larger sample of students to test this research question overall.

To ensure an equalized comparison of successful completion of engineering degrees, within three years of transfer date, (persistence) between ASSETS Scholars (60%) and Non-ASSETS transfer students comparison group (40%), we generated program completion rates between the overall samples. To test if this was a statistically significant difference, a Chi-Square was conducted. A significant marginal difference was observed $\chi^2(1) = 4$, $p = .0455$. This indicates that ASSETS Scholars are graduating at a higher statistical percentage than their non-ASSETS transfer student peers. Additionally, many ASSETS Scholars completed the program in less than the anticipated three-year threshold of completion.

One potential challenge at this stage of the project is to compare graduated versus enrolled students, within each group (ASSETS vs. non-ASSETS), as the analysis is limited in the project's ability to discern additional attributional variables that may enhance or inhibit the predictability of findings. This severely limits the potential empirical comparisons which can be made regarding the current trends in the effectiveness of program outcomes and those antecedent variables of potential influence.

Additional variables of interest for the future comparisons would include engineering major, racial, and gender categories, and socio-economic and high school differences, which may influence GPA and time to completion. Larger samples would also provide the potential for predictive analytics between ASSETS participation in predicting Institutional GPA.

V. DISCUSSION

Three research questions served as the guiding focus of the ASSETS project: (1) Which activities reduce 'transfer shock'; (2) Does the Boot Camp improve academic performance and matriculation among transfer students; and (3) Which activities most improve post-graduation employment?

Overall, ASSETS scholars have achieved a higher institutional GPA and a higher graduation rate than their non-ASSETS peers, without exhibiting a noticeable drop in GPA upon transfer to UTC. These results indicate that the ASSETS program activities have been effective in reducing 'transfer shock'. Based on surveys of ASSETS scholars, the most effective strategies include financial support, establishing a sense of community, and faculty mentorship.

ASSETS scholars expressed an ambivalent attitude regarding the Summer Boot Camp, as it was not mentioned as either the most or least effective support strategy. Individual student feedback indicates that bringing the students together and participating in icebreaker activities was an important first step towards instilling a sense of community, but that the academic activities were not beneficial.

Historically, students with a higher GPA are more successful at securing employment post-graduation [25-29]. As such, the ASSETS program activities most helpful for reducing 'transfer shock' are by extension valuable for ensuring post-graduation employment. However, a high GPA alone does not distinguish one from other job applicants. Participation in extracurricular activities such as professional organizations or community outreach, and evidence of prior experience through internships/co-ops, are also considered during the job interview process. As part of the ASSETS program, scholars were required to complete professional/workforce development activities through participation in industry seminars and plant tours, attendance at career fairs and professional development workshops, etc. They were also introduced to the many experiential learning opportunities available on campus, including not just internship/co-op postings but also student organizations and competition teams as well as undergraduate research opportunities.

Moving beyond the successes of the ASSETS program and its most valuable components, it is also important to take stock of lessons learned and make plans for sustaining these initiatives long term. Based on the observations of the project team and feedback from ASSETS scholars, the barriers to transfer student learning fall into two recognizable categories: (1) academic preparation; and (2) institutional culture. In terms of academic preparation, lack of access to a quality math and science curriculum in high school often follows students throughout their college journey. In particular, "watershed" courses that require foundational math and science skill sets (e.g., calculus 1 & 2, fluid mechanics, thermodynamics, control systems) are more problematic for transfer students. Regarding institutional culture, faculty may not be aware of and/or understand the unique challenges transfer students face and the additional support that may be needed to be successful. For instance, transfer students often feel more isolated and are slower to acclimate and develop relationships with faculty and peers than students who enter as "traditional" first-year students [30-32]. Transfer students also tend to be "non-traditional" students who work more hours outside of school, have family obligations, and are older than their peers.

In the short-term, there are several ways that the success of the ASSETS project can be sustained with the support of the University and College leadership. For example, a peer mentorship program for all engineering students was instituted in the current 2020-2021 academic year in collaboration with an external service. Moving forward, the project team will work with the CECS development office using scholar testimonials and other promotional materials generated by the ASSETS

project to secure additional scholarship funding for engineering transfer students. In addition, efforts will be made to augment transfer student orientation to include the icebreaker activities from the Summer Boot Camp that were so successful in instilling a sense of community amongst transfer students.

In the long-term, the UTC CECS must strengthen its relationships with its feeder colleges, namely Chattanooga State Community College, Cleveland State Community College, and Dalton State College. Among other aims, the CECS must work with this community college consortium to better align the 2-year and 4-year curricula and streamline the progression from high school to a 2-year institution and on to a 4-year institution. Potential opportunities include faculty guest lectures at community colleges, step-down courses and supplemental instruction in difficult gateway subjects, course sequencing adjustments and cultural competency training for faculty focused on transfer student needs.

VI. CONCLUSIONS

The NSF-funded ASSETS program has generated encouraging findings that show how the use of an integrated approach employing evidence-based strategies can foster a supportive community for transfer students. The quantitative and qualitative results indicate a net positive impact, signifying that a holistic approach to student support does facilitate persistence in engineering. Key aspects of the program include engaged partnership with regional community colleges; fostering a sense of community amongst transfer students through ongoing TLC activities, structured peer and faculty mentoring programs; and intentional communication and academic support strategies.

Moving beyond the importance of evidence-based strategies, it is also clear that the success of transfer students hinges on certain intangibles. These students often arrive at 4-year institutions in isolated groups with misaligned course plans and family and work time commitments. As such, it is vital to instill a sense of belonging, community, and support at the outset. Of perhaps equal importance is the need for a shift in student and faculty mindset. ASSETS participants in general expressed surprise at the rigor of engineering curricula and the time commitment required in order to succeed. Engineering faculty, on the other hand, generally give no consideration to the unique hurdles that transfer students face and accept little or no responsibility for ensuring that these students succeed.

Taken collectively, these findings demonstrate the need for 4-year institutions to move away from the "college-ready" model when it comes to transfer students, instead meeting these students halfway by offering a structured community (through orientation activities and peer and faculty mentorship) and supportive faculty (through transfer student-centered initiatives and training). This approach can be extended to non-traditional students in general, including adult learners, international students, and veterans, among others.

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