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Identifying student and institutional factors related to the academic performance and persistence of vertical transfer students pursuing baccalaureate engineering technology degrees

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Abstract- In this research paper, we utilized secondary, state-wide longitudinal data to examine the relationship of student-influenced and institution-influenced factors to academic performance and degree completion of engineering technology transfer students at public four-year institutions in North Carolina. Two-year institutions are a vital pathway in meeting the demand for a highly skilled workforce and serve as a means to broaden participation in engineering careers that have been historically overrepresented by White men. However, the literature on engineering transfer student success and baccalaureate degree attainment remains sparse. To address this gap in the literature, we utilized a dataset that includes students who transferred from community colleges to pursue baccalaureate degrees in engineering technology programs at UNC System institutions from 2009 to 2016. Based on the data structure, regression analyses were utilized to examine the factors that influence first-semester academic performance and persistence to degree attainment at the receiving institution. The hierarchical organization of student-influenced factors, institution-influenced factors, and factors influenced by both was based on a modified version of Smith and Van Aken's (2020) literature-based conceptual framework on engineering transfer student persistence. Our study found that academic performance and baccalaureate degree attainment are a function of student and institutional characteristics for engineering technology transfer students. Further, this study generated practical and actionable findings that can aid four-year engineering institutions in increasing the academic performance and persistence of vertical transfer students pursuing baccalaureate engineering technology degrees.

Keywords: vertical transfer students, engineering technology, persistence, and academic performance

Introduction

While a great deal of research and policy attention has been paid to understanding engineering education as key to the development of a diverse technical workforce, engineering technology education has been largely ignored. Engineering technology (ET) emerged as an academic discipline in the 1950s, starting with associate degree programs and expanding to baccalaureate programs in the 1960s (National Academy of Engineering [NAE], 2017). While ET baccalaureate enrollment and degree awards make up less than 10% of engineering-related figures, ET programs had over 30,000 students and 10,000 graduates in 2021 (American Society of Engineering Education [ASEE], 2022). Significant proportions of Bachelor of Science (BS) ET programs have articulation agreements that allow transfer of students with Associate of Applied Science (AAS) and Associate of Science (AS) in ET (NAE, 2017). A recent survey of ET leaders for the 2019 ET Leadership Institute indicated that serving community college transfer students was among the top perceived opportunities for the future of ET programs (Fox et al., 2020).

National data show that ET programs attract students from certain marginalized and minoritized groups, including neotraditional age (24 and older) and Black/African American

students (NAE, 2017). Data from 2021 illustrate this trend, with Black/African Americans comprising 7.7% of ET baccalaureate earners, versus 4.7% of engineering degree earners (ASEE, 2022). However, women earned only 15.5% of ET degrees, compared to 24% of engineering degrees. There is limited empirical evidence to understand what factors affect ET student persistence overall, let alone by marginalized and minoritized groups, including transfer students. In this study, we examined the relationship of pre-transfer and post-transfer factors with the academic performance and attainment of ET transfer students in North Carolina.

Conceptual Framework and Literature Review

Two-year institutions are a vital pathway in meeting the demand for a highly qualified STEM workforce (Hoffman et al., 2010; NAE & NRC, 2012) and serve as a means in broadening the participation in engineering careers that have been historically overrepresented by White men. Moreover, strengthening the vertical transfer pathway to engineering disciplines can improve equity by increasing the social and economic mobility of this diverse subpopulation of students (Dowd, 2012; Terenzini et al., 2014). However, the literature on engineering transfer student success, specifically for ET students, and baccalaureate degree attainment remains sparse. Smith and Van Aken's (2020) systematic review of the persistence of engineering transfer students found that the research predominantly focused on pre-transfer academic outcomes or, more broadly, on STEM transfer students. Due to the shortage of knowledge, further empirical research is necessary to determine how institutional context at receiving institutions promotes and detracts from the academic performance and the persistence of ET transfer students. Understanding the institutional characteristics experienced by vertical transfer students in ET majors at four-year institutions is crucial in understanding the overall adjustment of transfer students.

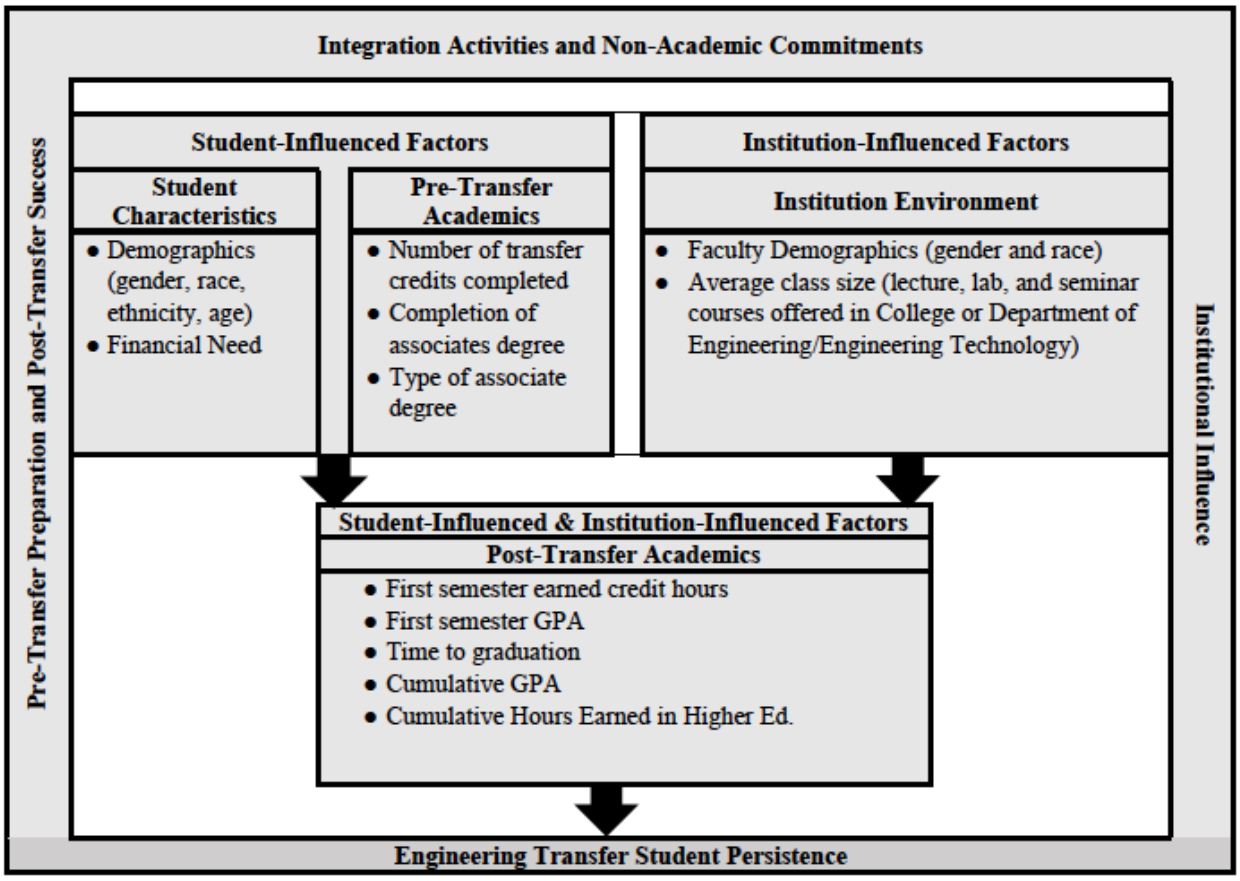
A modified version of Smith and Van Aken's (2020) literature-based conceptual framework on engineering transfer student persistence guided the study. Smith and Van Aken assert that the persistence of this student population is a function of three categories of factors: student-influenced, institution-influenced, and factors considered to be influenced by both student and institution. Smith and Van Aken’s conceptual model was based on a review of previous research on engineering transfer student persistence which included a few studies limited to ET majors. In our study, persistence is designated as baccalaureate ET degree completion. The variables included in the study were informed by a review of the literature on engineering transfer student persistence- see Figure 1.

Methods

In this study, we examined the influence of student characteristics, academic factors, and institutional factors on the academic performance and persistence of ET transfer students who transferred from two-year institutions to four-year institutions in North Carolina from 2009 to 2016. The statewide data set was provided by the Belk Center for Community College Leadership and Research, and the first author compiled the data on institutional characteristics via the institutional research offices of each of the five engineering degree-granting institutions in the sample (North Carolina A&T University, North Carolina State University, University of North Carolina at Charlotte, Western Carolina University, and East Carolina University). Three

of the NC institutions included in this study were among the top 30 in ET enrollment in 2021 (ASEE, 2022). The factors of Bachelor of ET degree attainment for this unique student population were examined using a non-experimental correlational research design through the lens of Smith and Van Aken's (2020) Engineering Transfer Student Persistence conceptual framework.

Figure 1
Framework for Engineering Technology Transfer Student Persistence



Note. Modified from Smith and Van Aken's (2020) conceptual model of engineering transfer student persistence.

We utilized regression analyses to investigate student, academic, and college/department of engineering factors associated with the academic performance and ET bachelor's degree attainment of students who transferred from NC community college to NC public universities. Semester GPA was selected as a measure of academic performance in the first semester at the receiving institution given it is the most commonly used and available measure of academic performance in educational research and assessment (York et al., 2015). While the utility of GPA to indicate academic success has been questioned, GPA as a measure of academic performance is useful given the notion of transfer shock, particularly in STEM (Lakin & Cardenas Elliot, 2016) . Two questions guided this study:

1. How are student and institutional factors related to the academic performance of ET transfer students in their first term at the receiving institution?
2. How are student and institutional factors related to the baccalaureate degree attainment of ET transfer students?

For the first research question, multiple linear regression was selected to examine the relationship of student backgrounds and pre-transfer academics, institutional characteristics, and post-transfer attempted and earned credit hours to the academic performance of transfer engineering students in their first-semester post-transfer. We analyzed the second research question using logistic regression to examine the relationship of student backgrounds and pre-transfer academics, institutional characteristics, and post-transfer academics to the baccalaureate degree attainment of ET transfer students.

Variables

All variables were selected based on the literature and available data. Table 1 provides the names, descriptions, and coding for each variable in the study.

Student-Influenced Factors

Student-influenced variables included four student sociodemographic characteristics (gender, age, race, Pell Grant) and two pre-transfer academic indicators (number of applied transfer credit hours, and associate degree awards). See the descriptions in Table 1. The definitions of the gender, age, and race variables are important to highlight. Gender was defined as male or female, as no other sexes or genders were reported in the dataset. Age was aggregated into two categories per the NCES (2020) definition of traditional (23 or younger) and neotraditional (24 or older) students. While race/ethnicity in the dataset included the nine IPEDS race/ethnicity categories, only five dummy-coded identities were explored in the model: Black or African American, Hispanics of any race, White, Asian, and other race. The category of other race was created by combining four low-incidence ($n<30$) categories (non-resident alien; race and ethnicity unknown; American Indian or Alaskan Native; Native Hawaiian or Other Pacific Islander; two or more races), all of whom represent marginalized groups in higher education.

Institution-Influenced Factors

Institution-influenced variables included characteristics of the faculty and class size in the college or department of engineering where the ET programs were offered. We examined the percentage of engineering faculty members who identified as female and as a member of an underrepresented racial/ethnic minority (URM) group (i.e., Black or African American, Hispanic, and American Indian or Alaskan Native). We were not able to obtain separate figures for ET faculty only. While we note that Asian faculty members are minoritized in the United States, they are overrepresented in engineering faculty positions compared to the percentage of the Asian population and thus were not included in the definition of URM. Class size indicates the average class size of courses offered by the College or Department of Engineering where ET programs were offered.

Table 1

List and Description of Variables in Model

Variable Name	Variable Type	Description
Outcome Variables		
First-term GPA	Continuous	Measured on a 0.00 to 4.33 scale
Degree Completion	Categorical	0= no baccalaureate ET earned; 1= baccalaureate ET earned
Student-Influenced Factors		
Gender	Categorical	Dummy coded: 0= male, 1= female
Race/ethnicity	Categorical	Dummy coded: 1=Black or African American, 2=Hispanic, 3=Other, 4=Asian, 5=White[a]
Age	Dichotomous	Calculated based on birth year and academic year at entry; aggregated to 0= 23 or younger, 1= 24 or older
Pell	Categorical	Dummy coded: 0= no Pell Grant awarded, 1= Pell Grant awarded
Pre-Transfer Academics:		
Applied Transfer Hours	Continuous	Measured in credit hours
Associate Degree	Categorical	Dummy coded: 0= no associate degree earned[a], 1= Associate of Arts, Fine Arts, or General Education, 2= Associate of Applied Science, 3= Associate of Science
Institution-Influenced Factors		
Female Faculty	Continuous	Percentage of college/dept of engineering faculty identifying as female
URM Faculty	Continuous	Percentage of college/dept of engineering faculty identifying with underrepresented racial/ethnic group
Average Class Size	Continuous	Average class size of courses taught in the College or Department of Engineering where ET programs were offered
Post-Transfer Academics:		
First-Term Attempted Hours	Continuous	Credit hours attempted during first term
First-Term Earned Hours	Continuous	Credit hours earned during first term
Total Semesters	Continuous	Total number of spring and fall semesters from entry
Cumulative GPA	Continuous	Measured on a 0.00 to 4.33 scale
Total Earned Hours	Continuous	Total number of earned credit hours at receiving institution

Note: [a] denotes reference variable

Student-Influenced and Institution-Influenced Factors

Five factors related to post-transfer academics, influenced by both student and institution factors, were included in the model: (a) total semesters at RI, (b) first-term attempted hours, (c) first-term earned hours, (d) total earned hours at institution, and (e) cumulative GPA. These are

defined in Table 1. Cumulative GPA ranged from 0.00 to 4.33, due to one institution that allowed for GPAs to be above 4.00.

Results

Descriptive Findings

A total of 1,964 community college students transferred to baccalaureate ET programs in the UNC System from 2009 to 2016. The demographic profile of this ET transfer student cohort is detailed in Appendix A. ET transfer students predominantly identified as male (89%) and White (70%). Black or African American students accounted for 12% of the sample, with other racial/ethnic groups making up significantly smaller proportions (<10% each). About 60% of the students were neotraditional age, with an average age of 28 years old, and had earned an associate degree prior to transfer. Roughly half (52%) of the students were Pell-eligible.

On average, ET transfer students had 63 hours (*SD*=22.44) of transfer credit applied at their receiving institutions. During the first semester at the receiving institution, the average attempted hours (10.4 hours; *SD*=4.45) were slightly higher than the average earned hours (9.6 hours; *SD*=4.66). Students' average first-term GPA (2.83; *SD*=1.13) was slightly lower than the average cumulative GPA (2.95; *SD*=0.83). The average length of attendance at the receiving institution was five semesters (*SD*=2.27; excluding summer semesters) and 123 hours (*SD*=37.48) of earned credit. Over 55% of the students earned baccalaureate ET degrees.

We examined the disaggregation of academics by demographic variables (Appendix B) along with crosstabulations of race/ethnicity with other demographic characteristics (gender, age, Pell eligibility) to better understand the nature of NC ET transfer students. The proportion of women was highest among Hispanic students (12.8%) and lowest among Black or African American students (5.8%). Black or African American (68.9%) and Other (66.1%) students had larger proportions of neotraditional age students. About 70% of Black or African American students were Pell-eligible compared to roughly 46% of White students.

ET Transfer Student Academic Performance

We conducted a multiple linear regression model to determine the relationship of first-term GPA at the receiving institution (RI) with a series of blocked variables organized by Smith and Van Aken's (2020) conceptual framework: (a) student characteristics and pre-transfer academic factors, (b) institution-influenced factors, and (c) post-transfer academics. Table 2 displays the unstandardized regression coefficients (*B),* robust standard errors (*SE),* and level of significance (*p*-value). Each block explained more variation in ET transfer students' first-term GPAs. The full model suggested that about a third of the total variation in first-term GPA was determined by student background, pre-transfer academics, institution, and post-transfer academic factors (R^2 = .333, F (16, 1963) = 60.78, p < .001).

For student-influenced sociodemographic variables, race/ethnicity and age were significantly related to first-term GPA. Black or African American students had a significantly lower first-term GPA than White students (B = -0.18, SE = 0.07, p < .001), scoring 0.18 points

lower on average. ET transfer students of neotraditional age scored, on average, 0.05 points higher on first-term GPA than traditional age transfer students. For the pre-transfer academic variables, the number of applied transfer hours was positively related to first-term GPA (B = 0.003, SE = 0.00, $p < .001$), showing a predicted increase of .003 points in first-term GPA for every one-hour increase in applied transfer hours.

For institution-influenced variables, first-term GPA was positively related to female faculty representation in the college/department of engineering (B = 0.01, SE = 0.00, $p < .001$), with a predicted increase of .01 points on first-term GPA for each one percent increase in female faculty. Additionally, average class size was a positive indicator, with a predicted increase of 0.01 points in first-term GPA for each student increase in average class size.

All first-term post-transfer academic variables were significantly related to first-term GPA. Attempted hours in the first term were a negative indicator of first-term GPA (B = -0.15, SE = 0.01, $p < .001$), with a predicted decrease of 0.15 points for each additional attempted hour. Contrastingly, earned hours in the first term (B = 0.22, SE = 0.01, $p < .001$) were a positive indicator of first-term GPA, with a predicted increase of .24 for each additional earned hour. Gender, certain racial/ethnic identities (Hispanic, Other, Asian), Pell Grant eligibility, associate degree types, and URM faculty were not statistically significant in the final model.

ET Transfer Student Degree Attainment

To ascertain the effects of a series of blocked variables on persistence in engineering, we performed a blocked logistic regression entered in the same hierarchical steps as the multiple linear regression models. Each block was statistically significant at the $p < .001$ level (Block 1 = 113.36, Block 2 = 145.06, and Block 3 = 1181.75). The model explained 63.7% (Nagelkerke R^2) of the variance in persistence and correctly classified 86.0% of the cases. The sensitivity was 94.5% and the specificity was 75.9%. The estimated coefficients, standard errors, and odds ratios (OR) are presented in Table 3.

For student-influenced variables, the relative likelihood of ET degree attainment was significantly associated with age and the number of applied transfer hours. There was a statistically significant and negative association between age and the probability of persistence or baccalaureate degree attainment (OR = 0.63, $p < .001$, 95% CI [0.37, 0.76]). This result indicates that the odds of neotraditional-age transfer students persisting were 27% less likely than the odds of traditional-age students persisting. Applied transfer hours were a negative and statistically significant factor (OR = 0.97, $p < .001$, 95% CI [0.96, 0.98]), however, the odds ratio was close to zero indicating negligible differences in the odds.

Regarding the effect of institution-influenced factors, the percentage of female faculty at the RI was negatively associated with baccalaureate ET degree attainment (OR = 0.95, $p < .001$, 95% CI [0.94, 0.97]). This result indicates that students were 5% less likely to persist with each 1% increase in the female composition of faculty.

Table 2

Relationship of Factors to first-term GPA among ET Transfer Students (n=1,964)

Variable	Block 1	Block 2	Block 3
	B (SE)	*B (SE)*	*B (SE)*
Student-Influenced Factors			
Female	0.03(0.08)	-0.03(0.08)	0.02(0.07)
Black or African American	-0.44(0.08)***	-0.47(0.08)***	-0.38(0.07)***
Hispanic or Latino	-0.17(0.11)	-0.13(0.11)	-0.12(0.09)
Other	-0.02(0.09)	-0.02(0.09)	-0.03(0.08)
Asian	-0.29(0.14)*	-0.17(0.14)	-0.10(0.12)
Age (24 and older)	0.23(0.06)***	0.17(0.05)***	0.16(0.05)**
Pell (eligible)	-0.05(0.05)	-0.02(0.05)	-0.03(0.05)
Pre-Transfer Academics:			
Applied Transfer Hours	0.01(0.00)***	0.00(0.00)***	0.00(0.00)***
AA, AFA, AGE	-0.02(0.11)	-0.07(0.10)	-0.08(0.09)
AAS	-0.13(0.06)*	-0.10(0.06)	-0.10(0.05)
AS	0.23(0.17)	0.27(0.17)	0.25(0.15)
Institution-Influenced Factors			
Female Faculty		0.00(0.00)	0.01(0.0)*
URM Faculty		0.01(0.00)	0.00(0.0)
Average Class Size		-0.06(0.01)***	-0.04(0.01)***
Factors Influenced by Both Student and Institution			
First-Term Attempted Hours			-0.26(0.01)***
First-Term Earned Hours			0.27(0.01)***
Model Summary			
F	10.148***	15.349***	60.776***
R^2	.054	.099	.333
ΔR		.045	.234

Note. b=regression coefficient*; SE*= heteroscedastic consistent (HC4) standard error

The reference variable for Race/Ethnicity was White, for Associate Degree was no associate degree

*p<.05, **p<.01, ***p<.001

Table 3

Predicted Odds of ET Degree Attainment among ET Transfer Students (n=1,970)

Variable	Block 1		Block 2		Block 3	
	b (SE)	Odds Ratio	*b (SE)*	Odds Ratio	*b (SE)*	Odds Ratio
Student-Influenced Factors						
Female	-0.15(0.16)	0.86	-0.17(0.16)	0.85	0.12(0.23)	1.12
Black or AA	-0.45(0.15)	0.64**	-0.41(0.16)	0.66*	-0.23(0.23)	0.80
Hisp. or Latino	-0.27(0.21)	0.76	-0.15(0.22)	0.87	-0.04(0.31)	0.97
Other	-0.13(0.18)	0.88	-0.05(0.18)	0.95	-0.13(0.26)	0.88
Asian	-0.44(0.27)	0.65	-0.28(0.27)	0.76	-0.02(0.43)	0.99
Age (24 + above)	-0.86(0.11)	0.43***	-0.88(0.11)	0.41***	-0.63(0.18)	
Pell (eligible)	0.39(0.10)	1.47***	0.39(0.10)	1.48***	0.04(0.16)	1.04
Pre-Transfer Academics:						
Applied Transfer Hours	0.01(0.00)	1.01**	0.01(0.00)	1.01*	-0.03(0.00)	0.97***
AA, AFA, AGE	-0.26(0.21)	0.78	-0.34(0.21)	0.72	0.32(0.33)	1.37
AAS	-0.31(0.12)	0.73**	-0.18(0.12)	0.84	0.28(0.17)	1.32
AS	1.12(0.46)	3.05**	1.14(0.46)	3.11*	0.61(0.54)	1.83
Institution-Influenced Factors						
Female Faculty			-0.03(0.01)	0.97***	-0.05(0.01)	0.95***
URM Faculty			-0.01(0.01)	0.99	-0.02(0.01)	0.99
Average Class Size			-0.07(0.01)	0.94***	-0.03(0.02)	0.97
Factors Influenced by Both Student and Institution						
First-Term GPA					-0.05(0.10)	1.03
First-Term Earned Hours					0.08(0.02)	1.09***
Total Semesters					0.03(0.04)	1.03
Cumulative GPA					1.16(0.16)	3.17***
Model Fit						
-2 x log likelihood		2395.03		2361.30		1314.39
% Correct Predicted		60.4		62.9		86.0

Note. b=regression coefficient*; SE*= standard error; the reference variable for Race/Ethnicity was White, and Associate Degree was no associate degree*; *p*<.05, ***p*<.01, ****p*<.001.

Of the post-transfer academic factors, first-term attempted hours, cumulative GPA, and total hours earned at the receiving institution were positively and significantly associated with ET degree attainment. The odds of earning a baccalaureate ET degree increased slightly with every one-hour increase in earned hours during the first semester (*OR* = 1.09, $p < .001$, 95%, CI [1.04, 1.13]) and with every one-hour increase in total earned hours at the RI (*OR* = 1.07, $p < .001$, 95% CI [1.06, 1.08]). Cumulative GPA had a much stronger relationship with degree attainment; odds of degree completion increased by a factor of 3.17 with every one unit increase in cumulative GPA (*OR* = 3.17, $p < .001$, 95%, CI [2.31, 4.36]).

Several factors were not significantly related to ET baccalaureate completion. While race/ethnicity and Pell Grant eligibility were significantly related to baccalaureate attainment in steps 1 or 2, these variables were no longer significant with the inclusion of post-transfer academic factors. Gender, percentage of URM faculty, average class size, first-term GPA, and total semesters at the RI were not statistically significant factors in persistence.

Limitations of the Study

There are notable limitations to our study. We used a secondary dataset, so the variables and variable definitions were limited to those included in the UNC System Transfer Student dataset. For instance, community college math, science, and engineering coursework completed by the student were not included in the dataset. Satisfying these course requirements impacts the amount of transfer credit hours that are applied to baccalaureate engineering technology degrees. Based on the number of excess credit hours, it is likely that many of the students in this study had transfer coursework that was not required for the undergraduate academic plans of study for engineering technology.

GPA was utilized as a proxy for academic performance, a common measure of academic performance in higher education research. In this study, inferences about academic performance in the first semester at the receiving institutions were determined from the *First-Term GPA* variable alone. Differences in instructor grading practices or student course-taking strategies impact course grades and GPA (Lei et al., 2001). Therefore, the GPAs of the students in this study do not necessarily have the same meaning since they took classes at different institutions by different instructors.

Lastly, this study did not account for motivation, interactions with faculty and peers, the number of hours worked per week, family, financial issues, degree goals, and commitments of transfer students. Yet, these factors are predictors of academic performance and persistence and were included in Smith and Van Aken's (2020) conceptual model.

Discussion and Implications

The results of our study demonstrated that academic performance and baccalaureate ET degree completion may be a function of student and institutional characteristics for ET transfer students. Key takeaways of this study include (a) Black or African American students had significantly lower predicted first-term GPAs than White students but were just as likely as White students to earn a baccalaureate ET degree; (b) neotraditional age students had a

significantly higher first-term GPA than traditional-age students, however, they were less likely to persist to degree completion; (c) an increase in applied transfer credit hours was significantly related to an increase in first term GPA, however, having an associate degree was not significantly related to academic performance in the first-term or persistence to degree attainment; and (d) first term GPA was not significantly related to persistence, however, cumulative GPA was the largest significant factor in baccalaureate ET degree attainment. While there has been very limited research on ET transfer students, we can interpret our findings in relation to research on engineering and STEM transfer students, while noting the need for a greater understanding of ET transfer students' unique experiences and pathways.

The finding that Black or African American students had significantly lower predicted first-term GPAs than White students is consistent with extant research on STEM transfer students (Lakin & Cardenas Elliot, 2016). Although, we cannot determine what causes GPAs differences from these data, such significant decrements in GPA is problematic and implies structural inequities for these students. Further, our finding that there was no difference in ET degree attainment based on racial/ethnic identity was in line with recent research on STEM degree attainment among transfer students (Zhang, 2022). Black/African Americans are more predominant among ET baccalaureate earners (7.7%) than engineering degree earners (4.7%) nationwide (ASEE, 2022), and this difference is similar in North Carolina with slightly greater proportions of Black students in each group (10.17% ET to 6.96% Engineering). More research would be necessary to understand what attracts Black students to ET and what particular institutional factors may promote the persistence of Black ET transfer students. ET program directors can take action to learn more from students about their motivation to attend, and the institutional and programmatic supports that help and hinder their persistence, particularly for women, Black/African Americans, and other marginalized groups.

Adult ET transfer students in our sample were less likely to persist to degree completion than their traditional-age counterparts, despite outperforming them in first-term GPA after transfer. There is limited information on adult (24 and older) students in engineering and ET. Some earlier evidence from the longitudinal multi-institutional MIDFIELD study indicated that adult engineering students were significantly more likely to be transfer students than traditional-aged students, yet both first-time and transfer adult students had higher graduation rates than their traditional-aged counterparts (Bushey-McNeil et al., 2014; McNeil et al., 2015). In a recent study of STEM community college transfer students, adult students were less likely to obtain a STEM degree than those younger than 24 years (Zhang, 2022), similar to our findings. Additional research is needed to understand how factors like part-time enrollment (e.g., Crosta, 2014) and life events (e.g., Goldrick-Rab, 2010) influence adult ET transfer student persistence. Older students may have less availability during daytime hours due to family or work obligations, thus evening and online resources should be available for advising, academic, and nonacademic support (Allen & Zhang, 2016).

In this study, an increase in applied transfer credit hours was significantly related to an increase in first-term GPA. Specifically, for every 10-hour increase in applied transfer credit hours, there was a 0.10 increase in predicted first-term GPA. This finding is consistent with existing research that the more transfer credit hours an engineering student earned before transferring, the higher their academic performance (Anderson-Rowland et al., 2015; Lakin &

Cardenas Elliot, 2016; Lopez & Jones, 2017). However, previous studies did not examine ET students specifically. Interestingly, completion of an associate degree, particularly an AS or AAS, did not significantly influence the first-term GPA nor persistence of ET transfer students in our sample. Zhang (2022) similarly found that STEM completers were less likely to have obtained an associate's degree. These findings contradict some previous research studies that found that associate degree earners had higher persistence rates at baccalaureate-granting institutions (Lee & Schneider, 2016; Lopez, 2012; Mattis & Sislin, 2005). It is important to consider transfer requirements and that baccalaureate-granting institutions may require students to take more classes at the university and allow fewer credits to be transferred (Zhang, 2022).

In summary, our study provides preliminary support for the alignment of ET transfer engineering student persistence with the Smith and Van Aken (2020) conceptual model, while suggesting a need for greater institutional efforts alongside research to understand the unique needs and perspectives of ET transfer students.

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Appendix A

Demographic Profile by Student-Influenced Variables and Academics (N=1,970)

			Mean (SD)		
Variable	Prop. of Sample (%)	ET Degree Compl. (%)	Applied Transfer Hours	First-Term GPA	Cum. GPA
Gender					
Female	10.6	49.8	68.3(21.9)	2.89(1.2)	2.99(0.9)
Male	89.4	56.0	62.3(22.4)	2.82(1.1)	2.95(0.8)
Race/Ethnicity					
Black or African American	12.1	46.6	61.6(24.2)	2.45(1.2)	2.69(0.8)
Hispanic or Latino	5.5	53.2	63.2(22.2)	2.71(1.1)	2.84(0.8)
Other	8.5	53.0	63.7(20.7)	2.88(1.1)	2.94(0.9)
Asian	3.5	47.8	60.4(22.9)	2.53(1.2)	2.62(0.9)
White	70.4	57.7	63.2(22.3)	2.91(1.1)	3.02(0.8)
Age					
23 or younger	39.6	67.4	53.7(20.4)	2.66(1.0)	2.85(0.8)
24 and older	60.4	47.6	69.0(32.6)	2.93(1.2)	3.02(0.9)
Pell Grant Eligible					
No Pell Grant awarded	48.0	51.2	64.5(22.7)	2.89(1.2)	3.03(0.9)
Pell Grant awarded	52.0	59.3	61.5(22.2)	2.77(1.0)	2.87(0.8)
Associate Degree Awarded					
No associate degree earned	31.7	60.0	50.0(22.2)	2.78(1.0)	2.95(0.8)
AA, AFA, or AGE earned	7.2	60.0	66.7(15.3)	2.89(1.0)	2.95(0.7)
AAS earned	57.8	51.2	69.1(20.5)	2.83(1.2)	2.93(0.9)
AS earned	2.5	86.7	69.1(16.1)	3.18(0.7)	3.33(0.5)
Total Sample		55.2	63.0(22.4)	2.83(1.1)	2.95(0.8)

Appendix B

Demographic Profile by Race/Ethnicity (N=1,970)

	Frequency (Percent)		
Variable	Female Students	Neotraditional Age	Pell Grant Eligible
Black or African American	34(5.6)	164(68.9)	167(70.2)
Hispanic or Latino	14(12.8)	60(55.0)	68(62.4)
Other	20(11.9)	111(66.1)	84(50.0)
Asian	6(8.7)	41(59.4)	51(73.9)
White	135(9.7)	818(59.0)	645(46.5)
Total	209(10.6)	1,194(60.6)	1,015(51.5)