Building Tennessee's Workforce: An Assessment of Credential Completion at Tennessee Colleges of Applied Technology

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Abstract

Tennessee Colleges of Applied Technology (TCATs) are the primary providers of public postsecondary Career and Technical Education (CTE) opportunities in the state. The purpose of this study was to determine which student demographic and enrollment characteristics significantly correlated with the completion of a postsecondary certificate or diploma at a TCAT. Using a state administrative dataset and employing multilevel modeling techniques, this study found students who enrolled on a full-time schedule, who had a prior postsecondary education background, and who received the state's need-based grant had significantly higher odds of credential completion. Students who had below a high school education, students who were classified as nontraditional based on gender and program of study, and Students of Color had significantly lower odds.

Keywords: technical colleges, credential completion, postsecondary attainment, career and technical education

Introduction

Postsecondary education is, for millions of students across the nation, a passport to higher lifetime earnings, greater career prospects, and social mobility. Following the Great Recession, the relationship between higher education, economic recovery, and projected workforce demands was reinforced through strategic goalsetting to increase postsecondary attainment rates across the nation. For example, Carnevale et al. (2013) predicted that 65 percent of jobs in 2020 would require some form of postsecondary credential, while the Lumina Foundation (2023) set the goal for 60 percent workforce-aged individuals (those between the ages of 25 and 64) to hold a postsecondary credential by 2025. Echoing the Lumina Foundation's timelines, the attainment goal in Tennessee, the geographic scope of this study, is to have 55 percent of the state's workforce-aged population hold a postsecondary credential by 2025. As of 2021 (the most recent data at the time of this study), Tennessee had an overall attainment rate of 47.3 percent, as measured and reported by the Lumina Foundation (2023). This rate is below the national attainment rate of 53.7 percent (Lumina Foundation, 2023), while the education-workforce gap in the state persists with an estimated 56 percent of jobs requiring some form of sub-baccalaureate postsecondary training (Association for Career and Technical Education [ACTE],

2022a). Moreover, between 2019 and 2021, Tennessee's education attainment rate increased by less than a percentage point (Lumina Foundation, 2023).

In meeting attainment goals and in providing open and equitable access to employable skillsets to match workforce needs, postsecondary Career and Technical Education (CTE) is essential. Generally, CTE is broadly defined, particularly in the postsecondary education space as workforce and occupational preparation (ACTE, 2022b). In Tennessee, the primary providers of postsecondary CTE are the state's community colleges and the Tennessee Colleges of Applied Technology (TCATs), both of which are overseen by the Tennessee Board of Regents (TBR). While both institutional systems are closely coupled with the local workforce and are classified as open access, they have distinct missions. Specific to providing less-than-two-year, competency-based training programs, TCATs are institutions aimed at ensuring students meet employers' technical training expectations and obtain entry-level job placement with a livable (i.e., family-supporting) wage.

TCATs often report high productivity and outcomes. In 2020-2021, for example, TCATs reported an overall completion rate of 75.6 percent and an overall job placement rate of 85.8 percent for graduates (Tennessee Higher Education Commission [THEC], 2022a). Unlike other types of postsecondary institutions where institutional success is determined from cohort-specific outcomes (e.g., retention and graduation rates), TCAT success metrics (such as the aforementioned completion and placement rates) are based on aggregated statistics. Completion rates, for example, are derived by dividing the sum of non-graduate and graduate completers (the numerator) by the difference between current enrollment and cumulative enrollment (the denominator) at the end of a reporting cycle (Council on Occupational Education [COE], 2021). While this method may be more sensitive to the practice of admitting and graduating students on a rolling basis in a reporting cycle, it masks how an individual student's background and experience informs his or her own outcome. Moreover, it aggregates non-graduates (i.e., those who did not earn a credential but gained adequate competency and are employed) with graduates (those who received a credential).

Beginning as Area Vocational-Technical Schools in the 1960s, TCATs span Tennessee and serve both rural and urban regions. While TCATs have evolved over the course of sixty years in operation, including nomenclature (from Area Vocational-Technical Schools to Tennessee Technology Centers to Tennessee Colleges of Applied Technology) and service-area expansions (e.g., increases in dual enrollment opportunities for current high school students), the institutions have always offered and emphasized workforce-relevant, hands-on learning experiences. TCATs operate on a rolling-admission basis and employ competency-based education. For competitive programs, waitlists are employed, which may—depending on the program and the institution—involve hundreds of potential enrollees. TCAT programs are typically 3-5 trimesters, which can take between 12 and 20 months to complete, though some programs may only take 1-2 trimesters, or between 4 and 8 months, to complete (Hoops, 2010). Students may achieve multiple credentials during their enrollment, but the highest award type offered at TCATs is a diploma. Beneath a diploma are certificates, which may be obtained in a shorter timeframe.

Given the role and importance of TCATs in preparing of Tennessee's workforce and the fact that TCAT success metrics are based on aggregated measures, both practitioners and policy advocates would benefit from an investigation into how characteristics of TCAT students intersect with TCAT institutional outcomes. Combining a paucity in research on TCAT student success with the increased imperative to meet state attainment goals for economic competitiveness, this study seeks to fill a knowledge gap to inform postsecondary policy and practice in Tennessee. The purpose of this study, therefore, is to assess which characteristics of TCAT students are significantly correlated with their successful completion of a certificate or diploma. This study is guided by an overarching research question: What characteristics of TCAT students are significantly associated with the successful completion of a postsecondary certificate or diploma? To explore how characteristics of students intersect with successfully earning a postsecondary credential, this study leveraged a state-level administrative dataset and employed multilevel modeling to account for differences across the distinct institutions.

Literature Review

Conceptual Framework

This study was built upon the premises of Human Capital (HCT) and Resource Dependency (RDT) theories to explain and contextualize TCAT student success. Together, these theoretical strands helped explain a TCAT student's pursuit of a postsecondary certificate or diploma while also accounting for the fact that TCATs operate in distinctive environments across the state.

Under HCT, student pursuit of and participation in postsecondary education is justified as a return on investment (Becker, 1993). Students seek formal training and education to expand their own human capital through additional knowledge and skill development in return for higher lifetime earnings. For TCAT students, the payoff for their time invested in the classroom can be much more immediate when compared to other postsecondary education providers. Because most academic programs at TCATs endure from 4 to 20 months (Hoops, 2010), human capital investments into the local or regional workforce occur quickly. This is demonstrated by 85.8 percent of TCAT students receiving placement in their field of study (THEC, 2022a).

Under RDT, institutional outcomes are contingent on their environments, as postsecondary institutions are not mutually exclusive from their communities (Pfeffer & Salancik, 1978). In the case of public institutions, some sustainability or predictability is guaranteed through annual state appropriations. Even so, institutions serving distinct regions of the state may face unique challenges, especially when coupled closely with local industry. For TCATs, this can dictate programmatic offerings, curricular changes (as industry competencies and employer expectations shift), as well as the richness of local resources (e.g., the pool of prospective students and local employer demands).

Previous Studies of TCATs

Specific to TCATs, studies are generally limited to dissertations, which emphasizes the lack of attention TCATs have received in refereed publications. Rayner (2020), for example,

analyzed institutional retention policies along with student questionnaire responses in a qualitative case study. Rayner's results indicated such themes as connected learning, competence, and academic rigor in relation to aiding TCAT students to persist in their training programs. Summers (2013) examined the motivations and perceptions of TCAT students related to their enrollment in postsecondary CTE opportunities through a series of mean comparisons. Summers observed significant differences between subgroups of TCAT students based on their demographic background and academic program. Further, West (2005) investigated the relationship between TCAT student characteristics and their programmatic outcomes. West observed a significant relationship between student enrollment status, student ethnicity, and institutional size with TCAT student outcomes. No significant relationships between completions and student gender, age, and prior education level were established through West's study.

Requiring entering students to have a high school diploma (or equivalent) or to be at least 18 years of age, TCATs are—arguably so—the most open-access public postsecondary institutions in the state. Relative to open-access policies, a predictive factor of a student's success is his or her educational background. For example, did the student graduate from high school? Was the student exposed to CTE coursework in their secondary education, and if so, to what degree? Has the student already gained some experience in postsecondary education? These are some of the critical questions that could lend student-facing personnel and CTE instructors valuable insight into odds of the student's success but also of the student's interests, motivations, needs, and goals. For instance, research from Arkansas and Massachusetts indicated that the more CTE courses students took in high school, the higher their education and labor market outcomes (Dougherty, 2016; 2018).

Also related to their open admission policies, TCATs represent an equitable opportunity for students, irrespective of their background or prior experiences, to seek employable training beyond the high-school level. Beyond admission requirements, students in CTE education may still face challenges to equitable education and employment outcomes in respect to both gender and racial background (e.g., Lufkin et al., 2007; Rojewski & Xing, 2013).

Student Demographic and Enrollment Characteristics

Beyond the special populations prescribed under the Perkins Act, research has underscored the importance of accounting for student demographic characteristics, especially gender and race, when studying CTE. Gender, as observed by Carruthers et al. (2021), can be predictive of the type of CTE programs (or *clusters*) in which students participate. The same research found that a student's race and ethnicity, in concert with locale, can correlate with CTE participation, with Black and Hispanic student participation being nonconstant across locations. Anderson et al. (2021) noted substantial equity gaps in postsecondary CTE programming by race and ethnicity (more specifically comparing Black and Latinx students to their White peers). Using national data, Anderson et al. also observed that Black and Latino students were significantly less likely to complete a credential and to enter the workforce within their program of study.

Across postsecondary education, being the first in one's family to attend college implies that the student enters postsecondary education without the same social preparation and expectations as their non-first-generation (or continuing-generation) peers (Redford et al., 2017). Gibbons and Borders (2010), for example, observed that prospective first-generation students (those yet to matriculate) reported lower self-efficacy and had less-positive expectations of their educational outcomes as compared to their non-first-generation peers. Research on first-generation students in postsecondary education, however, is largely centered outside of the technical college sector (e.g., Pascarella et al., 2016), and the effects of being a first-generation college student enrolled in postsecondary CTE merits further investigation. The exact effect of being a first-generation student in a technical college, therefore, could hinge on how the terms *first-generation* and *college* are defined (Toutkoushian et al., 2018).

Similarly, entering college from a low-income or low socioeconomic background carries implications for additional financial need, the increased potential for working while enrolled, and career and educational motivations. Carnevale and Smith (2018) noted that low-income students are overrepresented by Black and Latino students and first-generation, that they are less likely to attend a four-year college but are more likely to attend community or technical colleges, and that they have less financial security.

Characteristics of a student's enrollment, or how they are participating in postsecondary education, may correlate with their postsecondary outcomes. Using data from the Integrated Postsecondary Education Data System (IPEDS), Juszkiewicz (2020) noted that eight-year completion rates of part-time community college students were roughly half those of full-time students. Also using national data, Darolia (2014) observed that working while enrolled had little effect on part-time student academic outcomes. Though part-time students may have a decreased likelihood of timely completion, they may have equal odds of achieving academic competencies.

Under the Perkins Act, CTE providers identify subgroups of students as *special populations*, or students who may face added disadvantages regarding either their participation or success in postsecondary education. Broadly, special populations include students enrolled in a nontraditional major group based on their reported gender, low-income students, and students who are situationally disadvantaged (e.g., single parents, English language learners, and individuals with disabilities). Though their study is nearly two decades old at the time of the current research, Bailey et al. (2004) observed that individuals belonging to the special populations were less likely to complete a credential.

Institutional Rurality

Echoing the RDT premises invoked for this study, institutions located in rural environments are typically associated with distinct challenges in serving their students and with having access to fewer resources as opposed to urban institutions. Scott et al. (2015), for example, cited several challenges associated with rural colleges, such as low-performing high schools, high proportions of first-generation postsecondary students, and sparce connection of internet or technology. The researchers, too, observed through a multi-institution survey that academic preparation and funding were the primary drivers in a student's decision to matriculate

at a rural community college. Similarly, Hardy and Katsinas (2007) found significant and substantial differences between rural, suburban, and community college relative to their student enrollment composition (higher shares of female and full-time students at rural institutions). Rural institutions, too, had fewer types of academic program offerings and services available on campus for students. Hardy and Katsinas also noted that rural institutions may be more likely to rely on state appropriations given their inability to achieve the "economies of scale that help larger institutions bring in more money and reduce per-student expenditures" (p. 15).

Methods

This correlational study examined a binary outcome variable for students attending 26 public technical colleges in Tennessee. Because the outcome was measured on a binary scale (students completed or they did not) and the students were nested in different groups, this study employed a multilevel logistic regression as the primary analytical method.

Data

Data for this study come from two administrative datasets, the Tennessee Higher Education Commission's Student Information System (THECSIS) and the Financial Aid System of Tennessee (FAST). Additional institution-level data on the TCATs come from the Integrated Postsecondary Education Data System (IPEDS), which is maintained by the National Center for Education Statistics. Record-level data on TCAT enrollment and awards are submitted routinely to THECSIS by TBR, the governing body for Tennessee's community and technical colleges. Data within FAST represent in-state student financial aid and scholarship applications and payment records for state-based financial aid programs.

The study's sample consisted of 10,011 students enrolled at one of 26 TCATs in academic year 2015-16, which represents three academic terms within THECSIS: fall 2015, spring 2016, and summer 2016. For the purpose of this study, one TCAT was excluded as it is not wholly comparable to its sibling institutions in accreditation and practice. To be included in the study, students had to have initially enrolled (i.e., first term on record) during the 2015-16 academic year as a postsecondary student in a preparatory program. Under this logic, dual enrollment students and students enrolled in workforce or non-credit training programs were excluded.

The dependent variable for this study was diploma or certificate completion, a dichotomous measure with one indicating completion and zero indicating non-completion. Outcomes for the students included in the sample were assessed after a period of two academic years ending in academic year 2017-18 (corresponding to fall 2017, spring 2018, summer 2018). By the end of the observation period, 5.2 percent of the cohort was still enrolled and had not received a diploma or credential. Those who completed either a diploma or certificate were classified as completers, which represented 64.3 percent of the sample. The share of completers varied substantially by institution, with a maximum value of 80.5 percent and a minimum value of 34.8 percent. As prefaced in the introduction, this completion calculation differs from completion rates as reported by TCATs for COE accreditation purposes.

A set of independent variables pertaining to students' demographic and enrollment characteristics and the special population classifications under the *Strengthening Career and Technical Education for the 21st Century Act* (i.e., Perkins Act), were considered for the study. Descriptive statistics of the study's dependent and independent variables are captured in Table 1. All non-categorical variables are measured on a binary scale. For the two categorical variables included in the statistical model, the reference groups are indicated with an asterisk. Student demographic characteristics included race/ethnicity (a binary measure identifying Students of Color), first-generation status (based on the highest level of education received by either parent), and age category (25 years or older). Student enrollment characteristics included measures of prior education level, student major group, full-time enrollment, and need-based financial aid receipt.

Table 1. Descriptive Statistics of the Dependent and Independent Variables

Variable	Mean	Standard Deviation	Min	Max
Dependent Variable				
Diploma or Certificate Completion	0.64	0.48	0	1
Independent Variables				
Student of Color	0.24	0.43	0	1
First Generation	0.42	0.49	0	1
Age 25 or Older	0.43	0.50	0	1
Previous Education Level				
High School Graduate or Equivalent*	0.66	0.47	0	1
Postsecondary Education	0.17	0.38	0	1
Less than High School or Unknown	0.16	0.37	0	1
Enrolled Full Time	0.84	0.37	0	1
Student Major Group				
Trade or Industry*	0.52	0.50	0	1
Health Profession	0.29	0.45	0	1
Other Major Group	0.20	0.40	0	1
Received TN Student Assistance Award	0.30	0.46	0	1
Special Populations				
Economically Disadvantaged	0.79	0.41	0	1
Nontraditional Student	0.10	0.30	0	1
Other Special Population	0.22	0.42	0	1
Group-Level Variable				
Rurality	0.58	0.49	0	1

Note: Mean for categorical variables, interpreted as percent values, may not sum to 1 (100%) due to rounding.
*reference group for categorical variables

Under the Perkins Act, several special populations are identified, and a subset of these classifications is included in this study. TBR provides special population data to THECSIS, which is collected by means of a short, annual student survey administered electronically to all

enrolled students. These self-reported data were supplemented with other data within THECSIS, where possible and appropriate, to produce more robust estimates of the populations. The populations modeled in this study are students who are economically disadvantaged; students who are enrolled in a nontraditional field for their gender group; and students identified as an individual with disabilities, an individual with limited English proficiency, a single parent, or a student displaced from the workforce.

Students classified as economically disadvantaged were proxied through the self-reported responses collected by TBR and Federal Pell Grant eligibility. Nontraditional students are identified based on a combination of the student's gender group (categorized as male or female) and major group. These students are enrolled in a program of study (based on six-digit Federal CIP codes, or Classification of Instructional Programs) in which their gender group represents under 25 percent of those employed in the corresponding occupational field. The most recent revision by the Perkins Collaborative Resource Network (PCRN) identified 449 CIP codes for females and 262 CIP codes for males in which the respective gender group represented less than 25 percent of the corresponding occupation (United States Department of Education [USDOE], 2020). Data within THECSIS, as reported by TBR, were supplemented with PCRN's crosswalk of nontraditional majors. Students belonging to other special populations were coalesced into a single group representing single parents (as reported by TBR and supplemented with data within FAST), individuals displaced from the workforce, disabled individuals, and individuals with limited English proficiency.

One characteristic of the institutions is included in the model, rurality. This is a binary variable indicating whether an institution is in a rural environment per the IPEDS institutional characteristics data submission.

Analysis

Because the dependent variable is binary (students did or did not earn a diploma or certificate during the observation period), logistic regression is an ideal method of analysis. Because the students included in this study are clustered across 26 different institutions, the independence of errors statistical assumption is violated. The usage of a single-level model is inappropriate and could lead to an increased probability of a Type I error (Heck et al., 2014; Hox et al., 2018). Moreover, each of the 26 TCATs included in this study operate in different environments across the state: some within the state's urban centers and others serving rural communities across large geographic areas. To account for the natural grouping of students in the sample and to include institutional characteristics alongside student characteristics, this study leveraged a multilevel logistic regression, also referred to as a generalized linear mixed model, as the primary analytical method. Table 2 summarizes the grouping structure of the sample.

Table 2. Descriptive Statistics of Grouping Structure

Total Observations	Total Groups	Mean Group Size	Min Group Size	Max Group Size
10,011	26	385	139	940

For this study, constructing the multilevel model constitutes three phases: the unconditional model, the level-one model, and the level-two model. As a generalized linear model, the equation leverages a logistic link function to fit the model to the data and to predict outcomes measured on a log-odds scale. In estimating the unconditional model, only the dependent variable is included to determine the variation in log odds across the groups. Using the unconditional model, the intraclass correlation coefficient (ICC) in multilevel logistic regressions is calculated by dividing the random intercept variance by the sum of the random intercept variance and the standard logistic distribution (or $\pi^2/3$). Using the ICC as an index of data dependency and as a measure of differences in the outcome variable between groups, values in excess of .05 underscore the need for a multilevel model (Peugh, 2010).

Following the unconditional model and establishing the need for a multilevel model, the level-one model is estimated, in which the covariates measured at the student level are introduced to the model. The final phase of model building is to introduce the covariates measured at the group (or institution) level.

Because all independent variables were entered into the model as binary (categorical variables entered with a reference group coded as zero), all variables remained uncentered. Prior to building the multilevel model, variance inflation factors (VIFs) were inspected for evidence of multicollinearity, or large correlations between independent variables. To assess model fit, deviance statistics were compared between models (Heck et al., 2014; Hox et al., 2018).

Results

Before carrying out the full multilevel model, the unconditional model was estimated; the ICC was calculated as 0.17, which, as an index, exceeds Peugh's (2010) threshold of 0.05 and justifies the need to consider a multilevel model due to the nested nature of the data. More specifically, this indicates that 17 percent of the likelihood of completing a certificate or diploma is explained by differences between TCATs (Sommet & Morselli, 2017). The final results of the multilevel logistic regression are summarized in Table 3. Relevant to categorical variables included in the model, Table 1 in the methods section indicates reference group selections.

These results may be interpreted using the odds ratios, which are calculated by exponentiating the log odds in the coefficients column. Odds ratios less than one indicate lower likelihood of degree or certificate completion, and odds ratios greater than one indicate higher likelihood of degree or certificate completion. By subtracting one from the odds ratios, readers may interpret the output as a percent likelihood. The intercept represents the outcome variable when all values of the independent variables equal zero. In total, race, first-generation status, previous education type, student major, financial aid receipt, and special population membership shared a significant relationship with diploma or certificate completion at TCATs.

Pertaining to student demographics, once accounting for the rurality of the institution, Students of Color were 19.4 percent (i.e., 0.806 – 1 = -0.194) less likely to complete a certificate or diploma in a two-year period as compared to other students. First-generation students, however, proved to have 15.7 percent higher odds of completing compared to their non-first-

generation peers. Regarding the student's prior education before matriculation, students who had some measure of postsecondary education had 19.4 percent higher odds of completing compared to their peers educated at the high school level, whereas students with less than a high school education or students for whom their prior education was unknown were 53.5 percent less likely to complete.

Table 3. Summary of Results

Variable	Coefficient	Odds Ratio	Standard Error (Robust)	95% Confidence Interval	Sig
Intercept	-0.0636	0.939	0.182	(-0.420, 0.293)	
Student-Level Characteristics					
Students of Color	-0.215	0.806	0.071	(-0.354, -0.077)	**
First Generation	0.146	1.157	0.058	(0.033, 0.259)	**
Age 25+	0.085	1.089	0.112	(-0.134, 0.304)	
Previous Education Level					
Postsecondary Education	0.178	1.194	0.072	(0.037, 0.318)	**
Other or Unknown	-0.766	0.465	0.131	(-1.022, -0.510)	***
Enrolled Full Time	0.956	2.600	0.154	(0.653, 1.258)	***
Major Group					
Health Profession	-0.019	0.981	0.216	(-0.442, 0.403)	
Other Major Group	-0.578	0.561	0.111	(-0.795, -0.360)	***
Received TSAA Award	0.703	2.021	0.077	(0.552, 0.854)	***
Special Populations					
Economically Disadvantaged	-0.057	0.945	0.123	(-0.299, 0.185)	
Nontraditional Student	-0.229	0.795	0.0958	(-0.417, -0.041)	**
Other Special Population	-0.166	0.847	0.0515	(-0.267, -0.065)	**
Institution-Level Characteristic					
Rurality	0.091	1.095	0.022	(0.056, 0.148)	

*$p<.05$; **$p<.01$; ***$p<.001$

Over 50 percent of the students in the sample were enrolled in an industry or trade program of study, making it the predominant major of choice and the reference group used in these analyses. Compared to students in an industry or trade-related major field, students majoring in a healthcare field demonstrated a statistically insignificant difference in the odds of completion. Students in the *other* (i.e., non-industry and non-healthcare) major group, however, were 44 percent less likely to complete a diploma or certificate compared to students in a trade or industry-related program. Given how major fields were aggregated for the regression, readers are cautioned against applying these results toward a specific programmatic field within the aggregated categories.

Financial aid receipt was represented in the model using the Tennessee Student Assistance Award (TSAA), the state's need-based scholarship awarded on a first-come, first-serve basis. While matriculating TCAT students eligible for state aid should receive the Wilder-Naifeh Technical Skills Grant, TSAA serves as an indication for additional financial resources

given to the students in most need (as determined by expected family contribution and by the cost of attendance). In the model, TSAA recipients were more than twice as likely (102.1 percent higher odds) to complete a certificate or diploma compared to their peers. Likewise, TCAT students who enrolled full-time were more than two-and-a-half times as likely to complete a diploma or certificate within a two-year period compared to those who enrolled on a part-time schedule.

Of the three classifications of special populations included in the study, two emerged as significant predictors. The odds of a student who was flagged as nontraditional (i.e., those enrolled in a major for which their gender group is unrepresented in the corresponding occupational field) completing a diploma or certificate were 20.5 percent lower than that of their peers. Students identified as belonging to another special focus population in this study (i.e., those flagged as single parents, individuals with disabilities, individuals with limited English proficiency, or individuals displaced from the workforce) were 15.3 percent less likely to complete a credential. Given the aggregated treatment of the *other special population* variable, no specific inference may be drawn to any of the subgroups constituting the variable. As such, readers should consider the *other special population* variable as a covariate only and should refrain from extrapolating the results.

One group-level characteristic was included in the model to account for institutional rurality. While statistically insignificant, the average odds of completion were 9 percent higher at rural institutions than at urban TCATs. Because the overall number of groups represented in the sample (n = 26) and recommended minimum sample sizes for multilevel models can range from 30 to 50 (e.g., Hox et al., 2018; Raudenbush & Bryk, 2002), robust standard errors are estimated and reported, along with the 95 percent confidence intervals. The resulting model also produced a statistically smaller deviance statistic, indicating better model fit than the unconditional model, though the large deviance statistic may indicate an overall poor fit.

Limitations

In the academic terms following those included in this study's observation period, TCATs transitioned to a new data management system, which prompted the use of older data (relative to the most recent data within the administrative datasets). Data and research findings from this study may not be entirely sensitive to current-day TCAT operations. Likewise, the self-reported data representing Perkins Grant special populations may underestimate true population values, especially if students choose to not disclose group membership or do not fully understand questions posed on TBR's annual student survey.

Because the study focused specifically on postsecondary students in preparatory programs, dual enrollment students were excluded. Given expanding dual enrollment opportunities within TCATs, additional research is needed to explore the outcomes of dual enrollment students enrolled postsecondary CTE programs in Tennessee, as well as how participating in dual enrollment relates to the likelihood of receiving a postsecondary certificate or diploma.

While over ten thousand students were represented in the study, only 26 groups were able to be included. Another methodological limitation was encountered when fitting the level-two model. Additional information about TCAT institution characteristics, which included measures of institutional size and of institutional resources (e.g., student-to-faculty ratios), was initially considered for the study. When additional institutional characteristics were introduced, however, the model failed to converge.

Discussion

The purpose of this study was to identify which characteristics of TCAT students significantly relate to the successful completion of postsecondary certificate or diploma. To achieve this purpose, this study employed state administrative datasets and multilevel modeling techniques to accommodate salient and impactful differences between institutions. Readers should interpret these results as correlational and not as evidence of a causal relationship between TCAT student characteristics and their outcomes.

Four characteristics of students strongly, positively, and significantly corelated with a student's odds of completing a certificate or diploma: full-time enrollment, receipt of the TSAA grant, having some previous postsecondary education, and being a first-generation student. Enrolling on a full-time schedule equates to a 30-hour-per-week commitment. Students who did so, compared to their peers on a part-time schedule, had 2.6 times higher odds of completing a certificate or diploma. Based on the odds ratios being used as a measure of effect size, full-time enrollment exhibited the largest magnitude of effect on a student's odds of credential completion. One may find this result intuitive (students dedicating more of their time to their program of study have a higher likelihood of completing), and the result underscores that a student's initial commitment to their educational investment corresponds to a notably higher and positive outcome likelihood for that student.

A unique and valuable feature of this study is the inclusion of TSAA grant receipt, Tennessee's need-based financial aid program. Eligible TCAT students may receive up to $1,000 per year in grant funding through TSAA. The analyses presented here indicate that TSAA recipients were more than twice as likely to earn a certificate or diploma than non-recipients. This finding implies that having additional funding gifted to students demonstrating financial need can translate to a higher likelihood of a positive outcome for that student, and it underscores that supplemental, non-refundable monetary support plays a role in a student's human capital investment. Unknown within and beyond the scope of the data leveraged in this study is whether a student knew and understood his or her eligibility for TSAA. Emerging research (specific to high school seniors) in Tennessee demonstrated an overall lack of familiarity students have toward financial aid opportunities (THEC, 2022b). Considering adult students (those 25 and older; temporally removed from a secondary education environment) represented 43 percent of the study sample and that 82 percent of the sample had an education level of high school or below (including an unknown educational background), one could postulate that the students in the sample may not have had a strong understanding of their eligibility. More research is needed to understand how familiarity with financial aid opportunities moderates the relationship between aid receipt and the likelihood of completion.

Two other variables proved to be strong, positive correlates with a student's odds of completing a certificate or diploma: prior educational experience and first-generation status. To the former, students who had some postsecondary education experience exhibited higher odds of completion when compared to students with a high-school education. This implies that students who have a higher investment in their own human capital at the outset have greater chances to advance their investment. Students with a higher education level upon entry, too, may have an understanding of postsecondary institutional processes and have more defined career goals, as well as the discipline required to achieve learning outcomes (i.e., competencies).

The results for first-generation students, however, appear first as counter-intuitive and should be interpreted with caution. Where in other postsecondary venues, being a first-generation student may imply a disadvantage toward credential completion (e.g., Ishitani, 2006), the results of this study indicate that first-generation students are more likely to complete when compared to their peers. The most plausible explanation is that the measure of first-generation status used in this study is not wholly sensitive to TCAT enrollment. If a student's parents graduated from a TCAT, their experience could inform the student's intent to enroll in and be successful at a TCAT. Conversely, TCAT students classified as *not first generation* (i.e., either parent earned an associate degree or higher) may have had preconceived expectations of a college experience that differed from the social and academic environment at a TCAT.

The results also indicated certain characteristics of a student's enrollment and demographic background correlated with lower odds of completion. These variables included having below a high-school level or unknown prior education, belonging to a non-industry- or non-healthcare-related major group, being classified as a nontraditional based on gender and program of study, and being a Student of Color. From a HCT perspective, results specific to these variables indicate challenges to students being able to make an equal and equitable investment to their human capital. These results also express opportunities for change to improve student-support services and to increase overall diversity in TCAT program participation and in the qualified applicant pools for industry and workforce (Lufkin et al., 2007).

Where students who enrolled with some previous postsecondary education had significantly higher odds of completing a credential, students with less than a high-school level or an unknown educational background had significantly lower odds of completion. These students, when compared to their peers with a high school or equivalent education, had roughly 54 percent lower odds of completing a certificate or diploma, which makes this category of prior education experience the strongest negative correlate with the likelihood to complete. This finding is contradictory to past TCAT-specific research (e.g., West, 2005), in which prior education level was found not to relate to completion significantly. Though contrary to what the extant literature prescribes, the finding is intuitive under the assumption that students who did not successfully complete a high school education (or have an undisclosed educational background) may require higher levels of basic education remediation (quantitative and qualitative reasoning necessary achieving industry-specific competencies) at the outset of their enrollment. TCAT's open admission policies (requiring a high school diploma or being over the age of 18) make access to the opportunity to build human capital widely available across the

state. The results relative to a less-than-high school education should not dissuade such admission policies, but the results highlight that extra support and investment (on part of the student and of the institution) is necessary to close the equity gap in completion likelihood.

Depending on a student's program of study, his or her likelihood of completing a certificate or diploma could be more or less impacted. Compared to students in industry-related fields (comprising the majority of the sample), students in other majors (i.e., non-industry or non-healthcare, such as business or cosmetology) had 44 percent lower odds of completing a certificate or diploma. Given the aggregated nature of the *other major group* variable, it is impossible to extrapolate these results to any specific program of study, and readers are discouraged from applying these results holistically to all non-industry and non-healthcare majors. These results could be a reflection of institutional practices, students' career aspirations, and industry expectations of program outcomes. One could reasonably speculate that some major groups (and their intended corresponding workforce or industry fields) contained within the *other major group* variable may have been better aligned with lower credential levels. More investigation is necessary to determine the validity of such speculation. In context, however, these students represented a minority of the sample. Eighty-one percent of students in the sample enrolled in either an industry- or a healthcare-related program of study. The difference in completion likelihood between students in these two prominent major groups was statistically insignificant.

Based on the student's reported gender and major field, those considered nontraditional were significantly less likely to complete a certificate or diploma. This depicts a somewhat discouraging picture to gender inequity within postsecondary CTE as well as in the workforce. Even if credentialed, nontraditional students enter into employment opportunities where their gender group represents less than 25 percent of the workforce in their field. Because gender was not included as a covariate due to both model overspecification and concerns with multicollinearity, specific inference cannot be given to *nontraditional* men and *nontraditional* women. Even so, the results here echo findings from Bailey et al. (2004), which observed that students in special populations were less likely to complete a postsecondary credential. Bailey et al., however, also observed that nontraditional women were just as likely as nontraditional men to complete.

For Students of Color, this study found that their odds of completing a certificate or diploma were 19 percent lower than their White peers. Certainly, these results provide evidence of an equity gap in completion likelihood based on racial or ethnic background. From a HCT perspective, the results imply that Students of Color (representing 24 percent of the sample) encounter challenges impeding a successful and meaningful investment in their own human capital, which could then translate to fewer industry-specific employment opportunities and to a lack of diversity in qualified candidates. Given that Black, Hispanic, Asian or Pacific Islander, Native Alaskan, and American Indian students, as well as students from multiple racial or ethnic backgrounds, were collapsed into a single category for these analyses, group-specific effects or recommendations cannot be extrapolated and overall generalizability is limited (Rojewski & Xing, 2013).

Conclusion and Recommendations

The implications and recommendations for policy, practice, and research yielded from this study intersect the second theoretical framework, RDT. Under the RDT framework, TCATs have a more predictable stability of financial resources as a public institution but less autonomy as compared to a private entity. More so than other postsecondary sectors, however, TCATs are closely, inseparably, and rightfully coupled with local and regional industry. This proximity informs TCATs of academic and competency needs via institutional and programmatic advisory committees, but it also indicates that TCATs are sensitive to fluctuations in the private sector (i.e., supply and demand). Moreover, TCATs serve heterogenous student populations, which range from densely populated urban centers to isolated rural communities. As such, TCATs do not operate in controlled environments and each distinct TCAT has variable and limited regional resources (e.g., prospective student pools, industry partners, faculty, and student support personnel) at its disposal. From this perspective, the RDT framework, recommendations for policy and research are provided.

The principal recommendation for policy pertains to funding. The Perkins Act serves as the primary federal mechanism for funding postsecondary CTE programs. In fiscal year 2021, Tennessee received a total of $28.5 million in Perkins grant funding, 85 percent of which (roughly $24 million) was allocated to local formula distribution (i.e., for CTE providers and reserve funds). Of the 85 percent, roughly $3.1 million (or 15 percent) was allocated to postsecondary providers, not exclusive to TCATs (Tennessee Department of Education [TDOE], 2020; USDOE, 2021). The results of this study revealed that not all students have equal likelihood of completing a postsecondary CTE credential, which implies that some students require more or targeted support to promote the likelihood of a successful outcome. Having greater allocations toward the postsecondary sector, in addition to making more funding available through the Perkins Grants (so not to detract from support for secondary CTE programming), could permit TCATs to expand resources to serve students more individually and holistically during their enrollment and in their subsequent transition to the workforce.

Specific to allocations of state funding, consideration should be given to improving the mechanisms used for recommending state appropriations for TCATs. Currently, recommendations for TCAT state appropriations are made outside of Tennessee's outcomes-based funding formula, which is leveraged for the state's community colleges and universities (THEC, 2022c). While the current study does not and cannot prescribe specific revisions to the existing funding formula, it serves as fodder for conversations on revising or improving the funding formula for TCATs to account for student outcomes. For example, a funding formula revision might be to consider a premium or weight associated with the enrollment and successful completion of students identified as a Perkins Act special population (e.g., students classified as nontraditional based on gender and program of study).

For future research, this study yielded methodological and data-usage implications. From a methodological perspective, this study underscored that TCATs, while sharing a common mission, are truly distinct from one another. As evidenced in this study, the differences between institutions accounted for 17 percent of the variation in likelihood to complete a credential.

Future studies, therefore, should continue to be mindful of how differences between distinct TCATs can impact (and inform) research results. Future studies may consider newer data on TCAT outcomes and on different groups of TCAT students, such as the growing population of and focus on dual enrollment students (Tennessee State Government, 2019). While this recommendation may not be wholly applicable until TCATs fully transition into a new data management system and enough time has elapsed to permit consistent and longitudinal data collection, the opportunity for newer, deeper, and more practical insight into TCAT student success is on the horizon.

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