Predicting Community College Outcomes: Does High School CTE Participation Have a Significant Effect?

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Abstract

This study explored the relative importance of participation in high school career and technical education (CTE) programs in predicting community college outcomes. A hierarchical generalized linear model (HGLM) was used to predict community college outcome attainment among a random sample of direct community college entrants. Results show that even after controlling for various pre-college and environmental factors, community college students who had participated in a high school CTE program were either just as likely or more likely to attain all of the outcomes measured in the study when compared to students from general curriculum programs. Although high school CTE students who matriculated to community colleges were significantly less likely to transfer to a four-year college with or without a credential as compared with college prep students, they had significantly greater odds of earning an associate's degree or a certificate. Thus, among community college students, high school CTE participation may help facilitate goals related to the completion agenda, which call for increasing the number of individuals with quality postsecondary credentials.

Introduction

The study of community college outcomes is a rich field within higher education. Scholars have produced studies explaining community college outcomes using various models and approaches (Bettinger & Long, 2005; Bragg, 2001; Cohen & Brawer, 2008; Horn & Skomsvold, 2011). We focus on community college outcomes for two complementary reasons. First, a major purpose of community colleges is to function as a democratizing enterprise, aiming to serve students from a wide variety of backgrounds and interests (Cohen & Brawer, 2008; Dougherty, 2001). Relatedly, community colleges now serve half of the undergraduate students in the United States and therefore have a huge role in moving the nation towards the completion agenda goal of having 60% of the adult population with a high quality degree or credential by 2025 (Lumina Foundation, 2015).

As with community colleges, career and technical education programs at the secondary level serve students from varied backgrounds and interests. Another feature common to community colleges and CTE programs is that they offer opportunities for specific career preparation (Cohen & Brawer, 2008; Levesque et al, 2008). Despite these commonalities, few studies have made connections between community college outcomes and CTE participation at

the secondary level. For instance, it is unclear whether participating in a (CTE) program in high school helps to explain later community college outcomes.

The aim of this study is to examine the relative effect of CTE participation within the context of other predictors of postsecondary outcomes. We examine the effect of CTE participation among a random sample of students from the Illinois high school graduating class of 2003 who transitioned to community colleges the fall semester of 2003. More specifically, we are interested in exploring whether high school CTE participation is a significant predictor of community college outcomes when examined within a comprehensive, multi-level longitudinal model that also takes into consideration other student and environmental characteristics.

The current study provides a unique contribution to the literature base. As a longitudinal study, it brings to light the relative effects of high school CTE participation on a broad array of postsecondary outcomes, in this case, community college outcomes. Other research on the role of CTE and postsecondary education tends to fall into two major strands. The research within the first strand examines high school CTE participation and its correlation with outcomes such as high school graduation, occupational choice, likelihood of initial college enrollment, and long-term employment outcomes (Agodini & Deke, 2004; Arum & Shavit, 1995; Cellini, 2006; Castellano, Stringfield & Stone, 2003; DeLuca, Plank, Estacion, 2006; Fletcher & Zirkle 2009; Plank, DeLuca & Estacion, 2008; Pittman, 1991; Stone & Aliaga, 2005). Another strand focuses on describing the postsecondary outcomes of students who enroll in community college CTE programs (Alfonso, Bailey & Scott, 2005; Bailey et al., 2004; Hirschy, Bremer, & Castellano 2011; Roska, 2006; Ydoyaga, 2014). This study aims to bridge the gap in the literature and determine the connectedness between high school CTE participation and later postsecondary college outcomes, in this case community college outcomes.

Conceptual Framework of Community College Outcomes

To model the relative effects of student characteristics and environmental factors on later postsecondary outcomes, Wang (2009) proposed a comprehensive framework of postsecondary educational outcomes for community college transfer students. The framework by Wang (2009) is consonant with the model discussed by Porchea at al. (2011) and includes the following general characteristics that influence postsecondary outcomes: Precollege characteristics and environmental factors. This section includes studies that support the variables identified in the model by Wang (2009).

Precollege Characteristics

In Wang (2009), precollege characteristics referred to students' demographic background, gender, race, ethnicity and parental income. Students' academic performance could also be seen as a type of pre-college, background variable.

Gender. In terms of gender differences, although the rate of transfer to four-year institutions was fairly similar for male and female students, a significantly higher proportion of female students earned an associate degree or technical certificate during their community college enrollment (Smalley, Lichtenberger, & Brown, 2010). Bosworth (2010) found that approximately two thirds of women were certificate holders. Likewise, Smalley, Lichtenberger,

and Brown (2010) found that a significantly higher proportion of female community college students earned an associate degree or technical certificate during their community college enrollment.

Race. Recent research has found that regardless of academic preparation, white and Asian community college students tend to have higher rates of community college credential attainment relative to traditionally underserved students (Lichtenberger & Dietrich, 2012). Further, substantially higher proportions of traditionally underserved minority students (defined as Latino, Native American, and African American students) transferred to a four-year college without earning a community college degree (Lichtenberger & Dietrich, 2012). At the institutional level, community colleges with high percentages of African American, Native American and Hispanic students had lower graduation rates (Bailey et al., 2005). According to Carnevale, Rose, and Hanson (2012), seventeen percent of African Americans report certificate completion as their highest educational attainment. In contrast only 11% of, white, Latino, and Asians completed a certificate program as their highest educational attainment.

Income. After considering differences in academic preparation, Lichtenberger and Dietrich (2012) found that low income students had slightly higher community college credential completion rates than their high income counterparts. While differences between community college students in the high and mid-high income categories in terms of overall community college outcome attainment were quite small; the students in the high and mid-high income earned credentials at higher rates and higher proportions of high income students transferred to a four-year college without a credential (Lichtenberger & Dietrich 2012). This result is in line with the observation by Goldrick-Rab (2010), who noted that community college success, particularly in the form of transferring to four year programs, is related to middle class status. Further, certificate completers are concentrated among students from low to moderate family income (Carnevale, Rose & Hanson, 2012).

Academic performance. Previous research has shown that academic performance affects postsecondary outcomes for community college entrants. Relative to other factors, academic preparation or college readiness, defined as high school GPA and performance on the ACT, appeared to explain the greatest variation in outcome attainment for community college entrants (Smalley, Lichtenberger, & Brown, 2010). Further, performance on the ACT without considering high school GPA also helped to explain community college outcome attainment. Community college entrants meeting more of ACT's college readiness benchmarks were substantially more likely to earn a credential, transfer to a four-year college, or do both (Lichtenberger & Dietrich, 2012).

CTE participation as an academic resource. Wang (2009) pointed out that academic resources, defined as the intensity of the high school curriculum track, are a type of pre-college characteristic. Gemici (2011) noted three general curriculum tracks within the United States education system: CTE, college prep, and the general curriculum track. The notion that school curriculum track is a key factor in explaining postsecondary outcomes justifies an exploration of how CTE participation affects community college outcomes.

Several studies have shown that there is a positive relationship between CTE participation on high school outcomes and initial postsecondary enrollment (Arum & Shavit,

1995; Castellano, Stringfield & Stone, 2003; Cellini, 2006; DeLuca, Plank, Estacion, 2006; Fletcher & Zirkle, 2009; Karp & Hughes, 2008; Lichtenberger & Dietrich, 2012; Plank, DeLuca & Estacion, 2008; Reese, 2008). However, one study by Levesque et al (2008) offered a contradictory finding and noted that the more CTE courses taken at the high school level "the lower were their enrollment rates over this 8-year period" (p. 53). Furthermore, while Karp et al., (2007) described the postsecondary outcomes of dual enrolled CTE students, in general, the relationship between high school CTE participation among all high school students and later community college degree, certificate attainment or transfer to a four-year institution has not been established.

Environmental Factors

Wang (2009) explained that environmental factors refer to the 'external demands' that may affect postsecondary outcomes. One example of an external demand is family responsibility. For example, one could argue that students from large families may have more responsibility, both financially and as caregivers to siblings, than students from smaller families, thus leaving less time for academic pursuits. Likewise, work responsibilities are an additional external demand that may compete with academics.

Citing Bean (1990) and Bean and Metzner (1985), Wang (2009) explained that environmental factors may play a role in postsecondary outcomes. Specifically, family responsibilities, which generally increase as the number of siblings increase, and work demands may pull student attention away from studies. Lichtenberger and Dietrich (2012) found that expecting to work during community college enrollment appeared to have a negative impact on credential completion and vertical transfer; however, the differences in overall community college outcome attainment between those who expected to receive financial aid and those who did not were rather small.

Accounting for Context

The importance of examining the effects of context on developmental outcomes, such as various types of educational attainment, was proposed by theorists in human ecology, such as Richards (1907) and Bronfenbrenner (1979). For example, in their discussion of ecological theory, Klein, White, and Martin (2015) observed that ecological theorists believed that human phenomena are appropriately understood on several levels, such as the individual level and the population level. The importance of context advocated by ecological theorists helps provide a rationale for multilevel conceptual models.

Implicit in the conceptual model of community college outcomes proposed by Wang (2009) was the importance of both student-level and contextual-level factors in the explanation of these outcomes. Specifically, the importance of the family context was suggested in the description of environmental factors (Wang, 2009). However, all of the factors in the conceptual model proposed by Wang (2009) were defined at the individual-, or student-level. According to theorists such as Bronfenbrenner (1979), a comprehensive account of subsequent outcomes, in this case, a range of community college outcomes requires consideration of a level of context modeled beyond that of the individual.

Effect of high school context. One crucial context to consider is high school context. Nelson (1972) found that school context had a small, positive effect on college aspirations. Specifically, high schools with a higher percentage of high achieving students have slightly more students who report having college aspirations than schools with lower percentages of high achieving students. One could argue that differences in college aspirations during high school could, in turn, affect community college outcomes. Similarly, Rowan-Kenyon, Perna, and Swan (2011) later explained that career and educational aspirations appeared connected to the level of resources within a school. Furthermore, citing Smith et al. (2004), Chen and Vazsonyi (2013) noted that adolescents spend one half of their waking hours in school, which ostensibly affects their personal and academic development and further supports the notion that high school context is an important factor in explaining postsecondary outcomes. Community college outcomes could therefore be modeled in a multilevel manner, with student-level factors nested within high school context.

Temporal Assumptions

This model of postsecondary outcomes begins with factors measured during high school to help predict community outcomes at a later time point. Thus, this model can be viewed as a longitudinal model of community college outcomes (Pedhazur & Schmelkin, 1991).

Examining the relative effect of CTE participation on community college outcomes. Most of the aforementioned studies that examined the impact of high school CTE participation focused on initial college enrollment. Furthermore, none of the studies include vertical transferring to a four-year college as an outcome or consider combinations of these various community college attainment outcomes. Porchea et al. (2011) explained that several combinations of community college outcomes are possible. It is likely, for example, to earn an associate degree with a certificate, earn a certificate only, or vertically transfer to a four-year school with or without an associate degree.

The current study builds on previous work in the area of community college outcomes by providing a comprehensive approach to exploring postsecondary outcomes that includes the relative effect of high school CTE program participants. We also focus on the potentially overlapping outcomes that take place at community colleges, namely, associate degree and certificate attainment, in addition to vertically transferring to a four-year college.

Summary of Conceptual Framework

The modified predictive model based on Wang (2009), which displays the general characteristics and specific variables under each characteristic, is shown in Table 1.

Table 1:
Summary of predictors of community college outcomes based on Wang (2009)

Predictors of Community College Outcomes	**Empirical Support**
Pre-College Characteristics (Wang, 2009)	

Predictors of Community College Outcomes	Empirical Support
Demographic Background	
Gender	(Bosworth, 2010; Smalley, Lichtenberger, & Brown 2010)
Ethnicity/Race	(Bailey et al., 2005; Carnevale, Rose, & Hanson 2012; Lichtenberger & Dietrich 2012)
Family income	(Carnevale, Rose & Hanson 2012; Goldrick-Rab, 2010; Lichtenberger & Dietrich 2012)
Academic Performance	
ACT test scores and HS GPA	(Lichtenberger & Dietrich 2012; Smalley, Lichtenberger, & Brown 2010)
Academic Resources	
CTE participation versus college prep or general curriculum	(Arum & Shavit, 1995; Castellano, Stringfield & Stone, 2003; Cellini, 2006; DeLuca, Plank, Estacion, 2006; Fletcher & Zirkle, 2009; Gemici, 2011; Karp & Hughes, 2008; Levesque et al., 2008; Lichtenberger & Dietrich, 2012; Plank, DeLuca & Estacion, 2008; Reese, 2008)
Environmental Factors (Wang, 2009)	
Hours expected to work and family size	(Bean, 1990; Bean & Metzner, 1985; Lichtenberger & Dietrich, 2012)
Context (Bronfenbrenner, 1979; Klein, White, and Martin (2015); Richards, 1907)	
High school context	(Chen & Vazsonyi, 2013; Nelson, 1972; Smith et al., 2004; Rowan-Kenyon, Perna, & Swan 2011)

Research Questions

1. Controlling for precollege characteristics and environmental factors, is CTE participation a significant factor in predicting community college outcomes?
2. Does the predictive value of precollege characteristics—including CTE participation versus other curriculum types—and environmental factors, differ by the type of community college outcome?

For both research questions, we assumed that students were nested within high schools.

Methods

Research Design

This study is a non-experimental, longitudinal design. The aim of the design is explanatory, as we seek to confirm a conceptual model of community college outcomes. It is also longitudinal in nature, since the explanatory variables were measured while the students were in high school and the dependent variable, community college outcome, was assessed at a later point in time (Montero & León, 2007; Pedhazur & Schmelkin, 1991).

Sample

The sample included 7,805 students randomly selected from 26,146 direct community college entrants across multiple community college campuses in the state of Illinois. These students were enrolled during the fall semester of 2003 and had complete information in the factors and covariates that were employed in the model. Enrollment and degree completion information is from the National Student Clearinghouse (NSC). The NSC is a national collaborative, in which nearly 3,330 postsecondary institutions participate, covering 92% of all postsecondary enrollments (National Student Clearinghouse, 2010). Community college credential completion (both associate and certificate attainment) and transferring to a four-year college were measured for seven academic years or until the end of the spring semester of 2010. The researchers received the 2003 cohort data from ACT under shared data agreements with the testing company and the Illinois Board of Higher Education. Most of the information related to the student-level factors was gleaned from the student information section that precedes the standardized test. See Table 2 for a descriptive profile of the sample and a descriptive comparison of the sample.

Table 2:
Descriptive Statistics for Sample (n=7,805)

	Mean	Standard Deviation	Percent	Frequencies
ACT Math	18.89	4.18		
ACT English	18.25	5.01		
ACT Reading	19.08	5.21		
ACT Science	19.24	4.10		
Number of Siblings	1.45	1.31		
Male	.47	.50		
Expected to Receive Aid	.80	.40		
Expected to Work during College	.78	.42		
HS Program Type:				
CTE			.21	1,631
General			.38	2,936
College Prep			.42	3,238
Family Income:				
High $80K+			.16	1,273
Mid-High $50K-$79K			.27	2,066
Mid-Low $30K-$49K			.32	2,518

	Mean	Standard Deviation	Percent	Frequencies
Low $<30K			.25	1,948
Locale:				
Chicago			.06	428
Non-Chicago Urban			.11	872
Suburban			.50	3,896
Town			.14	1,124
Rural			.19	1,485
Race:				
White			.80	6,218
Latino			.08	280
African American			.08	657
Asian			.04	650
HS GPA:				
High 3.5-4.0			.14	1,116
Mid-High 3.0-3.4			.27	2,141
Mid-Low 2.5-2.9			.24	1,828
Low <2.5			.35	2,720
Community College Outcome:				
Transfer Only			.22	1,751
Transfer and Credential			.20	1,540
Associate Only			.11	818
Certificate Only			.03	218
No Credential No Transfer			.45	3,487

Variables

The predictor variables included were gender, race, family income, academic preparation (a function of ACT scores and grades), number of siblings, expectation of financial aid, expectation to work during college, and CTE participation.

Gender. Gender was defined as a dichotomous variable, male and female. 'Male' served as the reference category.

Race. The race variable included four categories: white, Latino/a, African American, and Asian.

Family income. Family income was divided into four categories: high ($80K or above), mid-high ($50K to $80K), mid-low ($30K to $50K) and low (less than $30K).

Academic preparation. Academic preparation was assessed by two types of measures. The first type of measures were the ACT subject tests in mathematics, English, reading, and science. The second type of measure was high school GPA. High school GPA consisted of four categories: high (3.5-4.0), mid-high (3.0-3.4), mid-low (2.5-2.9) and low (< 2.9).

Number of siblings. This variable was a continuous variable reported as non-negative integers.

Expectation of financial aid. This was a dichotomous variable with '1'= yes and '2' = no.

Expectation to work during college. This was also a dichotomous variable with '1'= yes and '2' = no.

CTE participation. This factor was measured by using variable called 'program type' in conjunction with two variables focusing the number of years of high school enrollment in CTE-oriented courses. A study group member was considered a CTE participant if s/he described his or her high school program type as CTE-oriented, as opposed to college prep or general, *and* s/he had enrolled in one of the CTE-orientated programs for three or more years. A study group member was considered college prep or general curriculum if s/he described his or her high school program type accordingly and had less than three years of enrollment in a CTE-oriented program. The program type variable consisted of three categories: CTE, college prep, and general curriculum. The CTE category served as the reference category.

Community college outcomes. The variable 'community college outcome' was a categorical outcome variable, operationalized as follows: 1) transfer to a four-year college only, 2) transfer and community college credential (either associate degree or certificate), 3) associate only, as highest credential, 4) certificate only, as highest credential, and 5) no degree/no transfer. The 'no degree/no transfer' category was used as the reference category.

Analysis

Examination of context: The effect of high school. We chose to examine the effect of high school context, as opposed to college context, primarily because of the nature of the data set. Because we were tracking a group of high school graduates as they transitioned to community college, high school context was more specific in nature and therefore provided additional information to our model. Generally, several high schools, that may or may not have been similarly composed, were located within the same community college district. We felt that

having the sample nested within high schools, as opposed to community colleges, provided more finely-tuned information and strengthened the empirical model.

Statistical analysis. For this study, a hierarchical generalized linear modeling approach (HGLM) was chosen to predict the likelihood of community college outcomes. HGLM is an appropriate model to use when the outcome variable is categorical (Gelman & Hill, 2007; Heck, Thomas & Tabata, 2012) and when individuals are nested within contexts. In this case, a multilevel approach was selected given the importance of high school context; for our model, students were nested within high schools.

Unconditional two-level model. Our first step was to test whether differences in two-year college outcomes vary across high schools. This model has no predictors. The equations used at level 1 to predict the log odds of a student *i* in school *j* being in the outcome category versus the reference category *C* (no transfer and no community college credential) are as follows:

$$\eta_{1ij} = \log(\pi_{1ij}/\pi_{Cij}) = \beta_{0j(1)}$$
$$\eta_{2ij} = \log(\pi_{2ij}/\pi_{Cij}) = \beta_{0j(2)}$$
$$\eta_{3ij} = \log(\pi_{3ij}/\pi_{Cij}) = \beta_{0j(3)}$$
$$\eta_{4ij} = \log(\pi_{4ij}/\pi_{Cij}) = \beta_{0j(4)}$$

In these equations, the numbers in the parenthetical subscripts refer to the variable categories. For instance, '1' refers to transferring only, '2' refers to transferring with a credential, '3' refers to earning an associate degree and '4' refers to earning a certificate. At level 2, the following equations are written to show the school specific random intercept:

$$\beta_{0j(1)} = \gamma_{00(1)} + u_{0j(1)}$$
$$\beta_{0j(2)} = \gamma_{00(2)} + u_{0j(2)}$$
$$\beta_{0j(3)} = \gamma_{00(3)} + u_{0j(3)}$$
$$\beta_{0j(4)} = \gamma_{00(4)} + u_{0j(4)}$$

Table 3 displays the variance components for transfer only students, students who transfer with credentials, associate degree only students and certificate degree only students. In all cases, the z tests are significant. This means that the variability in two-year college outcomes varies significantly between schools, and this helps to justify a nested model.

We then calculated the interclass correlation (ICC) to describe the proportion of the variability in two-year outcomes that lies between schools. This is achieved using the following equation:

$$ICC=\rho=\sigma^2_{between}/(\sigma^2_{between} + 3.29_{within})$$

where 3.29 is the variance of a logistic distribution with a scale factor of 1 (Heckman, Thomas, & Tabata, 2012; Hedecker, 2007; Hox, 2002).

Table 3 shows the ICCs for four multinomial categories versus the reference category, no transfer or no degree. For transfer only versus no transfer or degree, the ICC is 0.042, which suggests that 4.2% of the variability between transfer only students versus the reference category

is explained by schools. For transfer and associate degree versus the reference category, 6.1% of the variability is explained by schools. For associate degree holders versus the reference category, 7.5% of the variance is explained by schools. Finally, for certificate only holders versus the reference category, 13.7% of the variability lies between schools.

Table 3
Variance components of the null model

Residual Effect	Coefficient	Std. error	z-test	Significance	Confidence Interval		Intraclass Correlation
					Lower	Upper	
Transfer only	0.146	0.034	4.314	.000	0.093	0.230	0.042
Transfer with credential	0.214	0.042	5.097	.000	0.145	0.314	0.061
Associate only	0.265	0.060	4.431	.000	0.170	0.412	0.075
Certificate only	0.524	0.164	3.207	.001	0.285	0.966	0.137

Reference category: No transfer or no degree

Hypothesized model. The individual level factors included in the model were ACT performance on the individual subject tests (Math, English, Reading and Science), GPA, race and gender. In addition, four environmental variables were considered: number of siblings, expectation for financial aid, expectation for work, and family income. Finally, our variable of interest, program type was included in the model.

The equations for hypothesized model at the first level can be written as follows:

$$\eta_{1ij} = \log(\pi_{1ij}/\pi_{Cij}) = \beta_{0j(1)} + \beta_1 ACTMath_{ij(1)} + \beta_2 ACTEnglish_{ij(1)} + \beta_3 ACTReading_{ij(1)} + \beta_4 ACTScience_{ij(1)} + \beta_5 GPA_{ij(1)} + \beta_6 race_{ij(1)} + \beta_7 gender_{ij(1)} + \beta_8 siblings_{ij(1)} + \beta_9 expaid_{ij(1)} + \beta_{10} expwork_{ij(1)} + \beta_{11} familyincome_{ij(1)} + \beta_{12} program\ type_{ij(1)}$$

$$\eta_{2ij} = \log(\pi_{2ij}/\pi_{Cij}) = \beta_{0j(2)} + \beta_1 ACTMath_{ij(2)} + \beta_2 ACTEnglish_{ij(2)} + \beta_3 ACTReading_{ij(2)} + \beta_4 ACTScience_{ij(2)} + \beta_5 GPA_{ij(2)} + \beta_6 race_{ij(2)} + \beta_7 gender_{ij(2)} + \beta_8 siblings_{ij(2)} + \beta_9 expaid_{ij(2)} + \beta_{10} expwork_{ij(2)} + \beta_{11} familyincome_{ij(2)} + \beta_{12} program\ type_{ij(2)}$$

$$\eta_{3ij} = \log(\pi_{3ij}/\pi_{Cij}) = \beta_{0j(3)} + \beta_1 ACTMath_{ij(3)} + \beta_2 ACTEnglish_{ij(3)} + \beta_3 ACTReading_{ij(3)} + \beta_4 ACTScience_{ij(3)} + \beta_5 GPA_{ij(3)} + \beta_6 race_{ij(3)} + \beta_7 gender_{ij(3)} + \beta_8 siblings_{ij(3)} + \beta_9 expaid_{ij(3)} + \beta_{10} expwork_{ij(3)} + \beta_{11} familyincome_{ij(3)} + \beta_{12} program\ type_{ij(3)}$$

$$\eta_{4ij} = \log(\pi_{4ij}/\pi_{Cij}) = \beta_{0j(4)} + \beta_1 ACTMath_{ij(4)} + \beta_2 ACTEnglish_{ij(4)} + \beta_3 ACTReading_{ij(4)} + \beta_4 ACTScience_{ij(4)} + \beta_5 GPA_{ij(4)} + \beta_6 race_{ij(4)} + \beta_7 gender_{ij(4)} + \beta_8 siblings_{ij(4)} + \beta_9 expaid_{ij(4)} + \beta_{10} expwork_{ij(4)} + \beta_{11} familyincome_{ij(4)} + \beta_{12} program\ type_{ij(4)}$$

In the above equations, η_{1ij} refers to the log odds of transferring versus the reference category (no transfer or no degree), η_{2ij} refers to the log odds of transferring with a credential versus the

reference category, η_{3ij} is the log odds of earning an associate degree versus the reference category, and η_{4ij} stands for the log odds of earning a certificate versus no transfer or degree.

At level 2, the predictors β_1 through β_{12} are fixed, resulting in the following equations:

$$\eta_{1ij} = \gamma_{00(1)} + \gamma_{10}ACTMath_{ij(1)} + \gamma_{20}ACTEnglish_{ij(1)} + \gamma_{30}ACTReading_{ij(1)} + \gamma_{40}ACTScience_{ij(1)} + \gamma_{50}GPA_{ij(1)} + \gamma_{60}race_{ij(1)} + \gamma_{70}gender_{ij(1)} + \gamma_{80}siblings_{ij(1)} + \gamma_{90}expaid_{ij(1)} + \gamma_{100}expwork_{ij(1)} + \gamma_{110}familyincome_{ij(1)} + \gamma_{120}program\ type_{ij(1)} + u_{0j(1)}$$

$$\eta_{2ij} = \gamma_{00(2)} + \gamma_{10}ACTMath_{ij(2)} + \gamma_{20}ACTEnglish_{ij(2)} + \gamma_{30}ACTReading_{ij(2)} + \gamma_{40}ACTScience_{ij(2)} + \gamma_{50}GPA_{ij(2)} + \gamma_{60}race_{ij(2)} + \gamma_{70}gender_{ij(2)} + \gamma_{80}siblings_{ij(2)} + \gamma_{90}expaid_{ij(2)} + \gamma_{100}expwork_{ij(2)} + \gamma_{110}familyincome_{ij(2)} + \gamma_{120}program\ type_{ij(2)} + u_{0j(2)}$$

$$\eta_{3ij} = \gamma_{00(3)} + \gamma_{10}ACTMath_{ij(3)} + \gamma_{20}ACTEnglish_{ij(3)} + \gamma_{30}ACTReading_{ij(3)} + \gamma_{40}ACTScience_{ij(3)} + \gamma_{50}GPA_{ij(3)} + \gamma_{60}race_{ij(3)} + \gamma_{70}gender_{ij(3)} + \gamma_{80}siblings_{ij(3)} + \gamma_{90}expaid_{ij(3)} + \gamma_{100}expwork_{ij(3)} + \gamma_{110}familyincome_{ij(3)} + \gamma_{120}program\ type_{ij(3)} + u_{0j(3)}$$

$$\eta_{4ij} = \gamma_{00(4)} + \gamma_{10}ACTMath_{ij(4)} + \gamma_{20}ACTEnglish_{ij(4)} + \gamma_{30}ACTReading_{ij(4)} + \gamma_{40}ACTScience_{ij(4)} + \gamma_{50}GPA_{ij(4)} + \gamma_{60}race_{ij(4)} + \gamma_{70}gender_{ij(4)} + \gamma_{80}siblings_{ij(4)} + \gamma_{90}expaid_{ij(4)} + \gamma_{100}expwork_{ij(4)} + \gamma_{110}familyincome_{ij(4)} + \gamma_{120}program\ type_{ij(4)} + u_{0j(4)}$$

Each of the previously mentioned equations predicts the log odds for the four nominal outcomes versus the reference category.

Grand mean centering. In this study, we centered all variables around their grand mean. Heck, Thomas, and Tabata (2012) explain that grand mean centering "re-centers the individual's standing on the predictor against the mean for the predictor in the sample. For example, if the sample mean for employee attitude were 5.4, an individual on the grand mean would have her or his score rescaled to 0."

Results

Descriptive Findings

In terms of demographics, 80% of the community college entrants in the sample were white, eight percent were Latino, an additional eight percent were African American, and four percent were Asian American. As shown in Table 2, the sample included more female community college entrants than males (53% to 47%). Eighty percent of the sample expected to receive some sort of financial aid for their postsecondary education and an almost equally high proportion (78%) expected to work while they were enrolled at their respective community college. A relatively small proportion of the sample fell into the high income category (16%) in that the income categories roughly paralleled quartiles for the entire high school graduating class. The highest proportion of the sample included students from mid-low income families. A majority of the students were from suburban areas, while a disproportionately low number of the students in the sample were from the urban center of the state (Chicago). In terms of high school program type, roughly two-fifths were classified as college prep, slightly less than two-fifths

were classified as general curriculum, and a little more than one fifth were classified as a career and technical education participant.

The highest proportion of the sample fell into the low high school grade point average category (35%) and the lowest proportion fell into the high GPA category (14%). Roughly one-quarter fell into both the mid-high (27%) and mid-low (24%) categories.

Regarding community college outcomes, 22% of the students in the sample had transferred to a four-year college without earning a degree or certificate, 20% had transferred to a four-year with some sort of community college credential (nearly all were associate degrees), and an additional 11% had earned an associate degree without transferring to a four-year college. In terms of specific outcomes that included earning a postsecondary CTE Certificate, three percent had earned a certificate without transferring. This left 45% of the sample of community college entrants without a degree or a transfer to a four-year college (Table 3).

As shown in Table 4, community college students from high school CTE programs had lower ACT scores relative to both students from general curriculum and college prep programs. However, the differences were larger between the CTE and college prep students. Also, a higher percentage of high school CTE students fell into the two lowest high school GPA categories when compared with students from general curriculum and college prep students. However, once again, the differences between the CTE students and college prep students were much larger than the differences between CTE students and general curriculum students.

A substantially higher proportion of the CTE group was male. The group of community college students from high school CTE programs was also more racially diverse than either the college prep or general curriculum groups and a higher proportion of the students from the CTE group were from Chicago (fewer CTE students were from suburban locales). More of the college prep students were in the high income categories, while fewer were in the low income categories relative to both CTE and general curriculum students.

In terms of community college outcome attainment, students from college prep programs had significantly higher rates of transferring to four-year colleges both with and without credentials. This was relative to both students from CTE and general curriculum programs. Also, general curriculum students maintained a descriptive advantage over CTE students in terms of the proportion of group members transferring to four-year colleges. CTE students had a slightly higher percentage earning community college credentials without transferring. In terms of the rate of overall community college outcome, substantially more of the college prep students had achieved one or more of the outcomes relative to both CTE students and general curriculum students.

Table 4
Descriptive Statistics: Means (Standard Deviations), and Percentages by High School Program Type

	CTE	General Curriculum	College Prep
	(*n*=1,631)	(*n*=2,936)	*(n*=3,238)

	CTE	General Curriculum	College Prep
ACT Math	17.81 (3.68)	18.23 (3.91)	20.03 (4.38)
ACT English	16.71(4.54)	17.65 (4.87)	19.57 (5.03)
ACT Reading	17.76 (4.70)	18.48 (5.06)	20.28 (5.32)
ACT Science	18.26 (3.95)	18.59 (3.94)	20.32 (4.06)
Number of Siblings	1.47 (1.33)	1.45 (1.33)	1.45 (1.28)
Male	.59 (.49)	.43 (.50)	.44 (.50)
Expected to Receive Aid	.78 (.42)	.79 (.41)	.83 (.37)
Expected to Work during College	.78 (.42)	.78 (.41)	.77(.42)
Family Income:			
High $80K+	.16	.14	.18
Mid-High $50K-$79K	.23	.26	.29
Mid-Low $30K-$49K	.33	.32	.32
Low $<30K	.28	.28	.21
Locale:			
Chicago	.09	.05	.04
Non-Chicago Urban	.11	.11	.12
Suburban	.46	.52	.50
Town	.16	.13	.15
Rural	.19	.19	.19
Race:			
White	.74	.79	.83
Latino	.10	.10	.06
African American	.12	.08	.07
Asian	.04	.03	.04
High School GPA:			
High 3.5-4.0	.07	.10	.21
Mid-High 3.0-3.4	.23	.24	.32
Mid-Low 2.5-2.9	.27	.23	.22

	CTE	General Curriculum	College Prep
Low <2.5	.43	.42	.24
Community College Outcome:			
Transfer Only	.18	.21	.26
Transfer and Credential	.15	.17	.25
Associate Only	.12	.10	.10
Certificate Only	.04	.03	.02
No Credential No Transfer	.51	.49	.37

Predicting Community College Outcomes

Transferring without a credential. In terms of predicting an increased likelihood of transferring to a four-year college without a community college credential (see the Transfer Only columns in Table 5) there was no significant difference between community college students from a high school CTE program and those in a general curriculum program; however, as one might expect, community college students who were in a high school college prep program were significantly more likely to transfer without a credential than high school CTE students who initially enrolled at community colleges.

Only one of the environmental factors was statistically significant. The size of a student's family, as measured by their number of siblings, was negatively related to the likelihood of transferring to a four-year college without a credential. Family income was positively related to the likelihood of transferring to a four-year college without a community college credential, as students from the highest two family income categories had greater odds of transferring relative to low income students. No significant difference was established between students from the mid-low and low income categories.

In terms of academic preparation, one's performance on both ACT Math and English was significantly and positively related to one's odds of transferring; however, ACT Reading and Science scores lacked statistical significance. Further, community college students with higher high school GPAs were significantly more likely to transfer without a credential relative to their peers with low GPAs. In terms of race, African American and Asian American community college students were significantly more likely to transfer to a four-year college without a credential relative to their white peers.

Table 5
Hierarchical Generalized Linear Model Summaries: Fixed Coefficients

	Transfer Only		Transfer and Credential		Associate Only		Certificate Only	
	Sig.	Odds Ratio	Sig.	Odds Ratio	Sig.	Odds Ratio	Sig.	Odds Ratio
Intercept	.000		.000		.000		.000	

	Transfer Only		Transfer and Credential		Associate Only		Certificate Only	
	Sig.	Odds Ratio	Sig.	Odds Ratio	Sig.	Odds Ratio	Sig.	Odds Ratio
Siblings	.001	.923	.000	.911	.000	.873	.086	.905
Gender: Male	.053	.879	.000	.658	.000	.722	.052	.751
Expected Financial Aid	.803	1.019	.419	1.074	.349	.905	.282	.832
Expected to Work	.212	.909	.030	.847	.057	.814	.441	1.147
ACT Math	.003	1.033	.000	1.047	.071	1.026	.492	.980
ACT English	.000	1.040	.000	1.037	.478	1.009	.949	.998
ACT Reading	.131	1.013	.294	1.009	.670	.995	.992	1.000
ACT Science	.092	1.020	.030	1.031	.659	1.007	.752	.991
HS Program:								
General to CTE	.055	1.179	.811	.978	.023	.797	.103	.755
College Prep to CTE	.000	1.440	.046	1.198	.004	.732	.030	.647
Family Income								
High to Low	.000	1.945	.000	1.766	.504	.902	.135	.706
Mid-High to Low	.000	1.366	.000	1.670	.002	1.392	.832	.957
Mid-Low to Low	.067	1.156	.001	1.360	.118	1.189	.373	1.064
Race								
African-American to White	.001	1.501	.036	.720	.001	.517	.113	.654
Latino to White	.758	.965	.319	.860	.776	.954	.051	.563
Asian American to White	.000	2.588	.008	1.566	.032	.510	.451	1.356
HS GPA								
Mid-Low to Low	.000	1.499	.000	1.632	.000	1.654	.392	1.176
Mid-High to Low	.000	1.882	.000	3.135	.000	2.713	.000	2.047
High to Low	.000	2.556	.000	5.394	.000	.740	.004	2.130

Reference category: No transfer or no degree

Transferring with a credential. As shown in Table 5 within the columns focusing on the Transfer and Credential model, in terms of high school program type there were no statistically significant differences between community college students from high school CTE programs and their peers from general curricular programs. However, college prep students were more likely than CTE student to transfer with a credential. The model also established that the higher the family income, the higher the odds of transferring along with a community college credential. Expecting to work during college negatively impacted one's likelihood of transferring to a four-year college with a credential (associate or certificate) as did the size of one's family. In terms of demographic characteristics, gender and race were both statistically significant. Male students were significantly less likely to achieve this community college outcome relative to female students. African American students were less likely to transfer with a credential than white students. However, Asian students were more likely to transfer than white students. In terms of academic preparation, scores on ACT Math, English, and Science were statistically significant and positively related to transferring to a four-year institution with a credential. Once again, scores on ACT Reading lacked statistical significance. Finally, the higher the high school GPA the higher the likelihood of transferring with a community college credential.

Associate degree completion. As shown in Table 5, within the columns specific to the associate Degree Only model, community college students from high school CTE programs were significantly more likely to earn an associate degree as their sole outcome relative to students

from college prep and general curriculum programs. Students from larger families were less likely to earn an associate degree as their sole outcome. Male students relative to female students were significantly less likely to earn an associate degree as a singular outcome.

Students from mid-high income families were more likely than their low-income peers to earn an associate degree only. Scores on the ACT subject tests lacked significance; however, students with higher high school GPAs were significantly more likely to earn an associate degree only relative to students with low GPAs. African American students and Asian American students relative to white students were significantly less likely to earn an associate degree as a singular outcome.

Certificate attainment. Regarding earning a certificate as one's only community college-based outcome (the columns in Table 5 specific to the Certificate Only Model) there were fewer statistically significant factors relative to the other models. Community college students from high school CTE programs were significantly more likely to earn a certificate as their sole outcome relative to students from college prep programs. Finally, students in the high and mid high GPA ranges were significantly more likely to earn a certificate as one's only community college based outcome than students in the low GPA category.

Summary

After controlling for other pre-college characteristics, environmental factors and geography, community college students from high school CTE programs were significantly less likely than college preparatory students to transition to a four-year college with or without a credential. Yet, there was no statistically significant difference between the students from high school CTE programs and general curriculum programs. With regard to transferring to a four-year college with an associate or a certificate, there were significant differences based on high school program type. In terms of predicting the likelihood of earning an associate without transferring, students from CTE programs maintained a statistically significant advantage over their counterparts from both general and college prep programs, and CTE students maintained a similar advantage in terms of certificate attainment over students from college prep programs. Therefore, in most cases, community college students from high school CTE programs were just as likely or more than likely to attain the given community college outcome relative to students from general curriculum programs. Relative to college prep students, CTE students were significantly less likely to transfer to a four-year college, but significantly more likely to earn either an associate degree or a certificate without transferring.

Limitations

Despite the fairly large data set to which we had access, we were not able to take into consideration psychological attributes such as locus of control and self-concept, nor were we able to include factors related to the college experience within our conceptual model. Inclusion of such factors may change the relative effect of high school CTE participation on subsequent postsecondary outcomes. Another limitation to the study was that CTE participation was assessed using a student self-report measure of program type combined with student course-taking patterns. This variable did not allow us to measure the effect of various combinations of CTE, general, and academic participation on postsecondary outcomes as Plank, DeLuca and

Estacion (2008) explored in their study of high school dropout. A third limitation of the study was related to the composition of the study sample. In creating our sample, we drew from a population of Illinois high school graduates as they transitioned to college, which limits the generalizability of the results both geographically and to similarly aged students. However, we argue that the results may be more broadly applicable geographically given the similarity of Illinois to other states. For example, the college going rate of Illinois high school graduates parallels the national average and is fairly close to those of several nearby states (Mortenson, 2013).

Discussion

This study substantiates the importance of the conceptual framework established by Wang (2009), which included both precollege and environmental variables to predict community college outcomes, and demonstrates the importance of examining the effect of high school program type on postsecondary outcomes. Our findings show that high school CTE enrollment is a significant predictor not only of certificate attainment, but also of associate degree attainment among community college entrants when these outcomes are explored separately. Further, community college students from high school CTE programs had a relative advantage when compared with those students from college prep programs in terms of the likelihood of associate degree and certificate attainment as singular outcomes. This may be because high school CTE students are different from high school students in college preparatory programs with respect to their career goals. As mentioned in the results, there were other factors that were significant predictors of community college outcome attainment. Future researchers in this area may consider variables proposed in the conceptual model by Hirschy, Bremer, and Castellano (2011) such as educational intention and goals.

The results can be framed by the movement in CTE over the past couple of decades which has been described as a shift from preparing individuals for jobs, to preparing them for both job and college (Gray, 2004). The expanded emphasis and shift to be more inclusive of college attainment goals arguably places the community college in a central role. This shift, viewed as "new vocationalism" by Bragg (2001) and Lynch (2000), "emphasizes the importance of the two-year associate degree, certification, or advancement in employment and higher-wage careers, and transfer to four-year colleges and universities" (Bragg & Ruud, 2007, p.2). A number of high schools "adopted the vocational and academic integration ideas into their curriculum through programs like career academies, programs of study, and tech prep" (Kamalludeen, 2012, p.27). Since the implementation of such programs, there has been some research on the implications of this integrated curriculum trend. Plank, DeLuca, and Estacion (2008) suggested that CTE provides students with necessary skills to succeed in their career or post-secondary education, and thus appears more relevant. As such, it was important to establish the relative effects of CTE on postsecondary outcomes, including community college outcomes.

Given the positive impact that CTE enrollment has on certificate and associate degree completion as evidenced in this study, high school CTE enrollment may help to facilitate movement towards national goals focusing on college degree/credential attainment such as the American Graduation Initiative, which has the goal that by 2020 America will once again have the highest proportion of college graduates in the world and the "big goal" of the Lumina

Foundation (2015), which is to increase the proportion of individuals with quality postsecondary credentials to 60% by 2025.

In terms of implications for practice, at the level of the high school, guidance counselors can use the findings of this study to help justify advising students along an expanded catalog of options to include career preparation at the community college level--this is the central argument of Gray and Herr (2006). CTE administrators, at both the state and local levels, can use the findings of this longitudinal study to help market their programs to multiple constituencies, such as parents, students, the business community, teachers (CTE and non-CTE alike), and other educational administrators. For example, most new jobs within the next few years will require some form of postsecondary education (Carnevale, Smith, & Strohl, 2010), which is not necessarily limited to baccalaureate attainment. The degree and certificate programs, as well as other opportunities provided at community colleges, such as transfer programs, would definitely be a major part of that discussion. Therefore, the extent to which high school CTE programs increase the number of pathways to completion and ultimately to careers should be highlighted.

As we mentioned earlier, the sample for this study along with the measured outcomes and longitudinal approach provided a unique contribution to the literature base. This made it challenging to place the results within the context of the related literature. However, our findings seem consonant with (Arum & Shavit, 1995; Castellano, Stringfield & Stone, 2003; Cellini, 2006; DeLuca, Plank, Estacion, 2006; Fletcher & Zirkle, 2009; Lichtenberger & Dietrich, 2012; Plank, DeLuca & Estacion, 2008) as these studies established evidence of a positive effect of CTE on high school outcomes and initial postsecondary enrollment.

Future studies should include psychological attributes as well as subsequent college experiences in their conceptual models; these attributes were not available for consideration in the current study. Inclusion of these variables may increase or decrease the magnitude of the effect of CTE participation. Furthermore, researchers should isolate the impact of CTE program participation on community college outcomes, as opposed to examining its relationship to given outcomes among myriad other covariates. Such studies could build on the quasi experimental work by Gemici (2011) and conceptualize high school CTE program participation as a treatment effect.

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