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A Longitudinal Analysis of Young Adult Pathways to STEMH Occupations

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Abstract

In this study, we determined the educational pathways and key life course transitions of young adults who enter Science, Technology, Engineering, Mathematics, and Health (STEMH) technician and professional jobs using the 1997 National Longitudinal Survey of Youth (NLSY) dataset, tracking high school students from 1997 to adulthood in 2009. Using hierarchical linear modeling (HLM), findings underscored gender, ethnic and racial background, high school achievement and career and technical education (CTE) participation, earning high school industry certifications, postsecondary enrollment (2 year and 4 year), and degree attainment as factors contributing to the attainment of STEMH technician and professional careers. In light of the findings, we recommend that strategies to broaden the participation of minorities and women in STEMH fields include strengthening high school CTE programs and emphasizing career guidance in high schools to promote career awareness as a means to attract and retain students in STEMH pathways.

Keywords: career and technical education, STEMH; student outcomes.

Introduction

While a discussion of the need to focus on STEMH occupations is rampant in the scholarly literature (Hernandez & Fletcher, 2013; Malcom & Feder, 2016; Means, Wang, Young, Peters, & Lynch, 2016), little dialogue has ensued on the distinctions between technician and professional occupations within the broader umbrella of STEMH fields (Carnevale, Smith, & Melton, 2011). These differences are important because each job classification includes widely varying employment growth within each sector. For example, computer occupations are forecasted to increase its share by 51% by the year 2018, engineering and engineering technicians are forecasted to decline from 31% in 2005 to 28% in 2018, primarily associated with declines in the manufacturing sector (Carnevale et al., 2011). The growth rates for each of these sectors are commensurate with its employment share. STEM occupations are forecasted to grow by 17% and health occupations are expected to surpass the STEM occupational growth (Carnevale et al., 2011). Additionally, while STEMH workers earn substantially higher earnings compared to non-STEMH employees, individuals who enter STEMH fields have widely varied earnings as a result of their specific occupational choice (Carnevale et al., 2011).

Researchers have addressed the immense difficulty of attracting high-end talent into STEMH technician occupations (Carnevale et al., 2011; Malcom & Feder, 2016; National Academy of Engineering, 2008; National Science Board, 2016). As a result, researchers pointed to a opportunity in the American educational system. To that end, Carnevale et al. (2011) discussed the need to produce STEM workers at the sub-baccalaureate level. They noted, “The demand for high-level skills, including STEM skills, has grown well beyond the elite careers that require a bachelor’s or graduate degree (Carnevale et al. 2011, p. 76)." Currently, 27% of STEMH jobs require employees to possess competencies at the postsecondary certificate, some college credit, or associate degree level (Carnevale et al., 2011). Hence, a strong need exists for attracting individuals with STEMH-related technical certifications and associate degrees, thus, creating a pivotal role for community colleges. Research is needed to examine how high schools, community colleges, and four-year universities serve as pathways into technician and professional STEMH occupations (Hernandez & Fletcher, 2013; Malcom & Feder, 2016; Means et al., 2016). Hernandez and Fletcher (2013) pointed out the fragmentation and "leaks" in the pipeline of the U.S. workforce system in its lack of strategic articulation among K-12 schools, community colleges, universities, and business and industry.

Community colleges serve several interrelated purposes: (a) to prepare students to transfer into a four-year institution; (b) to train students for technical jobs; and (c) to provide continuing education for community members. Community colleges are best known for their "open-door" policies which welcome low income, older non-traditional, immigrant, and first-generation college students, who make up 42% of their students (American Association of Community Colleges, 2010; Zeidenberg & Bailey, 2010). Thus, community colleges serve an important role in developing young adults for STEMH career pathways. This is especially true for underrepresented, underprepared, and less affluent students, many of whom aspire to transfer to four-year institutions of higher education and earn bachelor's degrees (Bensimon & Santiago, 2013). Even though community colleges play a pivotal role in our national agenda of providing access as well as broadening participation of underrepresented students with STEMH degrees and careers, the empirical literature base on the role of community colleges in expanding opportunities for those interested in STEMH fields is quite dismal (Wang, 2013).

Purpose and Research Questions

To fill that research gap, we sought to understand the educational pathways and key life course transitions of young adults who enter STEMH technician and professional jobs using the 1997 NLSY dataset in high school and tracking their educational and occupational pathways until 2009. Our emphasis on pathways connects individuals' demographic characteristics, high school course-taking, and high school academic achievement to their post-secondary patterns of two-year and four-year college enrollment and degree attainment, eventually to their employment in STEMH (technician and professional) or non-STEMH fields. We further examined how personal relationships and childrearing coexist with individual work histories. Results yielded longitudinal profiles of individuals who eventually obtain employment in STEMH technician and professional occupations, thereby, uncovering student pathways from high school through community college and universities into industry. This study focuses on the following research questions:

1) What demographic characteristics and high school experience factors influence matriculation into STEMH technician and professional occupations; and
2) What life-course transitions and post-secondary experience factors influence matriculation into STEMH technician and professional occupations?

Theoretical Framework

Status Attainment

Because we explored both educational and occupational attainment, we relied on status attainment theory to select critical variables for inclusion in our study. Status attainment theory describes the manner by which individuals acquire employment within a structure of social stratification in society. Conceptually, social stratification includes two primary components: societal rewards and individuals' resources obtained to gain these rewards. Blau and Duncan (1967) laid the foundation for explaining occupational status attainment based on research of American adult males. Their model included socioeconomic status (SES) from father's educational and occupational levels as well as individual's educational and occupational factors. Further, Sewell, Haller, and Ohlendorf (1969) developed a more complex model of educational and occupational status attainment that included SES, mental ability, academic performance, among others. In effect, status attainment theory explores the phenomenon of social reproduction, the extent to which class and SES exacerbates inequalities from one generation to the next – as a result of human and social capital.

Secondary Schooling Experiences

A primary factor in social reproduction is different schooling experiences. Schooling plays an important role in the determination of students' long-term trajectories (Fletcher & Cox, 2012; Fletcher & Zirkle, 2009; Lerman, 2007). Most notably with respect to STEMH occupations, participation in STEMH fields within colleges and universities require the completion of advanced mathematics or science courses, which students ideally complete in high school (Ashby, 2006). The enrollment and performance of high school students in physics and calculus are strong predictors of eventual attainment of STEM degrees in college (Tyson, 2011; Tyson, Lee, Borman, & Hanson, 2007). For example, the highest mathematics course taken is a better predictor of majoring in STEM than high school GPA, standardized test scores, or even grades earned in high school mathematics (Adelman, 2006). From high school to graduate school – mathematics and science – in particular, are often thought of as "gateway courses" leading to student success for those pursuing postsecondary STEM degrees (Yull, 2013).

The Impact of Participation in Career and Technical Education

Additionally, CTE provides an alternative gateway from simply taking the highest level of mathematics and science courses. Part of the problem is that STEM education is often considered as an academic issue primarily focusing on mathematics and science in secondary and postsecondary education. As such, this strategy ignores secondary CTE as a legitimate STEM pathway, even though programs like career academies have produced promising results regarding academic and occupational preparation, with a particularly positive impact on minorities and women (Fletcher & Cox, 2012; Hernandez & Fletcher, 2013; Kemple & Willner, 2008). Thus, to broaden the participation of minorities and women in STEM fields, it is imperative to strengthen CTE programs and emphasize career guidance in high schools to promote career awareness as a means to attract and retain students in the STEM pipeline (Hernandez & Fletcher, 2013; Metcalf, 2007; Xie & Shauman, 2003).

The majority of studies examining the long-term labor market impact of participating in CTE in high school has demonstrated positive outcomes in terms of earning potential (Bishop & Mane, 2004; Fletcher & Zirkle, 2009; Mane, 1999; Meer, 2007), employment status (Arum & Shavit, 1995; Fletcher, 2012a), and attainment of STEM careers (Fletcher, 2012b). These positive labor markets are especially true for young adult males (Arum & Shavit, 1995; Fletcher & Zirkle, 2009; Kemple, 2004). For example, Fletcher (2012b) predicted occupational choices based on high school curriculum participation using the 1997 NLSY data set and following a cohort of graduates until 2006. Findings indicated CTE graduates were 2.7 times more likely to attain careers within STEM fields compared to their general curriculum student counterparts. However, it was not apparent whether CTE graduates were more likely to obtain STEM technician or professional occupations.

Students are sorted into different high school courses and experiences based on a range of factors students control such as: college and career aspirations (Akos, Lambie, Milsom, & Gilbert, 2007), purported interests and talents (Gamoron & Weinstein, 1998; Hallinan, 1994), and past achievement and performance (Gamoran, 1989; Lee & Byrk, 1988; Rubin, 2006). Stone, Alfeld, and Pearson (2008) noted: "Students may disengage from math because of difficulty with the subject, lack of support, or simply boredom…Many of these students believe that the math that they learn in school is not relevant to life after high school" (p. 769).

Studies also show that students are subject to factors they cannot control including: demographic factors, including their family backgrounds (Kelly, 2007); race/ethnicity (Akos et al., 2007; Alvarez & Mehan, 2007; Burris & Welner, 2005; Fletcher & Zirkle, 2009; Kelly, 2007; Lewis, 2007; Lewis & Cheng, 2006; Rubin, 2006); and SES, including parents' educational attainment and household income (Akos et al., 2007; Alvarez & Mehan, 2007; Fletcher & Zirkle, 2009; Kelly, 2007; Lewis, 2007; Lewis & Cheng, 2006; Rubin, 2006). In this respect, mathematics and science attainment cannot simply be addressed by requiring high school students to take more mathematics courses, even though school districts nationwide have indeed increased mathematics and science course taking requirements. Instead, the poor performance of students in mathematics is likely to be systemic of a more complex set of problems, problems that could linger as students enter higher education and young adulthood.

Research focusing on the consequences of sorting into math, science, and other high school course-taking finds that disparities in educational opportunities lead to an unequal education (Alvarez & Mehan, 2007; Rubin, 2006); long-term social inequalities (Biafora & Ansalone, 2008; Kelly, 2007); and unequal status attainment (Lewis, 2007; Rubin, 2006). Thus, it is not surprising that inequality in high school opportunities can limit students' perceptions of their own post-secondary educational and occupational opportunities (Akos et al., 2007).

Post-Secondary Technician Education and Life Course Transitions

The knowledge, skills, and dispositions gained from K-20 education are critical to the advancement of our citizens through their professional careers. And, as indicated earlier, the need to prepare students for STEM careers, in particular, is paramount. Therefore, it is critically important students in the U.S. are afforded a quality education in high school, and if they so choose, in community colleges and four-year universities. Community colleges play an integral role in bachelor's degree attainment through the number of student transfers, primarily due to population growth and increased demand for higher education. Community colleges have become a useful tool for states to manage the increasing demand for higher education that has restricted entry into four-year institutions for many talented high school students. The decreasing value of an associate of arts degree has placed more emphasis on the ability of community college transfers to successfully enter a four-year institution, earn a bachelor's degree, and meet their academic goals (O'Connor, 2009). To manage the increasing demand for a bachelor's degree, many states encourage students to begin at community colleges and create articulation agreements that facilitate transfer into a four-year university (Anderson, Alfonso, & Sun, 2006).

This approach in practice and the complementary research emphasizing community colleges with respect to remedial or developmental course-taking, largely ignores the role community colleges play in providing technician education through course-taking, certification, and AS/AAS degrees. Unfortunately, there is a negative stigma attached to community colleges and technician education. Wright, Washer, Watkins and Scott (2008) found a majority of high school technology teachers and stakeholders surveyed believed technician education is a dumping ground. Technician education is often treated as a "craft," making it difficult to legitimize technician education as a subject, particularly compared to STEM bachelor's degree programs (Lewis, 2004). High schools may not offer programs that prepare students for community college technician education, instead opting to prepare students for STEM bachelor's degree programs. Technician education and technological literacy are often not part of the standard secondary education curriculum since many high school students are not familiar with technician occupations. As a result, high school teachers, administrators, and peers may discourage students from pursuing community college technician education certification and degrees.

Research focusing on traditional students transitioning directly from high school into higher education may not recognize the broader life course transitions that take place during early adulthood, most notably childrearing and personal relationships. Higher education institutions often lack the supports needed for underserved adult learners who might find it difficult to manage a transition into a formal learning setting, particularly when faced with balancing transitions happening in their own lives (Adkisson & Monaghan, 2014). Culture plays a substantial role in influencing how we think of specific events as "linear, normal, and expected" (Adkisson & Monaghan, 2014, p. 25) leading to cultural mismatch between the life experiences of the learner and cultural expectations within higher education and the workplace. For example, for some, marriage and childbirth are viewed as heteronormative events which are planned and desired. For others, the birth of a child is unplanned and/or the onset or dissolution of a marriage may be unplanned, both prompting changes in short-term educational and occupational goals. Both can be problematic for individuals to face as students and workers if institutional supports are not in place. While research has begun to explore issues related to differentiated lived experiences as well as sociodemographic factors, and the impact that has on individuals' abilities to access and transition into higher and vocational education programs (Adkisson & Monaghan, 2014), we lack research with respect to how "real life" (e.g., children and marital status) challenges impact occupational pathways beyond schooling.

Methods

Research Design

To link demographic characteristics, secondary and higher education experiences, and life transitions to occupational outcomes, we employed an *ex-post facto* research design using a national, random sample of U.S. households. The 1997 NLSY dataset explores high school students' school-to-work transitions from adolescence to adulthood, and includes data primarily based on schooling experiences and labor market outcomes. The 1997 NLSY includes 8,984 students born in 1980 to 1984, ages 13 to 17 during the first round of data collection in 1997. This study includes 5,177 respondents with course-taking and achievement data aggregated from their high school transcripts and annual updates on their post-secondary enrollment or non-enrollment and occupation. We tracked enrollment and life histories starting in 1997 and continuing through 2009. Analyses track employment over a ten-year period from 2000 to 2009.

We utilized a repeated measures design to take advantage of having 10 annual records for each individual. Longitudinal analyses demonstrate how the timing of educational events such as enrollment in 2-year and 4-year institutions and associates' and bachelors' degree attainment are connected to entry into the STEMH workforce. Multi-level modeling with repeated measures data using Hierarchical Linear Modeling (HLM) allows this study to "model relations of person-level predictors to both status and change" (Raudenbush & Bryk, 2002, p. 163). Stated differently, we use multi-level methods to capture several measures of the same individual over time. Each person brings their own personal demographic characteristics and educational history accumulated through their elementary and secondary schooling into adulthood. Thus, at the highest level of the hierarchy (level 2) are the status variables related to individuals' demographic characteristics and schooling experiences. Situated at the lower level of the hierarchy (level 1) are repeated measures of factors related to life status and postsecondary experiences.

Variables in the Study

In alignment with the purpose of this study, level 2 factors included demographic characteristics, high school course-taking, and high school academic achievement. Level 1 factors included marital and family status as well as college enrollment and certificate/degree attainment for each year. The dependent variable for this study was the type of career obtained, and was coded as (1) non-STEMH, (2) STEMH technician, or (3) STEMH professional, based on the 2002 Census Occupation Codes used in NSLY.

STEMH technician jobs included:

- Engineering and related technicians (1540-1560)
- Life, physical, and social science technicians (1900-1960)
- Health care technical and support (3300-3650)

STEMH professional jobs included:

- Mathematical and computer scientists (1000-1240)
- Engineers, architects, and surveyors (1300-1530)
- Physical scientists (1600-1760)
- Health diagnosis and treating practitioners (3000-3260)

All other occupations were coded as non-STEMH. The result was a multinomial dependent variable comparing STEMH technician and STEM professional occupations to non-STEMH occupations. We used three sets of models to examine the relationship between occupation and (1) demographic characteristics including life transitions, (2) high school achievement, and (3) post-secondary enrollment and degree attainment.

Demographic Characteristics

Level 2 personal demographic characteristics included *gender* and *race/ethnicity* using the 1997 NLSY categories as shown in Table 1. Men and white, non-Hispanic respondents were used as comparison groups. Because race/ethnicity (predictor variables) and STEMH occupations (outcome variables) have multiple categories, the multinomial logit link function expresses the log-odds of a particular race/ethnicity subgroup relative to the reference category (Raudenbush & Bryk, 2002). We also included respondents' childhood *household net worth* as well as *parents' highest level of education,* measured as years of schooling for the respondent's residential mother and father as measures of socio-economic status. Mean substitution and an indicator variable were used for respondents missing data.

Level 1 longitudinal data on respondents' life transitions included annual measures of marital and family status. *Marital status* was coded as never married, cohabitating, married, or separated/divorced, with never married as the comparison group. Respondents with at least one *child* were coded as 1. Preliminary analyses yielded stronger models using an indicator variable for one or more children than for a continuous variable for the number of children.

High School Achievement

The second set of models added measures of high school achievement at Level 2 because prior achievement did not vary over time. High school academic achievement was determined by respondents' *math GPA* and *science GPA*. Overall GPA was collinear with both math and science GPAs and thus was not included in the models. Mean substitution and indicator variables were used for students missing either or both GPAs. Respondents' high school course-taking patterns were *CTE*, *college preparatory*, *both* (students enrolling in both college preparatory and CTE tracks), and *general* (students taking the minimum requirements to graduate) as coded by the 1997 NLSY. Additionally, the levels of high school mathematics and science courses were captured using the 1997 NLSY pipeline measures first constructed by Burkam and Lee (2003). Thus, *highest math course taken* and *highest science course taken* were coded into the following groups, with comparison groups marked by an asterisk:

Mathematics

- No mathematics/Non-academic courses (general, basic, consumer)
- Low academic—Pre-Algebra, Algebra IA, or Algebra 1B
- Middle academic I—Algebra I, Geometry
- *Middle academic II—Algebra II
- Advanced I—Trigonometry, Analytical Geometry, Probability/Statistics
- Advanced II—Precalculus
- Advanced III—Calculus, AP Calculus AB, AP Calculus BC

Science

- None
- *Primary and Secondary Physical Sciences and Life Sciences
- Chemistry 1 OR Physics 1
- Chemistry 1 AND Physics 1
- Chemistry 2 OR Physics 2

Post-Secondary Enrollment and Degree Attainment

Level 1 factors captured accumulated schooling and credentials over time. *Community college enrollment* was measured as the total years of enrollment in 2-year institutions up to the year in the record. *University enrollment* is a corresponding measure of enrollment in 4-year institutions. Measures of degree attainment included indicator variables for respondents who had earned a *vocational certificate*, *associate's*, and/or *bachelor's* degrees, using the 1997 NLSY broad categories. To simplify major and degree, associate's degrees earned at the same time a student majored in a STEMH category were coded as Associates of Science (AS) degrees and non-STEMH majors were coded as Associates or Arts (AA) degrees. A similar process was used to code bachelor's degrees into Bachelor of Arts (BA) or Bachelor of Science (BS) degrees.

Results

As shown in Table 1, longitudinal variables (level 1) represent the respondent's enrollment or life history at the time they held each type of occupation. Level 2 background variables are among respondents who held STEMH technician and STEMH professional occupations at some point in time and those who never held a STEMH occupation. As shown in Tables 1 and 2, STEMH technical and professional occupations are compared to non-STEMH occupations. Models 1, 2, and 3 include demographic characteristics and life transitions, high school achievement, and post-secondary enrollment and degree attainment variables.

Demographic Characteristics

Women were significantly most likely to be employed in technician occupations and as likely to be employed in professional occupations as non-STEMH occupations in Models 1a and 1b. When accounting for women's higher high school achievement, women were significantly less likely than men to enter STEMH professional occupations.

As shown in Table 1, there is a negligible amount of racial variance for STEMH technician occupations. Only Black Hispanic respondents were significantly more likely than white students to enter these fields. As shown in Table 1, Black Hispanics represent less than 1% of all respondents. As shown in Model 1b, Black and White Hispanic students were significantly less likely to enter STEMH professional occupations compared to Asian and "other race" respondents. Adding high school achievement in Model 2b accounted for lower rates of STEMH professional employment among Black respondents due to their lower high school achievement. Model 3b shows that White Hispanic and Black Hispanic students had lower rates of entering STEMH professional occupations after accounting for post-secondary enrollment and degree attainment. Stated differently, Black students with adequate post-secondary backgrounds were significantly less likely to enter STEMH professional occupations. More specifically, additional analyses show Black students with comparable years of enrollment in four-year universities to their peers are significantly less likely to enter STEMH professional occupations. Model 3b also indicates that Asian students were no longer more likely to enter STEMH professional occupations when accounting for post-secondary enrollment and degree attainment.

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Table 1

Predictors Related to the Attainment of STEMH Technician Occupations

	Model 1a			**Model 2a**			**Model 3a**		
	B	***S.E.***	***p***	***B***	***S.E.***	***p***	***B***	***S.E.***	***p***
Demographic Characteristics									
Intercept	-6.301	(.192)	<.05*	-6.621	(.252)	<.05*	-6.894	(.259)	<.05*
Female	1.364	(.104)	<.05*	1.354	(.106)	<.05*	1.407	(.107)	<.05*
Black, not Hispanic	.113	(.127)	.373	.153	(.130)	.238	.095	(.131)	.468
Hispanic	.086	(.176)	.626	.087	(.177)	.621	.053	(.177)	.766
White Hispanic	.155	(.181)	.392	.177	(.182)	.331	.088	(.184)	.634
Black Hispanic	1.749	(.504)	<.05*	1.778	(.507)	<.05*	1.584	(.502)	<.05*
Native American	-.109	(.710)	.878	-.162	(.723)	.823	-.295	(.716)	.680
Asian	-.491	(.341)	.150	.370	(.346)	.286	.256	(.349)	.463
Multiracial	.110	(.520)	.833	.085	(.527)	.872	-.203	(.538)	.705
Other	-.193	(.617)	.754	-.224	(.623)	.719	-.389	(.635)	.540
Parents' Net Worth	.000	(.000)	.369	.000	(.000)	.422	.000	(.000)	.409
Dad's Education	-.007	(.022)	.749	-.012	(0.23)	.608	-.014	(.023)	.541
Mother's Education	.026	(.022)	.237	.026	(.022)	.240	.035	(.022)	.114
Age	.135	(.012)	<.05*	.135	(.012)	<.05*	.081	(.014)	<.05*
Cohabitating	-.059	(.094)	.531	.055	(.094)	.562	.013	(.097)	.890
Married	-.089	(.110)	.420	-.086	(.111)	.437	-.166	(.113)	.144
Separated/Divorced	-.173	(.230)	.451	-.189	(.231)	.413	-.312	(.237)	.187
Children	.292	(.094)	<.05*	.294	(.096)	<.05*	.283	(.100)	<.05*
High School Achievement									
Math GPA	----	----	----	.052	(.087)	.550	.074	(.088)	.397
Science GPA	----	----	----	.095	(.087)	.274	.082	(.087)	.350
College Prep	----	----	----	-.058	(.114)	.608	-.057	(.115)	.618
CTE	----	----	----	.153	(.212)	.470	.039	(.214)	.857
Dual	----	----	----	.200	(.219)	.361	.144	(.220)	.512
No Math	----	----	----	.365	(.253)	.150	.284	(.256)	.269
Low Math	----	----	----	.656	(.323)	<.05*	.461	(.328)	.160
Algebra 1/Geometry	----	----	----	.364	(.182)	<.05*	.171	(.184)	.354

	Model 1a			**Model 2a**			**Model 3a**		
	B	***S.E.***	***p***	***B***	***S.E.***	***p***	***B***	***S.E.***	***p***
Algebra 2	----	----	----	.128	(.156)	.412	-.070	(.159)	.660
Pre-calculus	----	----	----	-.246	(.252)	.328	-.269	(.254)	.290
Calculus	----	----	----	.268	(.193)	.165	.243	(.197)	.217
No Science	----	----	----	.250	(1.366)	.855	.539	(1.411)	.702
Chemistry 1 or Physics 1	----	----	----	.133	(.138)	.337	.155	(.139)	.265
Chemistry 1 and Physics 2	----	----	----	.084	(.206)	.682	.184	(.209)	.378
Chemistry 2 or Physics 2	----	----	----	.468	(.171)	<.05*	.474	(.173)	<.05*
Postsecondary Education									
Years Enrolled in 2-Year Institution	----	----	----	----	----	----	.167	(.035)	<.05*
Years Enrolled in 4-Year Institution	----	----	----	----	----	----	.014	(.030)	.638
Vocational Certification	----	----	----	----	----	----	1.071	(.088)	<.05*
Associate of Arts	----	----	----	----	----	----	-.491	(.250)	<.05*
Associate of Science	----	----	----	----	----	----	1.406	(.208)	<.05*
Bachelor of Arts	----	----	----	----	----	----	-1.802	(.216)	<.05*
Bachelor of Science	----	----	----	----	----	----	1.150	(.184)	<.05*

Note. *p < .05.

Respondents who entered STEMH technician and non-STEMH occupations slightly differed in terms of their childhood socio-economic status. Respondents who entered STEMH professional occupations grew up with parents with higher net worth and parents with more years of schooling, likely beyond the mean of completing high school. These socio-economic effects were no longer significant when high school academic achievement was included in the analyses, a sign that socio-economic advantages manifests in childhood and secondary education, not necessarily in route to STEMH professional careers.

Respondents were significantly more likely to enter technician and professional STEMH occupations as they got older, but were no more likely to enter these occupations after marriage or divorce. Cohabitating respondents were significantly more likely to enter STEMH professional occupations, a finding consistent throughout all models. Respondents with children were significantly more likely to enter STEMH technician occupations. They were least likely to enter STEMH professional occupations until accounting for enrollment and degree attainment.

High School Academic Achievement

Students who only completed math up to Algebra 1 or Geometry were significantly more likely to enter STEMH technician occupations and significantly less likely to enter STEMH professional occupations compared to non-STEMH occupations. In addition, students who reached Algebra 2 and Pre-calculus were significantly less likely to enter STEMH professional occupations compared to those who completed up to Trigonometry and related courses. Pre-calculus is actually a higher level of math than Trigonometry.

In terms of science, respondents who took any chemistry and/or physics courses beyond physical sciences and life sciences were significantly more likely to enter STEMH technician occupations when accounting for their enrollment and degree attainment. Respondents who took Chemistry 2 or Physics 2 were also significantly more likely to enter STEMH professional occupations; however, this variable was no longer significant when enrollment and degree are included. Overall, high school science course-taking did not differentiate between those who enter non-STEMH and STEMH professional jobs.

Science course-taking, mathematics GPA, and science GPA, do not predict entering a STEMH occupation. The key difference in terms of high school mathematics and science was Calculus course-taking. As shown in Table 2, individuals with a CTE high school education were significantly more likely to enter STEMH professional occupations even when accounting for post-secondary enrollment and attainment.

Table 2

Predictors Related to the Attainment of STEMH Professional Occupations

	Model 1a			**Model 2a**			**Model 3a**		
	B	***S.E.***	***p***	***B***	***S.E.***	***p***	***B***	***S.E.***	***p***
Demographic Characteristics									
Intercept	-4.141	(.181)	<.05*	-4.014	(.257)	<.05*	-4.602	(.2720	<.05*
Female	.122	(.108)	.259	-.289	(.114)	<.05*	-.341	(.118)	<.05*
Black, not Hispanic	-.404	(.154)	<.05*	-.221	(.162)	.173	-.401	(.168)	<.05*
Hispanic	-.347	(.216)	.107	-.205	(.221)	.354	-.316	(.228)	.165
White Hispanic	-.700	(.241)	<.05*	-.566	(.250)	<.05*	-.675	(.262)	.165
Black Hispanic	-1.036	(1.089)	.342	-.839	(1.156)	.468	-1.107	(1.181)	.349
Native American	-.384	(.895)	.667	-.198	(.950)	.835	-.586	(1.015)	.564
Asian	1.101	(.292)	<.05*	.844	(.299)	<.05*	.504	(.305)	.098
Multiracial	-.292	(.585)	.617	-.375	(.622)	.546	-1.115	(.689)	.105
Other	1.085	(.510)	<.05*	.873	(.528)	.098	.669	(.541)	.217
Parents’ Net Worth	.001	(.000)	<.05*	.001	(.000)	.063	.001	(.000)	.092
Dad’s Education	.050	(.024)	<.05*	-.003	(.025)	.892	-.022	(.026)	.395
Mother’s Education	.078	(.025)	<.05*	.039	(.026)	.131	.025	(.026)	.331
Age	.309	(.014)	<.05*	.306	(.014)	<.05*	.144	(.019)	<.05*
Cohabitating	.219	(.112)	<.05*	.315	(.115)	<.05*	.267	(.121)	<.05*
Married	.245	(.123)	.047	.229	(.127)	.071	.159	(.134)	.238
Separated/Divorced	-.501	(.331)	.130	-.357	(.344)	.300	-.138	(.359)	.700
Children	-.643	(.121)	<.05*	-.394	(.127)	<.05*	.173	(.136)	.206
High School Achievement									
Math GPA	----	----	----	.185	(.112)	.098	.135	(.115)	.243
Science GPA	----	----	----	.217	(.114)	.056	.067	(.118)	.567
College Prep	----	----	----	.045	(.125)	.718	-.064	(.129)	.619
CTE	----	----	----	.723	(.244)	<.05*	.682	(.253)	<.05*
Dual	----	----	----	.067	(.282)	.812	.003	(.295)	.991
No Math	----	----	----	-1.091	(.358)	<.05*	-.934	(.384)	<.05*

	Model 1a			Model 2a			Model 3a		
	B	***S.E.***	***p***	***B***	***S.E.***	***p***	***B***	***S.E.***	***p***
Low Math	----	----	----	-.922	(.522)	.077	-.443	(.532)	.405
Algebra 1/Geometry	----	----	----	-.945	(.216)	<.05*	.728	(.226)	<.05*
Calculus	----	----	----	.621	(.172)	<.05*	.520	(.177)	<.05*
No Science	----	----	----	-1.155	(1.264)	.361	-1.436	(1.271)	.259
Chemistry 1 or Physics 1	----	----	----	.324	(.168)	.053	.197	(.175)	.259
Chemistry 1 & Physics 2	----	----	----	.393	(.215)	.067	.180	(.223)	.420
Chemistry 2 or Physics 2	----	----	----	.491	(.198)	<.05*	.301	(.206)	.144
Postsecondary Education									
Years Enrolled in 2-Year Institution	----	----	----	----	----	----	.291	(.043)	<.05*
Years Enrolled in 4-Year Institution	----	----	----	----	----	----	.277	(.031)	<.05*
Vocational Certification	----	----	----	----	----	----	.420	(.109)	<.05*
Associate of Arts	----	----	----	----	----	----	-.587	(.245)	<.05*
Associate of Science	----	----	----	----	----	----	2.629	(.215)	<.05*
Bachelor of Arts	----	----	----	----	----	----	-.694	(.139)	<.05*
Bachelor of Science	----	----	----	----	----	----	1.828	(.148)	<.05*

Note. *p < .05.

Post-Secondary Schooling and Credentials

Length of enrollment in both 2-year and 4-year institutions were significantly and positively associated with entering both STEMH technician and professional occupations, even taking into account STEMH associate's and bachelor's degree attainment, which also led to these STEMH occupations. Respondents with vocational certificates were also significantly more likely to enter both STEMH occupations. Students with non-STEMH associate's and bachelor's degrees were more likely to enter non-STEMH occupations.

Limitations

Readers should caution when making generalizations from the findings of this study because of the attrition of respondents within the 1997 NLSY data set. Despite the national random selection of participants used for the analysis, the attrition of respondents presents challenges for generalizing findings as it is quite plausible that particular subgroups could have unequal representation. Attrition is oftentimes an issue for longitudinal studies.

In addition, while GPA is commonly used in empirical studies to measure academic achievement (York, Gibson, & Rankin, 2015), nevertheless, it is important to acknowledge the problematic nature of using GPA for that specific purpose. The use of GPA as a measure of academic achievement is problematic because it is not always an accurate measure of learning or cognitive development and grading differs greatly within and among institutions as well as instructors/teachers.

Discussion

Numerous national efforts and initiatives have called for the need to address the lack of diversity and broadening of participation of underrepresented individuals in STEM fields (Bruning, Bystydzienski, & Eisenhart, 2015). Findings in this study suggest a more nuanced and complex pathway to STEMH technician and professional occupations then one might think. Prior research has demonstrated the importance of demographic factors in its contribution to labor market outcomes (Blau & Duncan, 1967; Fletcher & Cox, 2012; Fletcher & Zirkle, 2009; Sewell et al., 1969). We found women enter STEMH professional occupations at a rate lower than would be expected given their high school achievement. These findings support prior research revealing continued significant income and occupation choice disparities between males and females (Fletcher & Cox, 2012; Fletcher & Zirkle, 2009; Jantzer, Stalides, & Rottinghaus, 2009; Levenson, 2006).

Demographic Factors Associated with STEMH Careers

This study offered a more nuanced account of Blau and Duncan's (1967) model explaining the impact of socio-economic status, intellectual abilities, and academic performance on occupational status attainment. In fact, socio-economic status advantages did not contribute to the explanation of STEMH technician and professional occupational attainment when adding high school achievement to our model. Perhaps this is evidence that those students who overcome socio-economic disadvantages in high school can bridge the gaps with their higher socio-economic counterparts during adulthood.

Based on findings of this study, Blacks as well as Black and White Hispanics were less likely to enter STEMH professional occupations compared to their white counterparts. One contributing factor for the explanation of this finding was the lower academic performance of ethnic and racial minority students. An extensive accumulation of studies has demonstrated that white students academically outperform Black and Hispanic students, with significant differences in grades, exam scores, high school graduation rates, degree attainment, and long-term educational outcomes (Kao & Thompson, 2003; Warikoo & Carter, 2009). As a result, the current educational landscape for Black and Hispanic students is less than promising as these students are oftentimes not prepared for the expectations of college nor are they equipped with the skills needed in the workforce. Explanations for this occurrence are varied and complex. Many education researchers have attributed the academic achievement gap to cultural orientations for Black and Hispanic students. Increasingly, many of these individuals come from lower socio-economic backgrounds and are raised under the guidance of only one parent. In addition, they also often reside in poverty-stricken neighborhoods. These are some of the many factors that result in adverse effects on students' educational well-being (Goldsmith, 2004).

Other factors - related to the academic achievement gap - are more institutional, such as the quality of schools, educational curricula, and the teaching which Black and Hispanic students are exposed to in high school compared to their white student counterparts (Darling-Hammond, 2004; Henfield, Moore, & Wood, 2008). Even among talented and gifted African American male students, Ford, Grantham, and Whiting (2008) concluded, "it is unfortunate, but not surprising, that most of the underachievers (students with low effort, students with low GPAs), students with the weakest or poorest work ethic, and students with the lowest academic commitment are Black males" (p. 234). Also, those Black males who complete high school are still less likely to matriculate in and complete a postsecondary education (Symonds, Schwartz, & Ferguson, 2011; Whaley & Noel, 2012). Our findings showed Black respondents were less likely to enter STEMH professional occupations, even when accounting for their post-secondary enrollment/degrees.

Educational Experience Factors Associated with STEMH Careers

Silverberg, Warner, Fong, and Goodwin (2004) posited the most critical issue for CTE and federal legislation is investigating and understanding how well students in CTE programs fare during school and beyond. While research has found short and medium term advantages for CTE graduates in regard to labor market outcomes (Fletcher & Zirkle, 2009; Lerman, 2007; Silverberg et al., 2004), little is known of long-term workforce outcomes associated with differentiated schooling experiences.

In this study, we examined the occupational attainment of individuals within a ten-year span of graduating from high school. In that regard, we found that participation in various curricular programs in high school, for the most part, did not significantly predict enrollment in STEMH occupations. However, we did find that postsecondary enrollment (both 2 and 4 year), degree attainment, and earning vocational certifications were significantly and positively related to obtaining STEMH professional careers. This suggests that participation in CTE in high school might not only contribute to STEMH career interests and short-term positive labor market outcomes, it also may lead to the obtainment of STEMH occupations in the long-term.

This finding is quite revealing as it suggests CTE is a valuable pathway to STEMH occupations, while much of the research literature contends that participation in a high school college preparatory curriculum yields more promising results related to STEMH employment (Babco, 2003). Further, based on our findings, it is quite plausible that high school reform efforts, such as the implementation of STEMH career academies (which integrate core academics and CTE curricula as well as the push for students to be both college and career ready) are promising strategies for increasing long-term labor-market outcomes (Kemple & Willner, 2008).

As noted previously, part of the problem is that STEM education is often considered as an academic issue primarily focusing on mathematics and science in secondary and postsecondary education. As such, this strategy ignores secondary CTE as a legitimate STEM pathway, even though programs like career academies have produced promising results regarding academic and occupational preparation, with a particularly positive impact on minorities and women (Fletcher & Cox, 2012; Hernandez & Fletcher, 2013; Kemple & Willner, 2008). Thus, to broaden the participation of minorities (such as Blacks) and women in STEMH fields, it is imperative to strengthen CTE programs and emphasize career guidance in high schools to promote career awareness as a means to attract and retain students in the STEMH pipeline (Hernandez & Fletcher, 2013; Metcalf, 2007; Xie & Shauman, 2003).

Conclusion

With the rapid proliferation of technology and the emergence of a knowledge-based economy, a strong need to fill the increasingly growing jobs in high-tech fields has developed (Fletcher & Cox, 2012). However, colleges and universities, across the nation, are not currently producing enough graduates in fields, such as engineering, to seal the widening gap (National Academy of Engineering, 2008; National Academy of Sciences, 2007; President’s Council of Advisors on Science and Technology, 2012). As a result, there has been a national vested interest in improving the country’s international competitiveness and increasing the economic development of the nation. In light of the growing need for highly trained workers and attempts at increasing the nation’s international competitiveness, research investigating the characteristics of STEM participants is critical. Thus, this research responded to the need for well trained technicians, the changing role of the community college including increased emphasis on market orientation, growing diversity of students, and merging vocational and educational programs to facilitate student success (Zinser & Lawrenz, 2004).

Recommendations

Based on findings in this study, qualitative studies could provide a more rich understanding of the lived experiences (e.g., phenomenological studies) and complex ways race, gender, and socioeconomic status interacts, and factors as well as privileges and disadvantages contribute to and serve as barriers to enrollment in STEMH technician and professional occupations. More specifically, such investigations could focus on diverse ethnic and racial STEMH technician and professional employees to discover their experiences and pathways to successful employment. Critical factors which should be examined in such a study would include challenges related to their demographics, life course transitions, high school and post-secondary experiences which might lead to their employment.

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