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STEM Field Persistence: The Impact of Engagement on Postsecondary STEM Persistence for Underrepresented Minority Students

Daniel T. Flynn

Department of Educational Services, St. Georges University

P.O. Box 7, St. George's, Grenada, West Indies

Tel: 1-473-444-5008 E-mail: dflynn@sgu.edu

(Research Conducted at University of California, Irvine, CA, USA)

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Abstract

Persistence studies in science, technology, engineering, and math (STEM) fields indicate that the pipeline to degree attainment is "leaky" and underrepresented minorities are not persisting in the STEM fields. Those students who do not persist in the STEM fields either migrate to other fields of study or drop out of higher education altogether. Studies of STEM student attrition point to a student perception of faculty disconnection from students, calling this the "chilly climate" (Seymour & Hewitt, 1997). Engagement theory states, "…it is the individual's integration into the academic and social systems of the college that most directly related to his continuance in that college" (Tinto, 1993). A "chilly climate" in the STEM fields could then reflect in measures of academic and social engagement. This study uses the Beginning Postsecondary Longitudinal Student Survey, 2004-2009 (BPS:04/09) (Cominole, Wheeless, Dudley, Franklin, & Wine, 2007) and logistic regression analyses to examine academic and social engagements' impact on STEM field persistence in postsecondary education, net of individual and institutional factors. Analysis by ethnicity, initial major, and engagement demonstrate that underrepresented minorities have different engagement patterns, but these engagement behaviors do not contribute significantly to staying in the STEM fields.

Keywords: Postsecondary, Engagement, Persistence, STEM Education, Underrepresented Minority Students

1. Introduction

College completion rates for all fields are "stagnant" (Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2009): with only 59 percent of freshmen starting in 2005 at 4-year institutions completing a baccalaureate in 6 years (Snyder & Dillow, 2013). In the fields of science, technology, engineering, and math (STEM), national and societal demand in these fields creates special interest in increasing STEM field persistence and attainment. While STEM degree completion is on the increase since the beginning of the 21st century, the persistence gap for underrepresented minority students in STEM is still a concern (National Science Board, 2007). The college retention literature is robust and frequently relates student engagement to postsecondary persistence but with few exceptions it does not addresses student engagement measures directly with regard to persistence in STEM fields (NSSE, 2010).

Special attention has been focused on the reasons why women and underrepresented minorities are less likely to complete degrees when their initial degree goal was in a STEM field (National Science Board, 2007). This concept has been called the "STEM leaky pipeline", and is studied extensively (Griffith, 2010; National Science Board, 2007; Soe & Yakura, 2008) yet these studies fail to examine student engagement as a mechanism of STEM field attrition (Flynn, 2012).

This study uses nationally representative longitudinal survey data from the National Center for Education Statistics' (NCES) Beginning Postsecondary Longitudinal Student Survey 2004-2009 (BPS:04/09) to make unique contributions to the literature. First, it uses BPS:04/09 data to examine the frequent assertion that underrepresented minorities do not persist in the STEM fields. Second, BPS:04/09 data are used to examine differences in engagement behaviors by ethnicity for students who start in the STEM fields. Finally, this study asks the question: Do either academic and social engagement impact student persistence for initial STEM declared students, controlling for ethnicity, student-level and institution-level factors? Analysis of persistence in STEM fields, along with measures of engagement, allows the determination of engagement's impact upon STEM persistence for underrepresented STEM students.

2. Previous Research

The *Digest of Education Statistics 2013* finds only 59 percent of first-time full-time students entering 4-year institutions in 2005 attained a degree at that institution within 6 years (Snyder & Dillow, 2013). Attainment has been studied using the nationally representative National Educational Longitudinal Study (NELS) and the High School & Beyond (HS&B) (Aldeman, 2006; Bowen, Chingos, & Mc Pherson, 2009; Tinto, 1993). These studies have examined factors such as gender, ethnicity, and financial need and the resulting literature has contributed to both policy and practice. Unfortunately, few of these nationally representative studies addressing degree attainment address persistence in STEM fields with engagement variables within their analyses (Flynn, 2014). To properly frame the current research, the literatures of both the traditional STEM retention and engagement theories are necessary.

2.1 STEM Majors and Engagement

Prior to the mid-1990s the general consensus was that STEM attrition was due to the difficulty of the content (Seymour & Hewitt, 1997). In the mid-1990s studies addressing engineering retention found otherwise. Seymour and Hewitt asserted that institutional features rather than student characteristics contribute significantly to STEM postsecondary attrition. Most prominent was that students leave the science fields due to their perception of a "chilly climate". This "chilly climate" is the students' subjective perception of the STEM faculty as unapproachable, indifferent, and intimidating. Seymour and Hewitt (1997) published their qualitative study of "science" students' leaving the field using the acronym SEM defining science as inclusive of both mathematics and engineering students. The research now differentiates with studies in engineering and technology separate from studies that still use the amalgam STEM designation. For this study, STEM will be addressed as both an amalgam (STEM) and separated into the science/math subfield of STEM distinct from engineering/technology subfield.

2.2 The Campus and Institutional Context

Following Seymour and Hewitt (1997), Berger, Ramirez, and Lyon (2005) emphasize that "retention is also a campus-based phenomenon" (p. 2). Ohland, Sheppard, Lichtenstein, Eris, Chachra, and Layton (2008, p. 259) state that there "is significant institutional variation" and "assert a need to address persistence and engagement at the intuitional level and throughout higher education" in engineering. In effect, Berger et al. (2005) ascribe the ability for students to engage as a function of the institutions providing opportunity for students to engage.

Both Doolen and Long (2007), and Daempfle (2004) further confirm the "Chilly Climate Hypothesis" in survey studies where STEM faculty members were identified as being "unapproachable, cold, unavailable, aloof, indifferent and intimidating" by STEM students. Daempfle (2004, p. 41) concludes, "students were generally interested in the sciences but were 'turned off' by the structure and climate of the classroom". Doolen and Long's (2007) single institution study validated Seymour and Hewitt's (1997) "structural or cultural sources" as leading to STEM attrition. Not surprisingly, the perception of a chilly climate led to low levels of contact with faculty and attrition in STEM fields. These levels of personal contact with faculty can be directly equated with Tinto's (1993) concept of academic engagement indicating that climate impacts level of academic engagement behavior, specifically student-faculty contact.

2.3 The Engineering Student

Daempfle (2004) also addressed the differing cognitive abilities of students and found that the engineering students who switched majors out of STEM were not cognitively different from the non-migrating students, as was previously thought. Switchers worked as hard and had similar college GPAs to the non-switchers. These switchers were also found to be same "kinds of people" as non-switchers, and found to be no less qualified to master the necessary technical concepts as non-switchers. The only quality on which STEM switchers and persisters differed was that the switchers evaluated their academic experiences as unsatisfactory. Daempfle's term "switching" is also called migration (the change from one major to another) and was extensively analyzed by Ohland et al. (2008), with results consistent with Daempfle's.

Ohland et al. (2008) used two large-scale databases, the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MINDFIELD) and the National Survey of Student Engagement (NSSE), to explore persistence, engagement, and migration in engineering programs. They found that "engineering differs from other majors most notably by a dearth of female students and a low rate of migration into the major". Using both the NSSE and the MIDFIELD, Ohland et al. (2008, p. 261) find that "except for the low proportion of women, engineering students are demographically similar to other college students". Note that similar to the NSSE, the MIDFIELD collects data from only a subset of institutions (n = 9) and should not be considered nationally representative.

2.4 The Leaks of the Leaky Pipeline

While many students enter college with a specific major, many change majors during the initial years. This migration between initial and final major varies by institutions, yet some authors state that this is "especially the case" (Griffith, 2010) for the STEM fields. Citing the National Science Board (2007), Griffith (2010, p. 911) states "women and minorities are even less likely to persist in a STEM field major than are male and non-minority students". Griffith used two large national datasets, the National Education Longitudinal Survey, 1988 (NELS:88, n = 5500 from 1070 sampled institutions) and the National Longitudinal Survey of Freshman (NLSF, 1999, n = 1820 from 85 institutions). Griffith concludes by stating that "the environment of the institution and the STEM field departments can have strong impacts on the major choice". The leaky pipeline could multiply STEM attrition for underrepresented minority students because retention of minority students is a problem for all majors (Swail, Redd, & Perna, 2003).

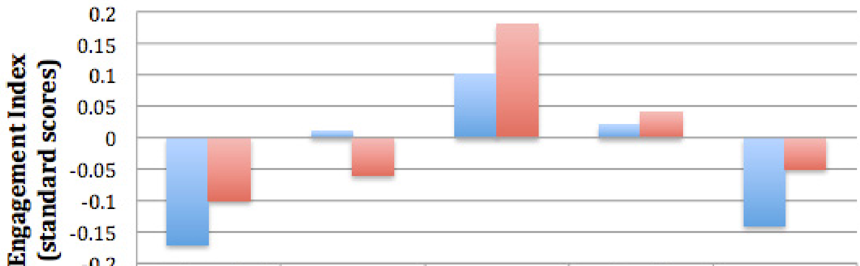
The key points from both the STEM and the engineering-specific literature are clear. The research indicates two primary factors leading to attrition in engineering: (1) a lack of student interaction with faculty resulting from a chilly climate and (2) an agreement that the students' ability is not solely responsible for their decision to change majors from engineering.

2.5 Student Engagement

According to Tinto (1993), "given individual characteristics, prior experiences, and commitments, … it is the individual's integration into the academic and social systems of the college that most directly related to his continuance in that college". Tinto (1973) delineates two distinct categories of engagement—academic engagement and social engagement. Academic engagement involves students actively engaging with the faculty, their advisors, and study groups while social engagement is the students active involvement with the social aspects of college—affiliated clubs, sports, or participation in campus arts, drama, or theatrical activities.

Student academic engagement is now well established as a contributory factor for postsecondary student persistence and attainment (Astin, 1993; Braxton, Hirschy, &

McClendon, 2004; Flynn, 2014; Kuh, et al., 2008; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006; Kuh & Pascarella, 2004; Tinto, 1993; Wolf-Wendel, Ward, & Kinzie, 2009). Another study found a difference in the levels of both academic and social engagement by field of study (Flynn, 2012). When mean standard scores of student engagement index scores were differentiated by field of study using the BPS:04/09, the STEM fields demonstrated the chilly climate (see Figure 1).



	Engineering/ ICS	Science	Humanities	Social Science	Voc/Prof
Academic Engagement 04	-0.17	0.01	0.1	0.02	-0.14
Social Engagement 04	-0.1	-0.06	0.18	0.04	-0.05

Figure 1. Chilly engagement in STEM fields

Note. First-Year engagement by initial declared major illustrates "Chilly Climate Hypothesis" using nationally representative data from the BPS:04/09 dataset (From Flynn, 2012).

Shortcomings associated with the existing research on engagement have prompted several scholars to call for student engagement analyses that based on large, multi-institution datasets using student level data (Kuh, et al., 2008; Pascarella & Terenzini, 2005). The current availability of the BPS:04/09 allows for a nexus of these literatures to address empirically whether engagement differentially impacts STEM persistence (Flynn, 2014). The positive impact of student engagement and the negative impact of the student perceptions of a chilly climate in STEM are resonant. The relationship between academic engagement and the chilly climate has not been studied in large-scale analyses.

3. Purpose

The purpose of this study is to quantitatively examine the relationship between ethnicity, engagement, and STEM persistence. Do student engagement behaviors help explain the persistence gap in the underrepresented minority students in STEM fields? The hypothesis is that academic engagement is a significant influencing factor contributing to the attrition of underrepresented minorities from the STEM fields. The three intermediate questions are:

(1) Do the BPS:04/09 data support that underrepresented minority students leave STEM fields?

(2) Does the BPS:04/09 demonstrate differential engagement for underrepresented minority

students in STEM fields?

(3) Do the differing engagement behaviors contribute to STEM attrition of underrepresented minorities?

4. Methods

4.1 Data Source

The National Center for Education Statistics' (NCES) Beginning Postsecondary Longitudinal Student Survey 2004-2009 (BPS:04/09) is well suited to provide information about the patterns of educational attainment and persistence in field. The BPS 04/09 provides extensive institutional and student self-reported survey information from 2004, 2006, and 2009 about persistence and student behaviors among a nationally representative sample of 16,700 students who first entered college in the Fall of 2003 (Cominole, Wheeless, Dudley, Franklin, & Wine, 2007). The analytic sample consists of students who began their studies in four-year baccalaureate-granting institutions in 2003, including public, private, not-for-profit, and for-profit institutions. The sample consists of 8700 individual students from 1350 different baccalaureate-granting institutions. Missing data identified in the institutional characteristics (specifically school size, residential status, and tuition) is addressed by mean substitution procedures for the 1030 subjects (12% of the sample) with missing data. (Note 1) All analyses are weighted using the BPS:04/09 "WTB000" weight so "the study respondents represent the target population" (Cominole et al., 2004, p. 107), in effect correcting for sampling bias. From the resulting weighted sample of 8700 students in the persistence analysis, 81% were still enrolled in higher education during the 2006 survey administration. All sample counts have been rounded to the nearest 10 to comply with National Center for Education Statistics' reporting policies.

4.2 Question 1 Methods

"Do the BPS:04/09 data support that underrepresented minority students leave STEM fields?" To explore this question, the analytic sample (n = 8700) of first-year starting students at 4-year institutions was categorized into six initial (2004) fields of study and seven (2006) fields of study. The BPS:04/09 majors of life science, physical science, and mathematics were combined into a single field of study labeled "Science/Math". Engineering and computer/information sciences were combined into the field of "Engineering/Technology". The BPS:04/09 majors of education, business/management, health, vocational/technical, and other technical/professional were combined into a single "Professional" field of study for this analysis. Although not a major per se, the BPS:04/09 also identified students who were undeclared or not in a degree program in both the 2004 and 2006 surveys. The undeclared/undecided, social/behavioral sciences, and humanities were carried into the analyses as the fields of "Undecided/Undeclared", "Social Sciences", and "Humanities". For the 2006 comparisons, a seventh category was created to capture students who were no longer enrolled. Since these could either be stop-outs (students who were currently not enrolled but who would return to complete their degree) or drop-outs (college leavers who will not return), the 2006 field of study has a seventh field labeled "Out".

Three cross-tabulations were created to answer Question 1. In the cross-tabulations the rows represent the field of study declared at survey administration of the first year (roughly April of the student's freshman year, 2004). The columns represent the field of study declared at the first follow-up survey administration (2006). Each cell represents percentages of the 2004 fields of study (row header) enrolled in the field of study in 2006 (column header). The first table illustrates field migration for all 4-year college STEM students as of the first follow-up survey (n = 1350). The second table is field migration for only Black/African-American STEM students (n = 170) and the third is for only Latino STEM students (n = 140) from 4-year colleges.

To determine significance of migration by ethnicity for STEM majors, the fields of Science/Math and Engineering/Technology are collapsed into a single field and a categorical variable to identify STEM persistence with three conditions (persisted in STEM, persisted in non-STEM, and no longer enrolled/left higher education). A multinomial logistic regression on this new variable and all ethnicity categories analyzes the relative risk ratio of staying in the STEM fields by ethnicity.

All statistical analyses were run within STATA version 11 in compliance with the National Center for Education Statistics restricted data license agreement with sample sizes and student counts all rounded to nearest 10.

4.3 Question 2 Methods

"Does the BPS:04/09 demonstrate differential engagement for underrepresented minority students in STEM fields?" To explore question two, the analytic sample (n = 8700) was filtered to include only students who initially declared a STEM field (n = 1350: Science/Math n = 600, Engineering/Technology n = 750) when they enrolled at a 4-year institution. Weighting was applied with the WTB000 weight to create an estimated population size of 258,250 students nationwide.

4.3.1 Dependent Variables

Two additive model regression analyses address (1) first-year academic engagement and (2) first-year social engagement. The first set of regression analyses addresses academic engagement as a function first of gender and ethnicity, then utilizes five additive models controlling for three additive sets of covariates (additional student-level controls, institutional level controls, STEM subfield [either Science/Math or Engineering/Technology]).

In order to address engagement as theorized by Tinto and subsequent researchers, The analyses utilize the BPS's Academic and Social Integration Index scales. The questions composite to the Integration indices were asked at the initial survey (2004) to all participants. The initial 2004 student self-reported data were collected beginning in April of the students' freshman year and represents their first-year engagement behaviors.

The academic engagement index represents a mean score of the four items measuring student academic engagement behaviors. The four behaviors representing academic engagement are: (1) meeting with faculty outside of class time; (2) meeting informally/socially with faculty; (3)

meeting with advisors; and (4) participating in study groups. Students could respond with "never", "sometimes", or "often" (coded 0, 1, or 2 respectively). The index score was created by summing the responses, each multiplied by 100, and then dividing the total by four to yield a score between 0 and 200 on the index. The mean academic engagement for STEM majors is 90.00 (SD = 41.75).

The social engagement index represents a mean score of the three items measuring student social engagement behaviors. The three behaviors representing social engagement are: (1) attends or participates in campus arts, drama, music, or fine arts activities; (2) attends or participates in campus clubs or organizations; and (3) participates or attends campus varsity, intermural, or club sports activities. Again, students could respond with "never", "sometimes", or "often" (coded 0, 1, or 2 respectively). The index score was created by summing the responses, each multiplied by 100, then dividing the total by three to yield a score between 0 and 200 on the index. The mean social engagement index for STEM majors is 64.68 (SD=51). The descriptive statistics for the STEM starters in 4-year institutions in 2003 are presented in Table 1.

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Table 1. Descriptive statistics for initially declared STEM students at 4-year postsecondary institutions in BPS:04/09 entering fall 2003

	Min	Max	Mean	SD	n
STEM Starter Overall Persistence	0	1	0.86	-	1350
2004 Academic Engagement Index	0	200	90.00	41.75	1350
2004 Social Engagement Index	0	200	64.68	52.00	1350
2004 Academic Engagement Index§	-2.17	2.60	-0.02	1.00	1350
2004 Social Engagement Index§	-1.24	2.54	-0.02	0.98	1350
Male	0	1	0.65	-	1350
Black	0	1	0.12	-	1350
Latino	0	1	0.10	-	1350
Asian	0	1	0.09	-	1350
Other	0	1	0.02	-	1350
White‡	0	1	0.75	-	1350
High School Grade Point Average	1.20	4.00	3.40	0.45	1350
Age	20	20	18.39	0.67	1350
Family Income	0	501,350	76,920	57,170.	1350
Total Aid Received	0	46,250	10,220	9,170.	1350
Dependent	0	1	0.98	-	1350
Tuition	490	39,030	10,790	8,430	1350
Highly Selective	0	1	0.36	-	1350
Moderately Selective	0	1	0.51	-	1350
Small Institution‡	0	1	0.23	-	1350
Medium Institution	0	1	0.23	-	1350
Large Institution	0	1	0.54	-	1350
Non-Residential	0	1	0.32	-	1350
Public Institution	0	1	0.61	-	1350

Note. §: Standardized values; ‡: Omitted/reference variable within logistic regressions.

4.3.2 Independent Variables

(1) Ethnicity and Gender Variables

The first model regresses both the academic and social engagement indices on ethnicity and gender. Gender is a dichotomous variable labeled "male" and coded "1" for male and "0" for female. Ethnicity is also coded into 5 dichotomous variables: White, Black/African-American, Latino, Asian, and Other. The Other category includes American Indians from recognized tribes, Hawaiian Islanders, and Pacific Islanders. For the analyses White was the reference category. Due to participants' ability to choose more than one ethnic/racial category the descriptive analysis percentages sum to more than 100% (Note 2).

(2) Covariates

Two categories of covariates were included in both regression analyses to address individual and institutional factors. Their inclusion within the analyses of the individual-level variables followed the literature on persistence. Attainment studies by Titus found gender and socioeconomic status (SES) were related to persistence (Titus, 2004); thus, gender and family income, as a proxy for SES, were included as individual-level covariates in the current study. Kuh et al. (2006) assert that financial aid significantly impacts college persistence, total financial aid received is also included as one of the individual-level variables. Closely related to both the financial aid and SES issues are the students' status as a dependent of their parents (Swail et al., 2003), so student dependent status was included as an additional dichotomous covariate in this analysis. High school grade point average (GPA) and age are also included as individual-level covariates to control for prior achievement. The regression uses standard scores of high school GPA, income and total financial aid.

The literature also informs the institutional-level covariate inclusion. Following findings on the financial considerations and their impact upon persistence and attainment (Kuh et al., 2006; Titus, 2004; Swail et al., 2003), the standardized annual tuition was included as a covariate within the institutional-level controls. While the debate over institutional selectivity continues (Kuh & Pascarella, 2004), institutional-level covariates addressing selectivity status were included as two separate dummy variables representing "highly selective" and "moderately selective" institutions, leaving less than moderately selective institutions as the reference variable. Kuh also considers institution size as a significant institutional attribute contributing to student success (2004). Schools with more than ten thousand students were coded as large schools. Non-residential (less than 25% of the students residing on campus) was also included as a dummy variable in the analysis with residential schools (more than 25% residing on campus) as the reference category.

(3) STEM Subfield Variables

In order to address a finer-grained understanding of initial STEM subfield and STEM persistence, dichotomous variables were created from the original BPS:04/09 data. The engineering/technology dichotomous (0-1) variable included students who declared either engineering or computer/information science during the initial wave. The science/math dichotomous variable was students who initially declared life science, physical science, or math as their major during the initial wave. The reference category in the regression analyses was engineering/technology.

(4) Interaction Terms

Interactions between the two STEM subfields (science/math and engineering/technology) and the two underrepresented ethnicities (Black/African-American and Latino) created four additional dichotomous variables.

4.3.3 Question 2 Analyses

The investigation consists of two separate additive-model logistic regression analyses. Regression analysis is like finding an equation for a curve—with the dependent variable being the "Y" and the various independent variables (primary and covariates) being multiple "Xs". The regression analysis results show the unstandardized coefficients for each independent variable. Each regression analysis table included here starts with the left-most column of coefficients representing the model including only the primary independent variables of. Each successive column of coefficients represents another additive model with additional independent variables or covariates added to the original set of variables. The rightmost column represents the full-model analysis, inclusive of all variables of interest and their relative impact upon the dependent variable. To address question 2, the analysis requires two separate regression analyses, each with parallel additive models, to address if either type of engagement is statistically different for underrepresented minorities in STEM. The first set of analyses uses the academic engagement scores as the dependent variable. The second set of analyses addresses social engagement scores as the dependent variable. Covariates were the same for both analyses, and the methods and structures are directly parallel.

4.3.4 Regression Models

Each analysis uses multiple sets of independent variables (ethnicity and gender, student level covariates, institution characteristic covariates, STEM subfields, and interaction terms), and reported the unstandardized ordinary least squared (OLS) slope coefficients for the respective standardized engagement index scores.

The first analysis addresses academic engagement. Model 1 regresses academic engagement index scores on gender and ethnicity. This examines the relationship solely between gender, ethnicity and the academic engagement index score. The second model adds individual level student controls to the analysis. The third model adds institutional controls. The fourth and final model adds the different STEM subfields (Science/Math differentiated from Engineering/Technology) and the interaction of both underrepresented minority status and STEM subfields to the analysis. The final model adds covariates by interacting student initial major with their STEM subfield to determine the effect of the combination of major and STEM subfield on academic engagement index score. The overall purpose of this analysis is to determine whether academic engagement index scores significantly differ for underrepresented minority students.

The second analysis is the same as the above analysis with the dependent variable being social engagement index score. The structure of the models and the sample are identical. The overall purpose of this analysis is to determine whether social engagement index scores significantly differ for underrepresented minority students.

4.4 Question 3 Methods

"Do the differing engagement behaviors contribute to STEM attrition of underrepresented minorities?" To explore question three, the analytic sample (n = 8700) is again filtered to include only students initially declared in a STEM field (n = 1350: Science/Math n = 600, Engineering/Technology n = 750) and enrolled at a 4-year institution. All variable construction for question 3 are identical to the variable construction described for question 2 (see Section 4.3.2).

To determine differences in of STEM migration and attrition by ethnicity for STEM majors as a function of engagement, a multinomial logistic regression on categorical STEM persistence was performed. The engagement index scores and all ethnicity categories were included to show the relative risk ratio of staying in the STEM fields by ethnicity and engagement. The fields of science/math and engineering/technology are collapsed, and the dependent categorical variable identifies STEM persistence with three conditions (stayed enrolled in STEM [STEM Stayer], stayed enrolled in a non-STEM field [STEM Switcher], and no longer enrolled/left higher education [Out]) are used in the multinomial logistic analysis. Two separate multinomial logistic analyses are included, the first solely addressing engagement index scores, gender and ethnicity, and the second adding the student-level and institutional-level covariates, and separate subfields to capture science/math fields separate from engineering/technology fields.

5. Findings

5.1 Question 1 Findings

The BPS:04/09 data support that underrepresented students leave STEM fields at a higher rate than do White, Asian, or students from other ethnic groups. Initial analyses for all students show that students migrate between fields of study between their first and third years. Of the students with declared majors, the range of in-field retention was from 53% (professional fields) to 43% (science/math and humanities).

Table 2. STEM migration crosstabulation for all students at 4-year postsecondary institutions in BPS:04/09 entering fall 2003

Declared Fields	Science/Math 2006	Engineering/Technology 2006	Out (left school) 2006
Science/Math 2003	43%	2%	10%
Engineering/Technology 2003	6%	44%	16%

Table 2 shows migration for the students in the STEM fields (n = 1350): 43% of students remained in the science/math fields and 44% remained in the engineering/technology fields. Science/math shows a 1% increase in enrollment from 2003 by 2006 and engineering/technology shows a 3% decrease in enrollment. Of the whole sample, 10% of the initial science/math starters and 16% of engineering/technology starters were no longer enrolled in school two years following their initial enrollment.

Table 3. STEM migration crosstabulation for Black/African American students at 4-year postsecondary institutions in BPS:04/09 entering fall 2003

Declared Fields	Science/Math 2006	Engineering/Technology 2006	Out (left school) 2006
Science/Math 2003	36%	0%	16%
Engineering/Technology 2003	4%	35%	22%

Table 3 shows the sample of Black/African-American students (n = 190): 36% of the science/math starters and 35% of the engineering/technology starters were still in their respective fields two years following initial enrollment. Black/African-American STEM students showed a 1% decrease in science/math enrollment and a 5% decrease engineering/technology enrollment by their third year. Of the Black STEM starters, 16% of the science/math starters and 22% of the engineering/technology starters had dropped out of school within two years.

Table 4. STEM migration crosstabulation for Latino students at 4-year postsecondary institutions in BPS:04/09 entering fall 2003

Declared Fields	Science/Math 2006	Engineering/Technology 2006	Out (left school) 2006
Science/Math 2003	37%	2%	10%
Engineering/Technology 2003	2%	37%	17%

Table 4 shows the sample of Latino students (n = 140): 37% of both the science/math starters and engineering/technology starters were still in their respective fields two years following initial enrollment. Latino STEM students showed a 1% decrease in science/math enrollment and a 5% decrease engineering/technology enrollment by their third year. Of the Latino STEM starters, 10% of the science/math starters and 17% of the engineering/technology starters had dropped out of school within two years.

Table 5. Net change in STEM subfield percent declared enrollment comparing all students, Black/African-American, and Latino students

	Science/Math 2006 to 2003	Engineering/Technology 2006 to 2003
All Students	1%	-3%
Black/African-American	-1%*	-5%*
Latino	-3%+	-5%+

Note. +: $p < 0.10$; *: $p < 0.05$.

Table 5 summarizes the net change in the STEM subfields, comparing the change in subfield enrollment between 2003 and 2006 for all students and separately for Black/African-American and Latino students.

The multinomial logistic regression results (see Table 6) found underrepresented minority students were significantly less likely than White students to remain in a STEM field. Compared to White STEM starters, remaining enrolled but in a field other than STEM was significantly more likely for Black students (Multinomial Logistic Relative Risk Ratio = 1.63, p < .05). Stated simply, the likelihood of switching is 1.63 times greater than that of staying in STEM. Compared with White STEM starters, dropping out of school entirely from STEM was also significantly more likely for Black students (Multinomial Logistic Relative Risk Ratio = 1.95, p < .05).

Table 6. Risk coefficients comparing STEM switchers and school leavers to STEM stayers by ethnicity and gender

	STEM switchers	School leavers from STEM
Male†	0.95	2.04**
Black/African-American†	1.63*	1.95*
Latino†	1.51+	0.92
Asian†	0.56*	0.30**
Other Ethnicity (non-White)†	0.60	-0.38

Note. Observations n = 1350; +: $p < 0.10$; *: $p < 0.05$; **: $p < 0.01$; †: Dummy/dichotomous 0-1 variable; Weighted multinomial logistic regression, relative risk ratios reported.

Compared with White STEM starters, STEM switching was nearly significant and more likely for Latino students (Multinomial Logistic Relative Risk Ratio = 1.51, p < .10). Stated simply the likelihood for Latino STEM students for switching is 1.51 times more likely. No significant difference with White STEM students was found for Latino STEM dropout rates. These migrations by ethnicity data are shown in Table 7.

Table 7. STEM migration by ethnicity at first follow-up survey (2006)

	Black	Latino	White^{r}	Asian
School Leavers (Outs)	21%**	16%	14%	8%
STEM Switchers	41%**	44%$^{+}$	36%	30%
STEM Stayers	38%	40%	50%	62%
n	100% 160	100% 140	100% 900	100% 120

Note. ^{r} Referenced category; $^{+}$: $p < 0.10$, *: $p < 0.05$, **: $p < 0.01$; Significance difference from referenced category.

The probability superscripts in this table are representative of the multinomial logistic regression significance levels relative to the referenced category of White STEM stayers. The difference between the ethnic minority groups is dramatic in Figure 2: Black students are both switching out of STEM and dropping out of college from STEM at a significantly higher rate than are White students. Latino students are switching out of STEM at nearly a significant level.

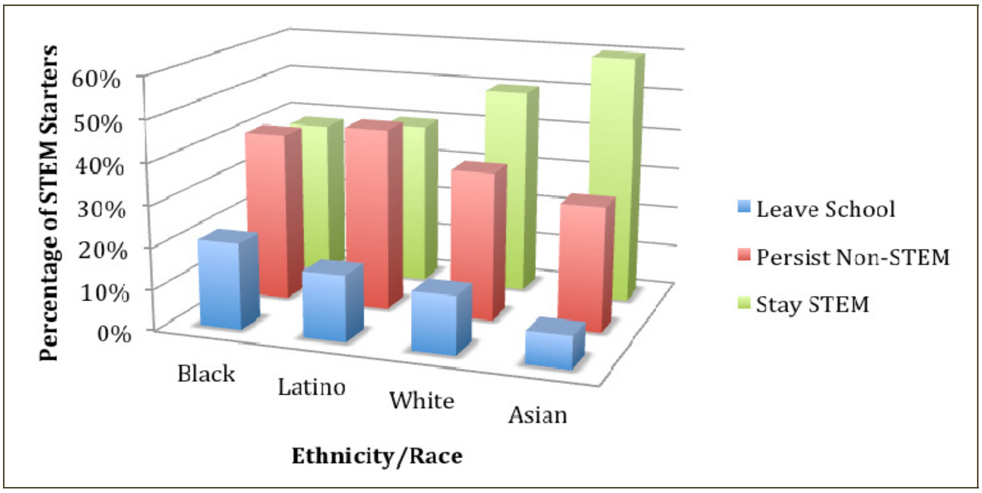

Figure 2. STEM migration percentages by ethnicity

Note. STEM migration by ethnicity at BPS first follow-up survey (2006).

In answer to question 1, the analysis shows that unrepresented minorities are switching and leaving school from STEM at a higher rate than other ethnically identified students. This analysis, using the BPS:04/09, supports the leaky pipeline theory for minority students.

5.2 Question 2 Findings

The BPS:04/09 data show that underrepresented minorities have different levels of self-reported academic and social engagement than White and other ethnically identified students.

Two separate additive-model ordinary least squared (OLS) logistic analyses with similar modeling using the nationally representative data yield engagement findings. All tables present results of the regressions as unstandardized OLS slope coefficients. In reporting unstandardized coefficients it is important to remember that a coefficient of 0 is the neutral position—equal likelihood/no increased or decreased likelihood over the reference category of White students. A positive coefficient indicates an increased or positive impact of the corresponding independent variable on the dependent variable. Negative coefficients indicate a negative impact or detrimental impact of the corresponding independent variable on the dependent variable.

5.2.1 Findings of Academic Engagement Regression Analyses for STEM Fields

Table 8. Ordinary least squared slope coefficients predicting academic engagement index score as a function of ethnicity for STEM majors at 4-year institutions

	Gender & Ethnicity	+ Student	+ Institutional	+ SM or ET and inter-actions
Male†	-0.21**	-0.19*	-0.18*	-0.05
Black/African-American†	0.26+	0.37**	0.39**	0.21
Latino†	-0.16	-0.03	0.07	0.19
Asian†	-0.13	-0.14	-0.14	-0.15
Other (non-White) Ethnicity†	0.13	0.16	0.16	0.11
Age		0.02	0.06	0.06
HS GPA§		0.07	0.04	0.02
Family Income§		0.05+	0.01	0.01
Financial Aid Received§		0.13***	0.09+	0.09*
Dependent†		0.65**	0.54**	0.56**
Tuition			0.12*	0.11*
High Selectivity†			0.42***	0.38**
Moderate selectivity†			0.32**	0.26*
Medium size†			-0.27*	-0.26+
Large size†			-0.36**	-0.33**
Non-residential†			-0.07	-0.08
Public†			0.18	0.16
Science/Math declared†				0.27**
Engineering/Tech declared†				0.00
Science/Math × Black				0.45*
Science × Latino				-0.25
Engineering/Tech × Black				0.00
Engineering/Tech × Latino				0.00
Constant	0.03	-1.08	-1.72	-1.98+
Observations	1350	1350	1350	1350
Pseudo R^2	0.02	0.06	0.10	0.12

Note. +: p < 0.10; *: p < 0.05; **: p < 0.01; ***: p < 0.001; §: Standardized values †: Dummy/dichotomous 0-1 variable; (MS) mean substitution applied as per text; Unstandardized OLS slope coefficients reported.

The academic engagement for STEM fields analysis is reported in Table 8. The first model demonstrates that compared with White, female students, being male is a negative predictor of academic engagement ($B = -0.21$, $p < 0.01$). In simple terms, male STEM students score significantly lower than do females on academic engagement. In model 2, we see being males still predicts lower academic engagement with the inclusion of student-level covariates in the analysis. With controls for individual covariates, being a Black/African-American STEM student is positively predictive of academic engagement ($B = 0.37$, $p < 0.01$). Also in model 2 we see the significance of academic engagement score with income, amount of financial aid received and dependent status. In model 3, following the addition of institutional-level covariates, we see similar values for both male and Black/African-American students as from the previous model. The expected and previously documented significance attributed to institutional selectivity, tuition, and institution size is supported in the BPS:04/09 data.

Model 4 includes the interactions between STEM subfield and interactions between both Black/African-American and Latino with STEM subfield. This analysis now shows no main effect for ethnicity in contrast to the previous models. Being a declared science/math major now predicts academic engagement relative to being an engineering/technology major: the science/math STEM subfield students academically engage more than do the engineering/technology subfield students ($B = 0.27$, $p < 0.01$). When subfields and ethnicity were interacted, compared with engineering/technology students, Black/African-American science/math students academically engage the most ($B = 0.45$, $p < 0.05$). With the effect size and significance of the institutional covariates dropping when subfields and interactions are included in the analysis, the indication is that it the discipline, not just the campus/institution, that impacts academic engagement.

5.2.2 Findings of Social Engagement Regression Analyses for STEM Fields.

The social engagement for STEM fields analysis is reported in Table 9. The first model demonstrates that for students, being male is a negative predictor of social engagement ($B = -0.17$, $p < 0.05$). Male STEM students also score significantly lower than do White females on social engagement. While both Black and Latino STEM students showed significant and negative coefficients for social engagement ($B = -0.30$, $p < .001$ and $B = -0.29$, $p < .001$ respectively) in the initial model, the significance of the effects disappear with the addition of student- and institutional-level covariates. In model 2 we see that males still yield lower coefficients with the addition of student-level covariates. Now, with controls for student-level covariates, Black and Latino STEM students' effect size drops and no longer demonstrate significance for social engagement.

Table 9. Ordinary least squared slope coefficients predicting social engagement as a function of ethnicity and gender for STEM majors at 4-year institutions

	Gender & Ethnicity	+ Student	+ Institutional	+ SM or ET and inter-actions
Male†	-0.17*	-0.12+	-0.11+	-0.04
Black/African-American†	-0.30***	-0.15	-0.11	-0.22*
Latino†	-0.29*	-0.16	-0.07	0.02
Asian†	-0.21+	-0.22+	-0.21+	-0.22+
Other Ethnicity (Non-White)†	-0.02	0.03	0.02	-0.00
Age		-0.05	-0.03	-0.02
HS GPA§		0.10**	0.08*	0.07+
Family Income§		0.12***	0.08*	0.08*
Financial Aid Received§		0.11***	0.05	0.05
Dependent†		0.27	0.18	0.20
Tuition			0.16**	0.16**
High Selectivity†			0.30*	0.28*
Moderate Selectivity†			0.28*	0.24*
Medium Size†			-0.24*	-0.23*
Large Size†			-0.28*	-0.26*
Non-residential†			-0.04	-0.05
Public†			0.14	0.13
Science/Math declared				0.15*
Engineering/Tech declared				0.00
Science/Math × Black				0.28
Science/Math × Latino				-0.21
Engineering/Tech × Black				0.00
Engineering/Tech × Latino				0.00
Observations	1350	1350	1350	1350
Pseudo R^2	0.02	0.07	0.10	0.11

Note. +: $p < 0.10$, *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$; §: Standardized values; †: Dummy/dichotomous 0-1 variable; Unstandardized OLS slope coefficients reported.

As with the academic engagement analysis, model 2 of the social engagement analysis illustrates the significance of income, amount of financial aid received and high school GPA, the covariates that have been studied elsewhere and were expected to relate strongly to persistence are also related to social engagement. In model 3, following the addition of institutional-level covariates, we see similar but slightly less negative slope coefficients for both male and Black students as compared with the previous model in this analysis. Here, too, we see the expected and previously demonstrated significance attributed to institutional selectivity, tuition, and institution size.

Model 4 includes the interactions between STEM subfield and interactions between both Black and Latino with STEM subfield. This social engagement analysis shows only a negative main effect for ethnicity of Black STEM students ($B = -0.22$, $p < 0.05$). Being a declared science/math major predicts higher levels of social engagement relative to being an engineering/technology major (smaller effect size than with academic engagement, but equally significant, $B = 0.15$, $p < 0.05$). In other words, the science/math STEM subfield students socially engage more than do the engineering/technology subfield students ($B = 0.27$, $p < 0.01$). When subfields and ethnicity showed no significant interaction.

In sum, there is a difference in the academic engagement of underrepresented minority students relative to White students. However, being Black in the science/math STEM subfield is a significant and positive predictor of academic engagement. Being Black is a significant and negative predictor of social engagement for these students. As for subfield, being a science/math student is positively and significantly predictive of both academic and social engagement ($B = 0.27$, $p < 0.01$ and $B = 0.15$, $p < 0.05$, respectively).

5.3 Question 3 Findings

The analysis of the BPS:04/09 data does not support that racially underrepresented students leave STEM fields at a higher rate than do White, Asian, or other racial/ethnic minorities as a function of engagement behaviors.

Table 10. Risk coefficients comparing STEM switchers and STEM school leavers as a function of ethnicity and gender compared with STEM stayers

	Ethnicity		+ Engagements	
	STEM Switchers	School Leavers (Outs)	STEM Switchers	School Leavers (Outs)
Black/African-American†	1.63^{*}	1.95^{*}	1.65^{*}	1.93^{*}
Latino†	1.51^{+}	0.92	1.44	0.83^{*}
Asian†	0.56^{*}	0.30^{**}	0.53^{*}	0.27^{**}
Other Ethnicity (non-White)†	0.60	-0.38	0.46	0.69
Academic Engagement§			0.88	0.79^{+}
Social Engagement§			0.92	0.77^{+}
Observations 1350				

Note. $^{+}$: $p < 0.10$; *: $p < 0.05$; †: Dummy/Dichotomous 0-1 variable; §: Standardized values; Weighted multinomial logistic regressions, relative risk ratios reported.

The multinomial logistic regression found nearly identical results as the initial comparison of STEM retention, switching, and postsecondary attrition (represented in the first two columns of Table 10), following the inclusion of the engagement variables in the multinomial regression (represented as the third and fourth columns). Table 10 shows that neither academic nor social engagement scores contribute a significant increased likelihood for switching out of STEM and only a trend ($p < 0.10$) for reducing likelihood for leaving school when controls for gender and ethnicity are included in the analysis. After controlling for engagement, Black and Latino STEM students still have a significantly increased risk ratio for leaving school altogether (RRR = 1.90, $p < 0.01$; RRR = 0.83, $p < 0.05$ respectively).

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Table 11. Risk coefficients comparing STEM switchers and STEM school leavers as a function of ethnicity and gender compared to STEM stayers inclusive of individual, institutional and STEM subfield covariates

	STEM Switchers	School Leavers (Outs)
Academic Engagement§	0.89	0.83
Social Engagement§	0.99	0.92
Male†	0.90	1.84*
Black/African-American†	1.14	0.80
Latino†	1.20	0.47*
Asian†	0.64+	0.31*
Other Ethnicity (non-White)†	0.35	0.61
Age	1.06	0.98
HS Grade Point Average§	0.67***	0.56***
Family Income§	0.94	0.61***
Financial Aid Received§	0.80*	0.66**
Dependent†	0.67	1.07
Tuition	0.74*	0.80
High Selectivity†	0.86	0.41*
Moderate Selectivity†	1.17	0.36**
Medium size†	1.83**	0.96
Large size†	1.30	1.02
Non-residential†	0.74+	0.72
Public†	0.68+	0.53+
Science/math declared major 2003†	1.47*	1.24
Engineering/tech declared major 2003†	0.00	0.00
Observations 1350		

Note. +: $p < 0.10$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$; §: Standardized values; †: Dummy/dichotomous 0-1 variable; Relative Risk Ratios reported.

Only Black STEM students demonstrated a significantly higher risk of switching out of STEM (RRR = 1.63, $p < 0.05$) than White STEM students. Interaction of the engagement scores and the dichotomous ethnicity variables showed no significant interaction and no change in the effect of the main variables.

Table 11 includes student- and institutional-level covariates, and STEM subfields for a finer grained analysis. The addition of the individual and institutional controls, the analysis still shows that male STEM students are more likely to leave both school and STEM, Latino STEM students are less likely to leave school, and that between the STEM subfields, science/math students are the more likely to both switch out of STEM and to leave school altogether.

6. Discussion and Conclusion

Descriptive and multinomial logistic regressions confirm the migration of underrepresented minorities from the STEM fields using the BPS:04/09 data. Black STEM students are more likely to switch out of STEM fields and to leave school two years post initial enrollment than are white STEM students. Regression studies of academic engagement as a function of ethnicity show that while there is no main effect for ethnicity, Black students in the science/math STEM subfields are significantly more likely to have higher academic engagement index scores. Yet, no interaction of ethnicity and engagement (either academic or social) significantly predicts STEM persistence.

Yes, the leaky pipeline exists and is evident in the BPS:04/09 data. Black students who start in STEM leave both STEM and school more often than do White students. While this is not inconsistent with the leaky pipeline hypothesis and previous research, the continued demonstration of this unfortunate fact in this current analysis using recent data indicates that STEM retention for underrepresented minorities is still an issue requiring further research. Griffith (2010) was using data that was 11 to 22 years old when she asserted that women and minorities were even less likely to persist in STEM. Using the most current longitudinal data of the BPS:04/09, the condition for women is quite different. Female STEM persistence is no longer a critical problem, but the pathways into postsecondary STEM are now more suspect. The persistence of underrepresented minorities is crucial if diversity of STEM postsecondary graduates is still the goal. The need for more STEM talent with postsecondary education is a pressing issue. Using new metrics, the K-12 pipeline into postsecondary STEM education is still "too shallow to meet demand" (Alphonse, 2014). The present study shows that postsecondary STEM attrition is also an area requiring future research.

Yes, underrepresented minorities demonstrate differential academic and social engagement scores. Most notably, Black science/math students have higher academic engagement scores than do either Black engineering students or Latino students in either the science/math or engineering/technology STEM subfields. But in answer to the final question, "Do differing engagement behaviors contribute to STEM attrition of underrepresented minorities?"— the BPS:04/09 data say no. Neither increased nor decreased academic nor social engagement improves the likelihood of underrepresented minority students in persisting in the STEM fields.

While neither academic nor social engagement significantly impacts STEM persistence, the analyses challenge some of the previous findings. Using the BPS:04/09 gives a nationally representative longitudinal view of STEM persistence. The analysis of the BPS:04/09 including academic and social engagement in the multinomial regression comparing STEM stayers, STEM switchers, and college non-persisters (see Table 11) challenges the assertion of

Ramirez et al. (2005), and Ohland et al. (2008) of retention as a "campus-based" phenomenon. While institution size and selectivity were significantly predictive of staying in STEM versus leaving STEM or school altogether, student-level variables have larger effect sizes and significance on STEM persistence. This also challenges Daemphle's (2004) statement that switchers were the same "kinds of people" as were non-switchers. The individual student characteristics are present before postsecondary enrollment and are more powerful predictors of STEM retention than postsecondary engagement. Only when researchers look at institution-level student populations could they say they are the "same kinds of people". The varied backgrounds predict STEM retention, specifically, high school grade point average, family income, and financial aid received. In combination, examination of the national data indicates that there is a selection bias in how students choose their STEM institutions. The circumstances seen by researchers studying STEM retention utilizing STEM-enrolled populations without controlling for earlier student-level characteristics decreased the impact of these earlier experiences. Olhand et al. (2008) hinted at this when they stated that engineering majors differed "most notably by a dearth of female students". The current analysis finds that STEM males significantly more often leave school altogether compared with females; while fewer in number, the female STEM starters are prone to stay in STEM. In effect, females are successfully pre-selecting into STEM albeit at much lower numbers.

The fact that the BPS:04/09 supports the existing literature that Black students who start in STEM both leave STEM and postsecondary education at higher rates is both tragic and discouraging. In concert with Ohland et al.'s statement that engineering students are demographically similar to other college students, it is especially discouraging that Black attrition out of engineering is so high relative to White students.

Engagement in this analysis was measured by student self-reported behaviors. Engagement was analyzed as neither a student-level nor an institutional-level factor in this analysis since it is functionally a factor that is influenced by both the student and the institution/faculty. Students cannot engage with faculty if faculty are not available. Also, faculty involvement with clubs and organizations may facilitate both students' academic and social engagement.

7. Limitations

This study explores STEM degree persistence and the impact of both academic and social engagement upon persistence, differentiated by ethnicity. This study is dependent upon two elements of the BPS:04/09, (1) that the academic and social engagement index scores are valid measures of academic and social engagement and (2) that the respondents were accurate and reliable in reporting. As is true of all survey data, it has limitations.

When NCES chose the items composite to the academic engagement index scores, they approximated Tinto's theory choosing two faculty interaction items, an advisor item, and a study group item. When they chose the social engagement items, they attempted to select campus activities that were not related to the curriculum but related to the campus social context. Without understanding the deeper nuances of each campus, this could have blurred the academic and social nature of the items. If a campus has a requirement that all clubs have faculty advisors, faculty contact is increased in the measure that attempts to capture a social concept. A student may join a club with a faculty advisor to impact academic goals. Likewise, meeting with faculty was specifically stated as "informally or socially" in the second faculty contact item of the academic engagement index score. The "socially" would imply, to strictly follow Tinto's framework, a social engagement item, yet NCES included this in their academic index score. The creation of the indices is only an approximation of student academic or social engagement behaviors. Although these are serious limitations of the engagement index scores in the BPS:04/09, there is still a difference between a student who chooses to engage in academic and social behaviors queried in the BPS:04/09 and a student who does not engage academically or socially. Previous studies have found that the indices have predictive value for both persistence and degree attainment (Flynn, 2013).

Another considerable limitation is that NCES chose categorical variables to measure the behavioral frequencies of the components for both the academic and social engagement index scores in the BPS:04/09. Respondents could choose never, sometimes, or often (coded 0, 1, or 2 respectively). What one respondent considered as "sometimes" was not necessarily the same as what another respondent considered "sometimes". The creation of the index by averaging the four academic and three social engagement index scores was arbitrary at best. No examples or stated definitions of "sometimes" and "often" were ever presented to the respondents (S. Chrissey, NCES, personal communication, January 9, 2014). A student who is conservative in rating their behavioral frequencies would appear less engaged. This is especially significant in this study of differences by ethnicity in light of Michelson's "attitude-achievement paradox" (1990). Black high school students were reported to inflate their achievement and attitude when self-reporting. The BPS:04/09 did not ask students to rate achievement, or attitude; it asked students to report frequency of behavior. While Downey, Ainsworth, and Qian (2009) challenge the attitude-achievement paradox specifically in large data analysis, the current analysis demonstrates that Black students both switch and drop out of STEM more often, while having higher academic engagement scores, significantly so for Black science/math students. If the Black respondents to the BPS:04/09 were inflating their frequencies of the behaviors in the engagement index scores relative to the other respondents, the relative impact of the engagement scales can be attributed to the paradox rather than to engagement. Future studies with alternate measures of both academic and social engagement that are not self-reported (and currently not available in the BPS:04/09 data) would be necessary to determine whether the Black attitude-achievement paradox is impacting behavioral frequency rating in the BPS:04/09.

Another concern with the BPS's academic engagement measures is that students can engage in all four of the behaviors (meeting with faculty, meeting with faculty informally, meeting with advisors, and study groups) for either positive/proactive or reactive/negative impetuses. Tinto envisioned academic engagement as curricular in nature and did not differentiate between meeting with faculty to further elaborate or improve their academic understanding from meeting in reaction to receipt of a poor grade on a paper or exam. In either case, the ability and willingness of a student to approach faculty, or advisors, or study groups was prophylactic of postsecondary attrition. This study examined staying in STEM. The desire for ethnic diversity in STEM is the societal goal. The need for individual and personal success for a student in any field will be the goal of any faculty member or advisor. Thus, increased faculty contact and/or advisor interaction may result in a change of field that is appropriate for the student (albeit counter to the societal goal of increasing STEM persistence and ethnic diversity). The fundamental limitation of this study is that it assumes staying in STEM meets a societal goal but negates the possibility that leaving STEM could be meeting a personal goal. The data indicate that more Black students leave STEM and Black science/math starters also demonstrate higher academic engagement. The behaviors measured by the academic engagement measures (and the concepts theorized by Tinto) were not designed to retain students in an initial field. They were designed to explore postsecondary persistence and degree attainment. Different questions and measures are necessary to address what keeps underrepresent minority students in STEM, quite possibly not using the BPS:04/09.

Finally, when the BPS:04/09 was developed (well before 2003 when it was initially implemented), both academic and social engagement was more personal and less technologically augmented. Even though the BPS:04/09 queries faculty contact "including email", the advancements in virtual interactions have changed the educational landscape. Message boards, learning management systems, and even social media have changed how students interact with faculty and fellow students. The ease of email communication, online discussion, and even social networking may profoundly alter how students currently engage with faculty. These technological changes were not considered in the creation of the BPS:04/09 and therefore the BPS:04/09 relies on student self-reported behaviors that are indicative of engagement. Technology may impact current and future conceptualizations of academic integration and engagement.

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Notes

Note 1. In the sample of all majors (n = 8700), six hundred forty students (7% of the sample) have missing tuition data and the mean tuition value of $11,030 was substituted for the missing values for those cases. Four hundred twenty subjects (5% of the sample) have missing data on residential status and the mean dummy value of "0," indicating "residential school", is used for students missing values for the non-residential dummy variable. Four hundred twenty students (5% of the sample) have missing data on the three school size dummy variables accounting for large, medium, and small institution size. These missing values are all assigned the "1" within the 'large school population' dummy variable. Comparison of listwise deletion results to results using mean substitution demonstrated no significant change in coefficients for any of the engagement variables. The mean substitution method yielded more conservative results than did the analyses utilizing listwise deletion.

Note 2. Approximately of 110 (8% of the STEM starter sample) students indicated two racial categories within the BPS:04/09 dataset. Fifty participants (3%) indicated both Latino and Asian. Less than ten participants (< 1%) indicated their as both Latino and White, as both black and white, both, or both Asian and Black. NCES/US Department of Education reporting policies reclassified students who reported both Black and Latino as Latino. This change in the way in which NCES reclassified multiracial Latino students was short-lived but impacted the BPS:04/09 (Newman, 2014) Two separate fully modeled analyses addressed an additional multiracial ethnic category and demonstrated no significant change upon either the engagement migration analyses.

Glossary

BPS: Beginning Postsecondary Longitudinal Student Survey;

BPS:04/09: Beginning Postsecondary Longitudinal Student Survey 2004-2009;

NCES: The National Center for Education Statistics';

OLS: Ordinary Least Squared;

RRR: Relative Risk Ratio;

STEM: Science, Technology, Engineering, and Math. More specifically, the academic fiedls of study that address Science, Engineering, Engineering and Math.