Understanding Persistence of Black Males in STEM

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Abstract

If you can keep them enrolled through their first year, it's a good chance that you will keep them to graduation! If this is indeed true as other researchers suggest, then it is imperative that potential barriers to persistence (internal, external, and institutional) through the first year be eliminated or mitigated as soon as possible. Unfortunately, the nation's college students are not a homogeneous group. That is, the barriers for one group may or may not be barriers for another group.

Regrettably, many of the research studies in the literature have considerable limitations: they are based on data from a handful of schools and/or are based on data from schools without sizable minority populations.

In this study, we use nationwide administrative data to determine and rank the characteristics that are most associated with the first-year persistence of Black males majoring in STEM. We use several multivariate techniques to address the following overarching research questions: What characteristics are most associated with persistence for Blacks? For Black males majoring in STEM? What has more predictive power in predicting persistence: academic preparation, academic and social integration, or finances?

Key Words: STEM, Multivariate Analysis, Persistence, Achievement, Black Males

1. Introduction

There has been a number of studies investigating factors that are associated with persistence and attainment of an undergraduate credential in the science, technology, engineering, and mathematics (STEM) fields. Studies have shown that many of the students that begin their postgraduate career majoring in a STEM field do not graduate with a STEM credential. Rather, they either stop out (transfer to a non-STEM field) or dropout (leave school altogether) before graduating with an undergraduate degree. Other studies have shown that some groups of students are more likely to leave STEM than others. Still others have linked persistence, attrition, and attainment to demographic characteristics of students (e.g. Bonous-Harnmath, 2000; Hilton and Lee, 1988), academic preparation (e.g. George et. al, 2001; Foltz et al., 2014; Adelman, 2006; Tyson et. al, 2007; Horn & Kojaku, 2001), financial aid (e.g. DePass and Chubin, 2008; Foltz et al., 2014; Ishitani, 2006; Ishitani and DesJardins, 2002; Cabrera et al., 1990; Braunstein et al., 2000) and intent to major in a STEM field (Bonous-Harnmath, 2000; Astin and Astin, 1992).

These studies generally investigate students at a single institution with modest (at best) minority populations. Unfortunately, these studies have been far from conclusive as to

the magnitude and even direction of any associations. Despite this, these findings have been instructive in obtaining an initial view of persistence in STEM, even if they are not conclusive. Some of the contradictions in the literature are provided below.

- Many papers link persistence and/or attrition to demographic variables (e.g. Ishitani, 2006), and socioeconomic status (e.g. Pascarella and Chapman, 1983; Hossler and Vesper, 1993). However, in a regression analysis study of data from the National Education Longitudinal Study of 1988, Maltese and Tai (2011) did not find a significant association between race, gender, or socioeconomic status and earning a degree in STEM.
- Maltese and Tai (2011) found that "… students involved in loan programs or work-study were no less likely to complete a degree in STEM...". But Ishitani (2006) found that first year students who received loans were 20% less likely to graduate in 4 years.

As reported in Flynn (2014), previous studies have found that academic and social indices have predictive value for both persistence and degree attainment. After synthesizing the available literature, it is not clear whether demographics, high school preparation, finances, or campus integration is most predictive of degree attainment in STEM.

1.1 STEM and Males

Nowadays, most students receiving undergraduate degrees in STEM are female (Spruill, 2014). Male students are noticeably missing from the graduation stage. Hilton and Lee (1988) found that males leave STEM fields at a faster rate than females. After controlling for individual and institutional controls, Flynn (2016) found that male students were more likely to both leave STEM majors as well as leave school altogether. To this end, Spruill (2014) recommended that researchers investigate the relationship between the decline of need-based aid, the increase of merit-based aid, and persistence to graduation for male college students.

1.2 STEM and Blacks

Many studies have shown the inequity in the US education system, especially for Black students. These studies suggest that Blacks do worse on standardized testing than their white counterparts (Camara, 1999), earn lower grades in their courses (Camara, 1999; Hoffman, 2003), drop out of high school and college at alarming rates (Hoffman, 2003), take fewer advanced level courses in high school (Tyson et al, 2007; (Camara, 1999), attempt and earn fewer math, science, and engineering credits (Radford, 2012), are more likely to leave STEM majors (Bonous-Harnmarth, 2000; Chen, 2013) and take longer to graduate (Ishitani, 2006; (Camara, 1999).

Research shows that the rate at which Black students switch out of STEM and drop out of college is significantly higher than the rate for White students (Flynn, 2016). Having said this, attempts have been made to investigate the persistence of Black students in STEM fields; however, they are inconclusive. Anderson and Kim (2006) suggest that attendance, hours worked, and rigor of high school curriculum are the most related to Black students' persistence in STEM. Flynn (2014) found that "race, parental, and peer factors when coupled with SES and high school ability, explained only 15% of the variance in regards to persistence." It seems as though just being Black is a significant yet negative predictor of persistence to degree (Spruill et. al., 2014). The authors suggest

that "more research is needed to fully understand the gap in degree completion among minority men."

1.3 STEM and Black Males

Of interest in this paper is the intersection of all three: Blacks, males, and STEM (figure 1). This group of students have unique issues that other groups of students do not have to face. For example, the well-defined pre-school to prison pipeline (Wald, 2003; Witt, 2007; Heitzig et al., 2009) is a major hindrance to Black males even enrolling in college, let alone majoring in STEM. To make matters worse, persons convicted of felonies are not eligible to receive federal loans, a major type of aid that helps students pay for their schooling.

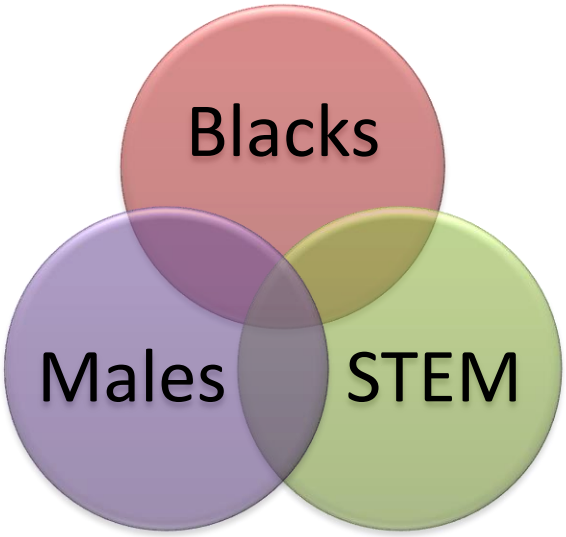

Figure 1: The target group for this study is the intersection of the three groups: Black, Males, and STEM majors.

It is clear from the current literature that several challenges exist that must be overcome for Black males to persist to graduation in STEM. But if just being Black is a true negative predictor of persistence to graduation, then the situation appears hopeless. Guided by this existential idea, this study attempts to address two research questions:

- What characteristics are most associated with persistence for Black males majoring in STEM?
- Which has more predictive power in predicting persistence: academic preparation, academic and social integration, or finances?

2. Data

Based on the available literature, six theoretical persistence themes were hypothesized to be associated with persistence. The first theme was *Academic Preparation*. This construct is assumed to be a measure of a student's preparedness for college level work. The second theme *College Intensity* measures the type and amount of coursework taken in college. The third theme *Home Life* was a combined measure of the student's socioeconomic status and whether or not the student lived in a single parent household. The fourth theme *Campus integration* is a measure of how well a student is academically

and socially acclimated to the campus environment. The fifth theme *Institution Type* takes into account the type of institution that the student attends. The final theme *Finances* takes into consideration the amount and type of financial aid that the student receives.

Seventeen variables from the 2004/09 Beginning Postsecondary Students Longitudinal Study (BPS:04/09) were used to operationalize these theoretical themes. This survey was given to students who started their postsecondary education in 2003/2004 and tracked them over the course of the next six years. The survey has data from student interviews and administrative sources for nearly 17,000 student respondents (Wine, 2011). Of the nearly 17,000 respondents, only 2,540 respondents were Black. Similarly, of the Black respondents, 900 were Black males. And of the Black males, less than ten percent (80) majored in a STEM field.

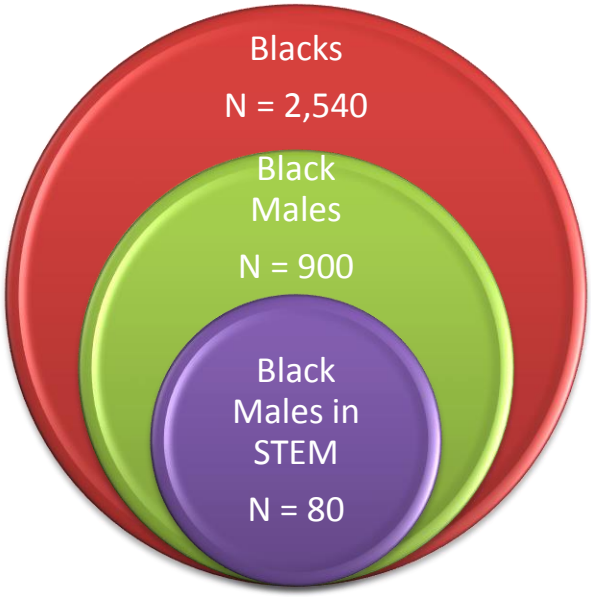

Figure 2: Counts of Black Males in STEM who responded to the BPS 04/09 Survey

In other words, only about 0.5% of the survey respondents were Black males in STEM. This fact limited the types of analyses that could be performed directly on data from the population of interest. This also informed how the data that was used was manipulated before use.

2.1 Confidentiality

A National Center for Educational Statistics (NCES) restricted use license granted access to the data used in this study. Following the requirements of the license, all summary data reported here have been rounded to the nearest 10 so as to protect the confidentiality of the respondents. Refer to table 1 to see the descriptive statistics of the variables used in this study for the 2,540 Black respondents to the BPS 04/09 survey.

Table 1: Descriptive Statistics of the Selected BPS 04/09 Variables
(Based on Data from Black Respondents Only)

Variable	*Label*	*N*	*N Miss*	*Minimum*	*Mean*	*Maximum*
SECTOR2	Institution Type (4-year, 2-year, Less than 2-year)	2,200	340	1.00	1.40	3.00
HBCU	Historically Black College or University indicator	2,200	350	0.00	0.02	1.00
TESATMDE	Derived SAT math score (/10)	1,310	1,230	20.00	40.84	80.00
TESATVDE	Derived SAT verbal score (/10)	1,310	1,230	20.00	41.70	80.00
ACAINX04	Academic integration index 2004	2,040	500	0.00	56.91	200.00
SOCINX04	Social integration index 2004	1,790	750	0.00	16.73	200.00
LOANRATIO2	Ratio of loans received in the 2003-04 academic year to the total amount of aid received during the same year	1,600	940	0.00	17.84	100.00
SINGLPAR	Single parent status in 2003-04 academic year	2,180	370	0.00	0.13	1.00
PCTALL	Income percentile rank for all students 2003-04	2,180	370	0.01	0.50	1.00
QE1STERN	Transcript: TOTAL # of credits earned in year 1	2,090	460	0.00	18.24	76.50
QE1STSTM	Transcript: STEM, # of credits earned, year 1	2,090	460	0.00	4.48	46.00
QESTMGPA	Transcript:	1,700	840	0.00	2.15	4.00

	STEM: GPA					
GENDER	Gender	2,180	370	1.00	1.59	2.00
STEM	Stem Major (0 – no, 1 – yes)	2,540	0	0.00	0.07	1.00
TOTGRT	Total grants 2003-04 (In $ Thousands)	2,540	0	0.00	1.38	22.29
TOTLOAN	Total student loans 2003-04 (In $ Thousands)	2,180	370	0.00	0.64	13.425
NEEDAID	Total need-based grant aid ($)	2,540	0	0.00	1,090.94	22,291.00

2.2 Variable Selection

Seventeen variables believed to operationalize the six theoretical persistence themes were selected from the BPS 04/09 to be used in this study (figure 3).

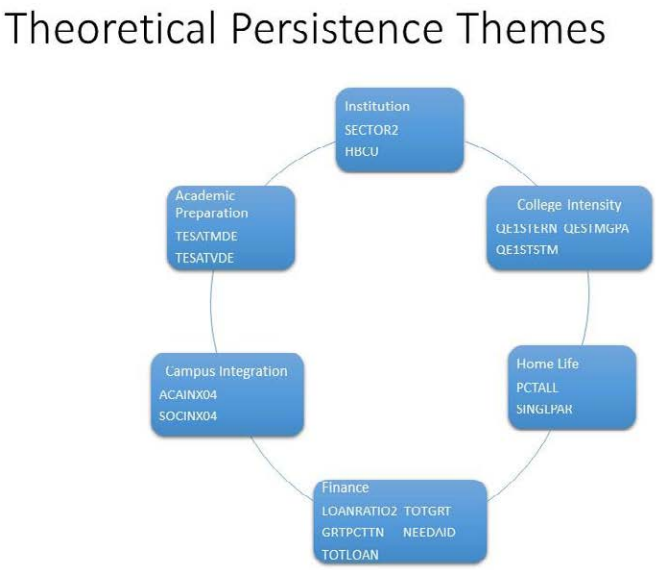

Figure 3: Theoretical themes and their loading variables believed to be associated with persistence. A STEM indicator is the seventeenth variable.

Some variables were derived from other BPS 04/09 variables. For example, the LOANRATIO2 variable was the ratio of loans received to total amount of aid received during the school year (both numerator and denominator available in the data set). Similarly, the STEM major indicator was derived from grouping several majors. The STEM variable found on the survey was not used to ensure that social science majors were excluded from the STEM group.

3. Methods

3.1 Data Pre-Processing

Many of the variables used in this study had missing data for a substantial number of Black respondents. (For example, 30% of the respondents were missing social integration data.) To address this, the missing data was replaced with the mean value for each variable (based on Black respondents only). The imputed and non-imputed data sets were created and analysis was run both with and without survey weighting (based on BPS 04/09 weight WTB000).

The decision was made to interpret and report the findings of the imputed, non-weighted dataset. This dataset was chosen over the non-imputed weighted dataset because very few Black males in STEM had positive weighs under the WTB000 weighting scheme. This would have in essence removed the information contained in the responses from a substantial percentage of the target group. The non-imputed, non-weighted group was not chosen for similar reasons: few Black males in STEM had complete data records. They would have also been eliminated from most multivariate procedures. While the imputation procedures took care of the missing data problem in the imputed, weighting data, many respondents would still be dropped because of non-positive weights.

3.2 Data Reduction

To reduce the dimensionality of the data, a principal components analysis (PCA) was conducted on the 17 selected variables. The number of factors to extract was set to six to mirror the dimensionality of the theoretical persistence themes. Factors with eigenvalues greater than one were considered significant (see table 2). The first six factors together explained nearly 70% of the variance in the data.

Table 2: Principal Components Analysis

Factor	*Eigenvalue of Correlation Matrix (n = 14)*	*Proportion Accounted For*	*Cumulative Proportion*	*Variance Explained By Each Retained Factor*	*Proportion of Variance of Retained Factors*
1	2.335	0.167	0.167	2.169	0.223
2	2.086	0.149	0.316	1.807	0.186
3	1.684	0.120	0.436	1.727	0.177
4	1.318	0.094	0.530	1.632	0.168
5	1.240	0.089	0.619	1.324	0.136
6	1.077	0.077	0.696	1.080	0.111

The PCA was successful in identifying four of the six theoretical themes (table 3). Variables from the *Finances* theme loaded positively (TOTGRT, NEEDAID) and negatively onto the first factor. Other finance variables (LOANRATIO2, TOTLOAN) loaded positively onto the third factor. As a result, the Finances theme was split into two separate themes: *Financial Need* (factor 1) and *Loan Support* (factor 3). Based on the rotated factor pattern, the second, fourth, fifth, and sixth factors were clearly identifiable as *College Intensity, Academic Preparation, Campus Integration*, and *Institution Type* themes respectively. One theme *Home Life* did not emerge as an identifiable theme.

Table 3: Data Reduction: PCA

	Varimax Rotated Factor Pattern					
	Financial Need	*College Intensity*	*Loan Support*	*Academic Preparation*	*Campus Integration*	*Institution Type*
ACAINX04	12	1	0	0	80 *	-1
TESATMDE	1	17	1	89 *	-2	-3
HBCU	5	-4	-7	3	5	73 *
PCTALL	-59 *	-3	11	-1	-6	-6
SOCINX04	2	1	1	-1	82 *	0
LOANRATIO2	-23	2	91 *	3	0	0
QE1STERN	3	83 *	2	7	-2	-5
QE1STSTM	0	82 *	0	10	1	-2
TESATVDE	4	8	2	90 *	0	2
SECTOR2	-3	6	6	-4	-6	73 *
TOTGRT	92 *	3	1	1	5	-3
TOTLOAN	11	0	94 *	1	2	-1
NEEDAID	94 *	1	3	3	4	-2
QESTMGPA	4	63 *	1	7	3	9

3.3 Logistic Regression

The six significant PCA factors were used as predictors in a logistic regression of persistence from year 1 to year 2 of students' postsecondary career (with the code one representing persistence). The model was run using a forward selection process to ensure that the most important factors are captured first, followed by the next important factor, and so forth. Those left out of the model can be considered as not providing any additional predictive power after accounting for the terms that are already included in the model. Table 4 shows that when using the imputed data from the Black respondents, three factors emerged as being significant predictors of first-year persistence.

Table 4: Logistic Regression Analysis

Effect Entered	*Summary of Forward Selection*				*Max Likelihood Est.*			*Odds Ratio*	
	DF	*# In*	*Score χ2*	*P-value*	*Est.*	*Wald χ2*	*P-value*	*Est.*	*95% Wald Confidence Limits*
Factor 3	1	1	43.20	<.001	0.429	39.907	<.001	1.536	1.344-1.754
Factor 1	1	2	5.73	.017	0.120	5.671	0.017	1.128	1.022-1.245
Factor 5	1	3	4.23	.040	0.102	4.212	0.040	1.107	1.005-1.220
Intercept					1.224	615.219	<.001		

The results from the regression provided preliminary results of significant persistence predictors. Discriminant analyses were then run to confirm or deny the findings for Black males in STEM in particular.

In the discriminant analysis, the data was partitioned based on three characteristics into eight groups: persistence result, STEM major, and gender. The analysis was run on all Black students (who fell into one of the eight categories). However, the focus of this

study was on the differences between two of the groups: Black males in STEM who persisted to year 2 and Black males in STEM who did not persist.

4. Results

4.1 Logistic Regression

The logistic regression model based on three factors was statistically significant ($\chi^2(3) = 62.64$, p-value <.0001) with three factors emerging as significant predictors of first-year persistence for Black students.

The factor that explained the most variability is the *Loan Support* factor. The positive coefficient in front of this term in the logistic regression suggests that Black students who obtain loan support are more likely to persist to the next year than those that do not receive loan support. The factor that explains most of the remaining variability in the data after accounting for loan support is the *Finances* factor. The positive coefficient for this factor suggests that Black students with high financial need are also more likely to persist. These students are typically those with low socioeconomic status who receive need-based aid including grants. Finally, the logistic regression suggests that students with high academic and social integration are more likely to persist than those with low campus integration. It is noteworthy to mention that the Loan Support factor emerged as the most important predictor of Black student persistence among other terms known to be associated with persistence including academic preparation, college intensity, and institution type. Would this still hold true for the much smaller group of Black males majoring in STEM?

4.2 Discriminant Analysis

The six PCA factors were used to discriminate between males and females who persisted and those who did not, those who majored in STEM and those that did not. Three factors emerged as significant in discriminating between the groups (table 5).

Table 5: Discriminant Analysis

Canonical Correlation		Eigenvalues of Inv(E)*H			Ho: The canonical correlations in the current row and all that follow are zero			
		Eigen value	*Prop.*	*Cum.*	*Likelihood Ratio*	*Approx F*	*DF*	*P-value*
1	0.188	0.0368	0.4404	0.4404	0.9208	4.38	(48, 12433)	<.0001
2	0.162	0.0269	0.3217	0.7621	0.9547	3.37	(35, 10633)	<.0001
3	0.116	0.0137	0.1634	0.9255	0.9804	2.09	(24, 8820.3)	0.0014
4	0.065	0.0042	0.0507	0.9762	0.9938	1.05	(15, 6981.9)	0.3985
5	0.044	0.0019	0.0229	0.9990	0.9980	0.63	(8, 5060)	0.7533
6	0.009	0.0001	0.0010	1.0000	0.9999	0.07	(3, 2531)	0.9770

Discriminant function 1 is associated with Institution Type (PCA Factor 6). Function 2 is positively associated with Loan Support (Factor 3) and Financial Need (Factor 1) while Discriminant function 3 is positively associated with Loan Support and Campus Integration and negatively associated with financial need (see table 6). It appears therefore that discriminant functions 2 and 3 separate students with high financial need from those with low financial need.

Table 6: Discriminant Analysis

	Pooled Within Canonical Structure		
PCA Factors	*Function 1*	*Function 2*	*Function 3*
Financial Need	0.053	0.665	-0.648
College Intensity	0.185	0.099	0.040
Loan Support	-0.175	0.716	0.489
Academic Preparation	-0.117	-0.025	0.240
Campus Integration	-0.116	0.131	0.489
Institution Type	0.949	0.090	0.213

The group means on each of the significant discriminant functions are provided in Table 7. The discriminant analysis was not able to differentiate groups based on the first function which is related to sixth principal component, institution type. This is because all of the 80 Black males who majored in STEM attended a 4-year institution that was not a Historically Black Colleges and Universities (HBCU), the two variables that loaded significantly on the sixth principal component. Having said this, the first function is useful in discriminating between most STEM groups (centered near -0.7), non-STEM groups (centered near |0.1|), and STEM females who did not persist (centered at 0.4).

Table 7: Group Means

Group	*Function 1*	*Function 2*	*Function 3*
STEM, Male, Persist	-0.728	-0.076	-0.075
STEM, Male, No Persist	-0.690	-0.907	-0.192

The second discriminant function is associated with loan support and financial need. A positive value of Function 2 indicates more loan support and more financial need. A negative value of Function 2 indicates low dependence on loans and grants and a higher socioeconomic status. Black males that do not persist to year 2 on average are substantially more negative on function 2 than those that do persist suggesting that those that do persist have more financial need and secure more loans. This finding is identical to the logistic regression finding that both loan support and financial need are positively associated with persistence for Black students overall.

The third discriminant function associates loan support and financial need with campus integration. Positive values on Function 3 indicate higher socioeconomic status with higher levels of loan support and campus integration. As shown in Table 7, Black males that do not persist to year 2 on average are more negative on function 3 than those that do persist. The combined analysis of functions 2 or 3 suggest that need-based grant aid can be associated with more or less persistence. The sign of the association may be mitigated or controlled by the amount of campus integration a particular Black male student has.

Indeed, there seems to be two distinct types of Black male students that do not persist in STEM: ones with low dependence on loans and grants and a higher socioeconomic status and those of lower socioeconomic status who have been awarded more need-based grant aid and less loan support, and have less academic and social integration on campus.

Table 8 provides the mean values of Black male respondents to the BPS 04/09 who were majoring in STEM. The data seems to support the discriminant analysis conclusions: Those that persisted to year 2 received more and larger grants and loans, more need-based aid, had a lower socioeconomic status, and had a higher campus integration than those respondents that did not persist.

Table 8: Mean Values in the Dataset

Black Males in STEM	*Persist*	*Did Not Persist*
TOTGRT	$1,273 (mean)	$372 (mean)
	$112.50 (median)	$0 (median)
NEEDAID	$1,017.03 (mean)	$222.73 (mean)
	$0 (median)	$0 (median)
PCTALL	48.8th percentile	61.8th percentile
LOANRATIO2	22.5% (includes all)	0% (includes all)
	72.3% (w/ loans only)	0% (w/loans only)
TOTLOAN	$636 (includes all)	$0 (includes all)
	$2,914.57 (w/ loans only)	$0 (w/ loans only)
ACAINX04	51.32	33.07
SOCINX04	19.01	9.04

4.3 Discriminant Analysis - Finances

The first PCA function, *Financial Need*, is associated with the two functions that can discriminate between Black males majoring in STEM who persist to year 2 and those that do not. This factor loads positively onto the second discriminant function and negatively on the third discriminant function. In addition, those that persisted on average were more positive on both functions than those that did not. This seems to suggest that financial need (as measured by the total amount of grants and need-based aid received) can be associated with **more** or **less** persistence. The sign of the association may be mitigated or controlled by the amount of campus integration a particular Black male student has.

To test whether or not campus integration moderates the association between financial need and persistence, another discriminant analysis was conducted. Six finance related variables (percent of grants and loans received that are grants, total merit only grants, total need-based grant aid, total grants received, total student loans received, and ratio of loans to total aid) and the campus integration factor were used to discriminate between the eight persistence-gender-STEM groups. Two discriminant functions (table 9) were shown to distinguish between the groups.

Table 9: Discriminant Analysis - Finances

Canonical Correlation		*Eigenvalues of Inv(E)*H*			*Ho: The canonical correlations in the current row and all that follow are zero*			
		Eigenvalue	*Prop.*	*Cum.*	*Likelihood Ratio*	*Approx F*	*DF*	*P-value*
1	0.324	0.1172	0.7426	0.7426	0.8598	6.91	(56, 13603)	<.0001
2	0.152	0.0237	0.1505	0.8931	0.9606	2.43	(42, 11851)	<.0001
3	0.114	0.0132	0.0835	0.9766	0.9834	1.42	(30, 10110)	0.0652
4	0.043	0.0018	0.0117	0.9883	0.9963	0.47	(20, 8385.4)	0.9786
5	0.037	0.0014	0.0088	0.9971	0.9982	0.39	(12, 6691.4)	0.9681
6	0.016	0.0003	0.0017	0.9988	0.9995	0.19	(6, 5060)	0.9794

The loan ratio variable positively loaded onto the first function (correlation = 0.584). The total need-based grant aid (r = 0.811), total grants (r = 0.704), and total loans (r = 0.578) terms positively loaded onto the second function. Campus integration (r = 0.702) positively loaded onto the non-significant third function while the percent of grants and loans received that are grants negatively loaded (r = -0.628) onto that third function. These results suggest that campus integration does not really modulate the effect of financial aid on persistence.

In addition, the results suggest that non-persisters tend to have a smaller loan-to-total aid ratios than persisters. On the other hand, persisters have substantially more grants and loans than non-persisters. They also receive more need-based aid than non-persisters. It is interesting to note that the ratio of loan-to total aid is more useful in predicting persistence then either the total amount of grants or the total amount of loans. Ironically, neither the amount of merit aid received nor the percent of grants and loans received that are grants discriminated between Black STEM male persisters and non-persisters.

5. Discussion and Conclusion

This study attempted to determine the leading factors associated with first-year persistence of Black students. There is currently no consensus in literature as to the primary causes of attrition and/or persistence and attainment for this group. Various factors have been proposed including academic preparation, campus integration, finances, and institution type.

Even after accounting for various hypothesized factors including institution type, campus integration, academic preparation, loan support, financial need, and college intensity, the results of a logistic regression show that loan support is most associated with persistence for Black students. Generally speaking, Black students who get loans are more likely to persist to the second year of postgraduate studies than those that do not get loans. A further analysis using a discriminant analysis showed that loan support can differentiate between those Black males who major in STEM and persist from those that do not persist.

The second most important factor, after accounting for the variability explained by the loan support factor, was the financial need factor. Students who received need-based aid and grants who were of lower socioeconomic status were more likely to persist than those of higher SES status that did not secure need-based grant aid.

Campus integration is also positively associated with persistence for Black students. Those with high levels of academic and social integration are more likely to persist than those with lower levels of integration. Campus integration does not moderate the association between financial need and persistence. Rather, it accounts for its own unique amount of variability in the persistence variable.

Despite including several variables that were hypothesized to be associated with STEM, with Blacks, and/or with male persistence, the factors involving financial-related variables stood out as the most important factors in predicting persistence. It is clear that even after accounting for the various hypothesized predictors, the finance related terms has more predictive power than academic preparation or academic or social integration.

5.1 Results in Context of the Literature

This study supports St. John, Kirshstein, and Noell (1991) that found that "with a range of background and college experience variables taken into account, financial aid exerts a positive effect on college persistence. Loans as well as grants and work significantly affected persistence." It also provides additional support for Maltese and Tai (2011)'s assertion that "students involved in loan programs or work-study were no less likely to complete a degree in STEM…". Accordingly, it may be the case that participating in loan programs may be imperative for some Black students to persist to year 2. Students from lower socioeconomic status whose families cannot financial support them in college may rely on loans to pay for living expenses, including tuition and fees. However, after earning high grades the first year, these students may be picked up by Honors Colleges and have their tuition waived, thereby reducing their reliance on loans going forward. Another set of students who could be influenced by loans are first year students. These students may not have the capital or know-how to navigate the financial aid process. As a result, they may be unaware of or fail to timely apply for grants and scholarships that can offset the cost of attendance. However, by the second year, after interaction with administration, advisors, faculty and other students, these students may become more aware of the available opportunities and apply for support the following year.

Spruill (2014) was only able to explain 15% of variability in regards to persistence after considering race, parental, and peer factors, SES, and high school ability. However, adding financial aid terms should increase the amount of explainable variability since it is a major factor in understanding the persistence of Black students. Finally, this study also supports Maltese and Tai (2011) assertion that "neither race, gender, nor SES had a significant association with earning a degree in STEM." In the present study, neither institution type, nor academic preparation nor college intensity were useful in predicting persistence for Black students overall after accounting for finance-related predictors. Only campus integration was useful. However, with the shift towards much more online education, this campus integration is likely to not be significant in the very near future.

5.2 Limitations

There are a number of limitations to this study. For one, the results are based on mean-imputed data. It is not known if the mean was the optimal statistic to impute. No doubt that the results presented here would have been different if the median or some other percentile was imputed instead (or if no imputation was done at all). Similarly, the analysis was done on the unweighted data. If the weight was taken into consideration, many of the Black respondents' information would not have been included because they had non-positive weights. Using the weighted data would have also skewed the results reported here.

Secondly, the analyses were based off of 17 pre-selected variables believed to operationalize six theoretical constructs. If other variables were selected, then it is possible that the variables loading onto the principal components could have shifted thereby altering the interpretation of the principal components and the logistic regression and discriminant analysis based on the principal factors.

Thirdly, the results presented here are based on the performance of principal components, which are themselves linear combinations of variables. All variables load onto every principal component to some degree. As such, each principal component is itself a mixture of variables. Perhaps the analysis would have been slightly (or radically) different if the original variables were used as inputs instead.

Finally, this study used data from students who began their postsecondary education in 2003-2004 school year. At that time, nearly every college course was taught in a brick and mortar building. With the advent of the internet, online education became possible. With the advent of faster computers that could hold larger amounts of data, mobile devices, and tablets, online education became more practical. It is possible, therefore, that in the near future, the campus integration factor which played a major role in this study may not be significant in studies using more recent data.

5.3 Next Steps

This study attempted to understand persistence of Black students from freshman to sophomore year. Additional research needs to be done to investigate persistence factors from sophomore to junior year and from junior to senior year. Only when those are understood can researchers truly understand the factors associated with degree attainment.

Similar analyses should be performed on a more recent dataset to ensure validity and sustainability of the findings here. It is quite possible that the advent of the internet and online education has a stronger association with persistence than campus integration. Many online students have no personal interactions with their professors or faculty and do not participate in on-campus social events. In this new climate, is social integration and academic integration really necessary?

Finally, this study focused on Blacks and particularly Black males in STEM. It would be informative to repeat the analysis with other minority groups, including Hispanics and Native Americans. It would also be informative to compare the predictors of Black students' persistence with those of non-Black students (especially to Whites, Asians, and Hispanics).

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