Non-cognitive Associations with Academic Achievement for First-Year Engineering and Computer Science Students at an HBCU

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Abstract - Our study is a replication of the Tracey and Sedlacek study that demonstrated non-cognitive attributes (such as self-concept and realistic selfappraisal) to be predictive of collegiate academic achievement and retention for black and white students, with more of the non-cognitive variables being significant for black student retention than whites. Tracey and Sedlacek's work is based on a survey of students from across academic majors at a large, northeastern public university. Our investigation at a Historically Black University sought to determine the relationship between noncognitive attributes, retention, and academic achievement within the undergraduate engineering and computer science disciplines. Tracey and Sedlacek's 23-item Non-Cognitive Ouestionnaire measured self-concept, realistic self-appraisal, racism understanding and response, long-range goal preferences, strong support person availability, successful leadership experience, community involvement, and nontraditional knowledge acquired in the field. Results are reported on 108 FTIC US citizen and permanent resident engineering and computer science HBCU students. The majority of the surveyed students self-identified as African American/Black (90.7%, n = 98), male (59.3%, n = 64), ages ranging from 16 to 22 years, with an average age of 18 (61.1%, n = 66). None of non-cognitive attributes was associated with retention, determined by correlational analysis. However, self-concept showed positive, but small associations with second, third, and fifth semester GPAs for the students. Non-traditional knowledge acquired through life experiences showed positive but small associations with second through fourth semester GPA. Implications of using non-cognitive attributes in providing support to minority engineering students are discussed.

Index Terms – Attrition, Academic Achievement, Non-cognitive variables, Retention.

INTRODUCTION

Given the persistent problem with attrition in undergraduate engineering degree programs, engineering colleges and universities have directed efforts at providing support to students to encourage retention. Research shows that students typically drop out from engineering programs within the first two years, due to difficulties coping with the academic rigor of the programs, lack of financial support, and experiencing unfriendly engineering departmental climates [1]. As a result, engineering colleges and universities have employed methods such as providing increasing mentorship. faculty-student research opportunities, and providing tutoring and other academic support programs, particularly for underrepresented students such as women and students of color [2]-[3].

The impact of high school GPAs and standardized test scores in predicting student retention in college is well established in the literature [4]-[5]. To address retention challenges in undergraduate education for students of color, some researchers have focused on assessing student characteristics other than academic achievement to determine their effects on students' successful matriculation through their undergraduate education. For example, Tracey and Sedlacek suggested that non-cognitive variables, such as having a positive self-concept, realistic selfappraisal, an understanding of and coping mechanism for racism, a preference for long-range goals, the availability of a strong support person, successful leadership experience, community involvement, and nontraditional knowledge acquired in the field were important predictors of retention for students of color

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[6]. Based on a survey of students from across academic majors at a large, northeastern public university, these researchers demonstrated that noncognitive attributes (such as self-concept and realistic self-appraisal) were predictive of collegiate academic achievement and retention for black and white freshman students, with more of the non-cognitive variables being significant for black student retention than for that of whites [6].

Given these findings, Sedlacek and colleagues advocated for the use of non-cognitive indicators in college admissions processes as a fairer assessment of students' abilities to succeed in college, particularly when assessing students of color. Many colleges and universities have since adopted the use of non-cognitive indicators in their assessment [7]-[10]. This practice in higher education admissions has potential implications for the retention of students of color in fields like engineering, where attrition is high. The rationale behind conducting this study was to uncover which non-cognitive variables were more indicative of academic success and retention for first-year students majoring in engineering at an HBCU, so as to ascertain how the college could invest resources into the development of such students. To assess the potential impact of using non-cognitive variables in admissions processes with students of color in engineering, this study was undertaken to answer the research question, "What is the relationship between non-cognitive variables and academic achievement and retention?" Tracey and Sedlacek's work is based on a survey of students across many academic majors at a large, northeastern public university. Our investigation at a Historically Black University (HBCU) sought to determine the relationship between non-cognitive attributes, retention, and academic achievement within the undergraduate engineering and computer science disciplines.

METHOD

Participants

The original sample consisted of 149 freshman engineering and computer science students at a mid-Atlantic HBCU. However, this report is limited to data analyzed from a sample of 108 first time in college (FTIC), U.S. citizen and permanent resident, engineering and computer science students. This approach was taken in order to interpret results based on U.S. students, since the non-cognitive variables may operate differentially with academic achievement and retention for international students [11]. The majority

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of the sample identified as African American/Black (90.7%, n = 98) and male (59.3%, n = 64), with ages ranging from 16 to 22 years and an average age of 18 (61.1%, n = 66). The majority of the sample consisted of chemical and mechanical engineering majors (50.5%, n = 57). Table 1 provides more details about the sample characteristics.

TABLE 1

SAMPLE CHARACTERISTICS FOR FRESHMEN IN YEAR 2013

Characte	ristic	n	%	
Gender				
	Men	64	59.3	
	Women	44	40.7	
Race				
	African American/ Black	98	90.7	
	Hispanic/Latin-American	1	.9	
	Multi-racial	7	6.5	
	Other	2	1.9	
Age				
0	16 - 17	25	23.2	
	18 - 19	78	72.2	
	20-22	5	4.6	
Major				
0	Chemical Engineering	20	21.5	
	Mechanical Engineering	27	29	
	Civil Engineering	9	9.7	
	Electrical Engineering	10	10.8	
	Computer Engineering	9	9.7	
	Systems & Computer Science	18	19.4	
	-			

Instrument

The Non-Cognitive Questionnaire (NCQ) was administered to the sample. The NCQ was developed to assess non-traditional predictors of academic achievement in underrepresented groups in higher education [6], [8]-[11]. The NCQ is a 23-item instrument, consisting of 18 Likert scale questions (1 =Strongly Disagree, 5 = Strongly Agree) that measure expectations and self-evaluations, two nominal items about educational expectations, three open-ended questions about current previous goals, accomplishments, and previous leadership positions. Items were scored according to the developers' rubric to create 8 non-cognitive variables that were found to predict retention of black students at a large northeastern public university. These variables are positive self-concept, realistic self-appraisal, understands and deals with racism, prefers long-range goals, availability of a strong support person, successful leadership experience, community involvement, and

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nontraditional knowledge acquired in the field [6], [8]-[11].

Procedure

At the beginning of the fall 2013 semester, 149 engineering and computer science freshmen were surveyed as part of a pre-assessment of student attributes, skills, and, self and engineering perceptions in an introductory engineering course. Questions from the entire NCQ were included. University records were subsequently retrieved on their academic achievement (GPA from the second through fifth semesters) and retention in the second and third academic years. Data were then analyzed using the Statistical Package for the Social Sciences software (SPSS).

RESULTS

Descriptive Analysis

Of the sample of 108 students, 98.1 % (n=106) were enrolled in the second year (2014), and 69.4% (n=75) were enrolled in the third year (2015). The average GPA across semesters was 2.8. The lowest average ratings on the non-cognitive variables came from nontraditional knowledge acquired in the field (M = 4, SD = .94), and the highest mean ratings were from the positive self-concept variable (M = 13.6, SD = 2.22). Table 2 provides the means and standard deviations for GPA across the semesters as well as for student ratings on the non-cognitive variables.

TABLE 2

MEANS AND STANDARD DEVIATIONS FOR GPA AND NON-COGNITIVE VARIABLES

Variable	п	М	SD
Academic Achievement (GPA)			
Second Semester	93	2.8	.89
Third Semester	93	2.8	.76
Fourth Semester	93	2.9	.69
Fifth Semester	73	2.8	.60
Non-Cognitive			
Positive Self-Concept	108	13.6	2.22
Realistic Self-Appraisal	108	6.4	1.33
Deals with Racism	108	11.4	2.31
Prefers Long Range Goals	108	6.3	1.51
Availability of a Strong Support	108	8	.90
Person			
Successful Leadership	108	6.6	1.59
Experience			
Demonstrated Community	108	5	.99
Service			
Knowledge Acquired in the	108	4	.94
Field			

Correlational Analysis

In terms of the study's research question, the correlational analysis revealed no significant relationships with the non-cognitive variables and retention. However, two non-cognitive variables were significantly correlated with academic achievement. Specifically, positive self-concept showed positive, but small associations with second, third, and fifth semester GPAs for engineering students. Additionally, nontraditional knowledge acquired in the field showed positive, but small associations with second through fourth semester GPA. Table 3 contains the results of the correlational analysis of the bivariate relationships among study variables.

TABLE 3

BIVARIATE CORRELATIONS AMONG GPA, RETENTION, AND NON-CONITIVE VARIABLES

Variables	Correlations													
2nd Semester GPA	1	2 .997**	3 .862**	4 .802**	5 134	6 .420**	7 .281°	8 .241°	9 012	10 .209	11 002	12 .056	13 088	14 .059
3rd Semester GPA			.865**	.809**		.367**	.285*	.161	.062	.168	.098	.076	105	.076
4th Semester GPA				.871**		.501**	.192	.051	006	.011	.073	.059	053	072
5th Semester GPA					.021	.085	.357**	.127	.055	.043	.125	.034	008	.079
Ind Year Retention						.186	019	055	026	119	020	046	035	065
3rd Year Retention							049	.019	103	130	044	.009	.038	086
Positive Self-Concept								.173	.153	.190	.120	.167	.019	.135
Realistic Self-									.233*	.231°	083	.075	.118	126
Deals with Racism										.259*	.121	.178	.164	028
Prefers Long Range											.136	.431**	.212	058
Availability of a												.201	.044	.192
Successful Leadership													.425**	218
Community olvement Knowledge Acquired														138

Note: ****** significant at the .01 level (2-tailed); ***** significant at the .05 level (2-tailed)

DISCUSSION AND CONCLUSIONS

Since students of color, who generally score lower than white students on standardized tests, are disadvantaged in the college admissions process where these tests are required, the use of other indicators of college success is particularly important for ensuring that underrepresented groups of students have access to higher education [8]-[10]. Within the larger context of the United States' mission of increasing and diversifying the STEM workforce, the selection of underrepresented students who are likely to succeed in STEM undergraduate education is imperative. Moreover, given what is known about the strong academic basis of attrition in engineering, it is imperative that universities continue to provide academic support to their students and encourage successful matriculation through such programs [1].

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Therefore, the use of alternative criteria in the admissions process for engineering students of color would be advantageous, as this would enable colleges and universities to better supply the STEM workforce with diverse students. HBCUs supply a large number of African Americans to the STEM workforce, so it important that they attract students who are likely to succeed [12]. It is equally important that HBCUs and other universities employ support programs for students of color within their first two years of the engineering program, as these two years are critical for their retention.

The results suggest that the knowledge black engineering and computer science students gain from their precollege extracurricular experiences may contribute to higher collegiate academic achievement. However, caution should be taken with this interpretation since the correlations were not strong. Likewise, this study's findings do minimally (with positive but small correlations) support the literature on the positive relationship between self-concept and achievement. Higher self-concept or beliefs in one's abilities to succeed in specific domains is generally associated with higher GPAs [4]. An issue related to the salience of the positive relationship between selfconcept and GPA along with no significant relationship between non-cognitive variables and retention could be that students who may have difficulties with the academic rigor of the program may be more likely to transfer to non-STEM majors. If they feel that their academic standing would be threatened by remaining in engineering, they may transfer to majors where they perceive less difficulty or feel more competent. Some researchers have demonstrated that academic underpreparation or difficulty is one of the main reasons for student attrition in engineering [1]. An implication of this is that university intervention programs could impact their students' retention rates by incorporating programs that promote and support high self-concept amongst engineering students within the first two years of college.

The overall findings of our study suggest that the non-cognitive variables that were utilized may not be the best indicators of retention for African American students at an HBCU. However, based on a metaanalysis of studies that utilized the NCQ showing similar results, some researchers suggested that the issue resides with the NCQ instrument [7]. In other words, the non-cognitive variables may have the potential to provide useful predictions about the academic achievement and retention of college students if better measures of these variables are used. Their analysis demonstrated a lack of strong support for the validity and reliability of the NCQ scales, and they suggested that researchers desist from utilizing the instrument. This suggests that future research moves in the direction of developing more precise measures of the non-cognitive variables in studies that examine their relationship with retention in an effort to demonstrate statistical significance. Caution is advised about dismissing the non-cognitive variables from the admissions process, however, as universities have reported some practical success with including noncognitive considerations, particularly in its impact with admitting successful students from underrepresented groups [8]-[10].

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