

**Factors that Affect Grade Point Average and Retention Status
of First-Time Science, Engineering, and Mathematics Students
at Morgan State University, an Historically Black University**

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Abstract

Many colleges conduct summer bridge programs to prepare incoming freshmen for matriculation into their institutions. From 1994 to 1998 Morgan State University (MSU) conducted two summer bridge programs for science, engineering, and math (SEM) students, *The Alliance for Minority Participation Math Bridge Program* and *The National Aeronautical Space Administration Morgan Engineering Enrichment Program*. This study examined the effects these programs and other factors had on students' academic performance and retention in SEM during the first year of college.

This study tested five hypotheses that state attending a summer bridge program is a predictor of first year academic performance and retention in SEM, after high school grade point average (GPA), total Scholastic Aptitude Test (SAT) score, and gender are controlled.

This causal-comparative descriptive study had a correlational design. A sample of 500 first-time MSU SEM freshmen was randomly selected and their first year academic records were analyzed. Hierarchical linear regression and hierarchical binary logistic regression models were used to test the hypotheses.

The data analysis did not support the five hypotheses, except for engineering students where attendance at a SEM summer bridge program predicts second semester GPA. But, participants of the bridge programs performed better academically and were retained in SEM at higher rates than non-participants, and 70% of the participants of one program recommended it for other students. High school GPA and total SAT score were found to be predictors of first-year college GPA. High school GPA and first-year college GPA were found to be predictors of retention in SEM for the first year of college. In addition, although females performed better academically than males, they were retained in SEM at identical rates. High school GPA was negatively related to retention in SEM.

Introduction

African Americans, Hispanics, and Native Americans, as minority groups in the United States, are underrepresented in the fields of science, engineering, and mathematics (SEM).¹ Reasons why minorities are underrepresented in SEM stem from a history of oppression, unequal education, and unequal career opportunities.² However, as the United States moves into the twenty-first century, industry leaders recognize that this country must develop all of its technical talent if it is to remain competitive in the global economy.

Since the early 1970s many government and private initiatives have focused on increasing the number of SEM college graduates from underrepresented groups.³ One of the strategies encouraged in these initiatives is the use of summer bridge or transition programs designed to help students successfully make the transition from high school to college.⁴ For more than ten years Morgan State University (MSU) has offered summer bridge programs. MSU is one of several Historically Black Colleges and Universities (HBCUs) that continue to play a significant role in increasing the number of African Americans who successfully obtain degrees and establish careers in SEM.⁵ HBCUs are institutions of higher education founded before 1965 with a primary mission of providing higher education access and opportunities to African-Americans.⁶

MSU conducted two SEM bridge programs during the summers 1994 to 1998. This dissertation study analyzed the academic records of SEM students who entered MSU as first-

¹Alexander Astin, Minorities in American Higher Education (New York: Jossey-Bass, 1980), 52-69, 178; Report of the Planning Commission for Expanding Minority Opportunities in Engineering, Minorities in Engineering: A Blueprint for Action, by Louis Padulo, chairman, (New York: Alfred P. Sloan Foundation, 1974), 1.

²J. U. Ogbu, Minority Education and Caste: The American System in Cross-Cultural Perspective (New York: Academic Press, 1978), 101-147; Brenda Hart McAnulty and Carol Alf O'Connor, "The Experience of Black Engineering Graduates," Journal of College Student Personnel 28 (1987): 546-547.

³Astin, Minorities in American Higher Education, 113-128; Report of the Planning Commission for Expanding Minority Opportunities in Engineering, 127-146; McAnulty and O'Connor, "The Experience of Black Engineering Graduates," 546.

⁴Janet Mancini Billson and Margaret Brooks Terry, "A Student Retention Model for Higher Education," College and University 62 (Summer 1987): 295; Ron Simmons, "Precollege Programs: A Contributing Factor to University Student Retention," Journal of Developmental Education 17 (Spring 1994): 43-44; Ellen R. Robert and Gregg Thomson, "Learning Assistance and the Success of Underrepresented Students at Berkeley," Journal of Developmental Education 17 (Spring 1994): 10.

⁵Eugene M. DeLoatch, "What are the HBCU's?" in Maintaining a Technological Edge Through Diversity and Academic Excellence: Meeting of the Council of Engineering Deans of the Historically Black Colleges Universities and Top Fortune 100 Industrial Corporations Held in Abbott Park, Illinois 10 August 1992, 7.

⁶DeLoatch, "What are the HBCU's?", 6.

time freshman in the fall semesters during the interval of 1994 to 1998 to determine if attendance at a SEM summer bridge program would be a significant predictor of academic performance and retention status in SEM after the first and second semesters of college. The results of the study identify and describe factors relating to the successful production of underrepresented minorities in SEM at an HBCU.

Research Questions

The research questions that were hypothesized in this study are:

1. Is attendance at a SEM summer bridge program a significant predictor of academic performance (GPA) after the first and second semesters of college for SEM students at MSU, after high school GPA, total SAT score, and gender are controlled?
2. Is attendance at a SEM summer bridge program a significant predictor of retention in SEM status after the first and second semesters of college for SEM students at MSU, after high school GPA, total SAT score, and gender?

Secondary questions addressed include:

3. Are the following variables significant predictors of academic performance (GPA) after the first and second semesters of college for SEM students at MSU?
 - a) High School GPA
 - b) Total SAT score
 - c) Gender
4. Are the following variables significant predictors of retention in SEM status after the first and second semester of college of SEM students at MSU?
 - a) High School GPA
 - b) Total SAT score
 - c) Gender
 - d) First semester GPA (for retention in SEM status after first semester)
 - e) Cumulative GPA after the second semester (for retention in SEM status after second semester)

For purposes of analysis, SEM majors were divided into three groups: Life Sciences (biology, medical technology), Physical Sciences (chemistry, physics, engineering physics, computer science, and mathematics), and Engineering (civil engineering, electrical engineering, and industrial engineering).

Student Academic Performance and Retention in College

The subject of student attrition in higher education has been extensively studied. There are three recognized comprehensive theories or models that attempt to explain student persistence and attrition. They are Spady's Explanatory Sociological Model of the Dropout

Process,⁷ Tinto's Longitudinal Model of Dropout that he first proposed in 1975 and updated in 1987,⁸ and Bean's Conceptual Model of Nontraditional Undergraduate Student Attrition.⁹ By far, Tinto's model has been most studied and used in trying to understand the phenomenon of student persistence. Tinto hypothesized students persistence in college was largely determined by two factors, academic integration and social integration. Academic integration is measured by academic performance and faculty/staff interactions, and social integration is measured by extracurricular activities and peer-group interactions measure. Other factors, such as family background, individual attributes, and pre-college schooling can also influence students' success in college. Many studies have been undertaken to test the validity of the theoretical models of student attrition proposed by Spady, Tinto, and Bean.¹⁰ For the most part, the findings in these studies have supported much of theory that they set out to test. Most often studies focused on one theory, but some looked at multiple theories at one time and were able to highlight similarities and overlapping conclusions.

Minority Persistence and Graduation Rates in College

In 1982, Astin, in his book about minorities in higher education, reported that all minority groups in the United States were not only underrepresented in higher education but they were increasingly underrepresented at each higher transition point in the higher education system. Starting with graduation from high school and proceeding to completion of professional or graduate schools, minorities accounted for a smaller percentage of the pipeline at each point.¹¹

⁷W. G. Spady, "Dropouts From Higher Education: An Interdisciplinary Review and Synthesis," Interchange 1 (1970): 64-85.

⁸Vincent T. Tinto, "Dropout from Higher Education: A Theoretical Synthesis of Recent Research," Review of Educational Research 45, no. 1 (1975): 84-137.

⁹John P. Bean and Barbara S. Metzner, "A Conceptual Model of Nontraditional Undergraduate Student Attrition," Review of Educational Research 55, no. 4 (Winter 1985): 485-540.

¹⁰Ernest T. Pascarella and Patrick T. Terenzini, "Interaction Effects in Spady's and Tinto's Conceptual Models of College Dropout," Sociology of Education 52, no. 4 (1979): 197-210; Patrick T. Terenzini and Ernest T. Pascarella, "Toward the Validation of Tinto's Model of College Student Attrition: A Review of Recent Studies," Research in Higher Education 12, no. 3 (1980): 271-282; Ernest T. Pascarella and David Chapman, "A Multi-institutional, Path Analytic Validation of Tinto's Model for College Withdrawal," American Educational Research Journal 20, no. 1 (1983): 87-102; David Chapman and Ernest T. Pascarella, "Predictors of Academic and Social Integration of College Students," Research in Higher Education 19, no. 3 (1983): 295-322; Patrick O. Terenzini and Ernest T. Pascarella, "Voluntary Freshman Attrition and Patterns of Social and Academic Integration in a University: A Test of a Conceptual Model," Research in Higher Education 6, (1977): 25-43; Shelley B. Getzalaf, Gordon M. Sedlacek, Kathleen A. Kearny, and Jane M. Blackwell, "Two Types of Voluntary Undergraduate Attrition," Research in Higher Education 20, no. 3 (1984): 257-268; Alberto F. Cabrera, Maria B. Castañeda, Amaury Nora, and Dennis Hengstler, "The Convergence Between Two Theories of College Persistence," Journal of Higher Education 63, no. 2 (March/April 1992): 143-164; Alberto F. Cabrera, Amaury Nora, and Maria B. Castañeda, "College Persistence: Structural Equations Modeling of Student Retention," Journal of Higher Education 64, no. 2 (March/April 1993): 123-139.

¹¹Astin, Minorities in American Higher Education, 51.

Tinto also documented that minority students graduated from college at lower rates than white students do. Like Astin, he also noted that minorities enter college at lower rates. In 1990, the percentage of African Americans and Hispanics who entered four-year colleges immediately after high school and earned bachelor degrees within six years were 25.8% and 25.3% respectively, well below the 48.8% for white students. He also documented that a similar pattern exists when comparing minority students to white students in regards to persistence.¹²

The underrepresentation of minorities is not evenly distributed in various fields of study in college. This underrepresentation is most acute in engineering, the physical sciences, and the biological sciences.¹³ In 1970, only 2.8% of engineers in the United States were African American, Mexican American, Puerto Rican, or Native American, even though these minorities were 14.4% of the U.S. population. In 1973, although it was estimated that 5.1% of entering engineering freshmen were from these four minority groups, an increase of nearly 80%, they were still woefully underrepresented.¹⁴

Jackson, in his study of the role of Black Colleges and Universities in producing African-American engineers and scientists, provided additional documentation on the level of underrepresentation of African Americans in these areas. Although African Americans were 11.7% of the U.S. population in 1978-1979, they were less than 2% of the engineers and scientists at all degree levels. To achieve parity with whites, Jackson estimated that the number African-American undergraduate degrees would have to increase by a factor of two to four, and at the Ph.D. level would have to increase by a factor of ten.¹⁵

Noncognitive Variables, Race, Gender and Other Determinants of Academic Success

Historically, lack of academic success has been viewed as largely related to academic dimensions, such as lack of ability and poor study habits. But growing evidence indicates that noncognitive dimensions are as important or more important to academic success than are traditional academic measures, especially for African-American students attending white higher educational institutions. In 1976, Tracey and Brooks hypothesized that for minority students these noncognitive dimensions were more important to academic success and persistence to graduation than traditional measures. They proposed eight noncognitive variables that are related to academic success: (1) positive self-concept, (2) realistic self-appraisal, (3)

¹²Vincent Tinto, *Leaving College: Rethinking the Causes and Cures of Student Attrition*, 2d ed. (Chicago: University of Chicago Press, 1993), 28-33.

¹³Astin, *Minorities in American Higher Education*, 52-76; Report of the Planning Commission for Expanding Minority Opportunities in Engineering, 1-4; William M. Jackson, "Black Colleges and Universities: A National Resource for Black Science and Engineering Manpower," in *Black Colleges and Universities: Challenges for the Future*, ed. Antoine Garibaldi, (New York: Praeger Publishers, 1984) 80-85; Edward N. Prather, "Better Than the SAT: A Study of the Effectiveness of an Extended Bridge Program on the Academic Success of Minority First-Year Engineering Students," (Ed.D. diss., University of Cincinnati, 1996), 27-28.

¹⁴Report of the Planning Commission for Expanding Minority Opportunities in Engineering, 1.

¹⁵Jackson, "Black Colleges and Universities: A National Resource for Black Science and Engineering Manpower," 80-81.

understanding of and an ability to deal with racism, (4) preference for long-term goals over more immediate, short term needs, (5) availability of a strong support person, (6) successful leadership experience, (7) demonstrated community service, and (8) academic familiarity.¹⁶ Tracey and Sedlacek developed a Non-Cognitive Questionnaire (NCQ) to measure these variables, and validated it in predicting graduation after five and six years by race.¹⁷ Part of their motivation for doing so was that the persistence rates for African Americans were much lower than whites, especially at predominantly white institutions. What roles do these non-cognitive variables play at minority institutions, such as HBCUs?

Studies have found that gender and race are also determinants of students' success in college. A study by Nettles and Johnson investigated the effect race and gender had on students' socialization in college."¹⁸ There was evidence of important race and sex differences in the three measures of socialization. According to Tinto's model there is a positive relationship between student social integration and persistence.

Zea, Reisen, Beil and Caplan conducted a study to test the equivalence of models that predicted minority and nonminority students' intentions to remain enrolled in college and found that there were similarities and significant differences in the between ethnic minority and nonminority students in their commitment to remain in college.¹⁹

In 1984, McAnulty and O'Connor reported that African-American and female students reported problems in the classroom due to race and sex.²⁰ They concluded that professors support African-Americans and white students differently in engineering programs.

¹⁶T. J. Tracey and W. E. Sedlacek, "Noncognitive Variables in Predicting Academic Success by Race," Measurement and Evaluation in Guidance 16, no. 4 (1984): 171; T. J. Tracey and W. E. Sedlacek, "The Relationship of Noncognitive Variables to Academic Success: A Longitudinal Comparison by Race," Journal of College Student Personnel 26, no. 4 (1985): 405.

¹⁷ T. J. Tracey and W. E. Sedlacek, "Prediction of College Graduation Using Noncognitive Variables by Race," Measurement and Evaluation in Counseling and Development 19, (1987): 177-184.

¹⁸Michael T. Nettles and Janet R. Johnson, "Race, Sex, and Other Factors as Determinants of College Students' Socialization," Journal of College Student Personnel 28 (1987): 514.

¹⁹Maria C. Zea, Carol A. Reisen, Cheryl Beil, and Robert D. Caplan, "Predicting Intention to Remain in College Among Ethnic Minority and Nonminority Students," Journal of Social Psychology 137, no. 2 (April 1997): 149-160.

²⁰ It is important to note that "although Speed Scientific School was established in 1925, the first Black was not graduated from the school until 1953. Before 1950 there was a law in Kentucky that prohibited the education of Blacks and Whites on the same campus at the same time. Blacks attended Louisville Municipal College (LMC), which opened in 1931 and closed at the end of the 1951 spring semester. Comparable to the University of Louisville's College of Arts and Sciences, LMC did not offer graduate, professional, or engineering classes. Thus, Blacks interested in pursuing careers in engineering were obliged to enroll in out-of-state institutions of higher education." McAnulty and O'Connor, "The Experience of Black Engineering Graduates," 546-551.

In 1987, Jordon-Cox reported the results a study designed to understand the differences in three major developmental areas of African-American students attending three traditionally Black institutions (TBIs) located in a southern city.²¹ The three developmental areas were developing autonomy, developing purpose, and developing mature interpersonal relations. They concluded that women master more developmental behaviors than men do and seniors master more developmental behaviors than freshmen do.

MSU SEM Summer Bridge Programs (1994-1998)

Two summer bridge programs specifically designed for SEM majors were conducted at MSU from 1994 to 1998. They are *The Alliance for Minority Participation Summer Math Bridge Program* (AMP Math Bridge) and *The National Aeronautical Space Administration Morgan Engineering Enrichment Program* (NASA). Each spring semester from 1994 to 1998, invitations and SEM summer bridge program applications were mailed to MSU applicants with intended majors in SEM. For the most part, only applicants that had been accepted for admission to MSU were invited to participate in the SEM summer bridge programs. All students who applied were generally accepted into the programs except when the number of applications exceeded the number of places available. Then based on several criteria, such as SEM major, the dates the applications were received, and the completeness of the applications, a limited number of applicants were accepted.

The two programs had similar goals and structures, but were one week different in duration. Both programs were residential and were offered at no cost to the participants. Both programs had students attend classes in traditional academic subjects, such as math, English, science, and an introduction to computers. Participants took the MSU placement tests and were registered for their fall semester classes. Both programs introduced the students to the realities and expectations of college as compared to high school. Armed with this academic reinforcement and advance orientation to the physical campus and procedures, it was expected that these students would benefit from the experience and have higher levels of social and academic integration, allowing them to perform better academically than if they had not attended these programs.

The AMP Math Bridge was a four-week program where SEM students took academic classes in math, English composition, chemistry, and an introduction to computers. Chemistry was added to this curriculum in 1996. Other time periods were devoted to exploring SEM careers, group study and discussions, study skills development, and field trips. The AMP Math Bridge was aimed at students with math SATs in the range of approximately 470-570 (after SAT score re-centering of 1995).

NASA was designed for engineering students only with relatively high total SAT scores of 1000 or more, and high school GPAs of 3.00 or more. In most cases, these students were ready to take the first courses in Calculus and Physics together, in an accelerated program, when

²¹Carmen A. Jordon-Cox, "Psychosocial Development of Students in Traditionally Black Institutions," *Journal of College Student Personnel* 28 (1987): 504-512.

they matriculated as first semester freshmen. NASA was a five-week program with academic classes almost identical to The AMP Math Bridge, except it had two science classes, chemistry, and physics. Although it was very similar to The AMP Math Bridge program in content, its daily hours of operation were often extended most days of the week.

It is important to note that it was not always possible to restrict participation to students with high school GPAs and SAT scores in the ranges described above. This was due to applicant pools that were too small and an imposed upper twenty percent limit on the number of AMP Math Bridge participants that could be life science majors. If the applicant pools were too small, then just about all applicants were accepted into the programs. Sometimes, when the number of applicants exceeded the number of available places, some applicants within the ideal ranges had to be rejected to avoid violating the twenty-percent limit of life science majors. The program that each student attended was recorded in the data, but was not used in this analysis.

Methodology

From 1994 to 1998, 7,895 SEM students enrolled at MSU. During that time, 1,932 first-time SEM freshmen matriculated into MSU. These students were eligible to apply for one of two summer bridge programs offered. The demographics for this group indicate that 95.2% are African-American, 0.7% are Other Minority, 1.2% are Non-minority, and 2.9% are Other/Unknown. These students are 49.9% male and 50.1% female.

A sample of 500 students was randomly selected from the 1,932 first-time freshmen, well above the estimated required minimum sample size of 120.²² Two hundred sixty (52%) students in the sample were female and 240 (48%) were male. Eighty-one (16.2%) attended a SEM summer bridge program, and 419 (83.8%) did not attend. One hundred fifty-one (30.2%) were majoring in the life sciences, 132 (26.4%) in the physical sciences, and 217 (43.4%) in engineering.

This causal-comparative descriptive study used a correlational research design to analyze the first-year academic performance and retention in SEM status of 500 first-time SEM freshmen that entered MSU from 1994 to 1998. Table 1 lists the variables used in this study. Analysis of the academic records of the 500 students in the sample determined which of these variables were predictors of first year academic performance and retention status in SEM.

²²Meredith D. Gall, Walter R. Borg, and Joyce P. Gall, *Educational Research: An Introduction*, 6th ed. (White Plains, NY: Longman Publishers, Inc., 1996), 229; Barbara G. Tabachnick and Linda S. Fidell, *Using Multivariate Statistics*, 2d ed. (New York: Harper Collins Publishers, 1989), 128-129.

Table 1. Variables Used in the Study

| Symbol | Name | Scale | Values | Type |
|---------|---|----------|---|----------------------------|
| ATTPGM | Attendance at a SEM Summer Bridge Program | Nominal | 1 - attended 0 - did not attend | Independent |
| HSGPA | High School GPA | Ratio | 0.00 - 4.00 ²³ | Control |
| TSAT | Total SAT Score | Interval | 400 - 1600 | Control |
| GENDER | Gender of Student | Nominal | 1 - male 0 - female | Control |
| SEMGRP1 | SEM Major Group | Nominal | 1 - Life Science 2 - Physical Science 3 - Engineering | Used for subgroup analysis |
| GPA1 | MSU First Semester GPA | Ratio | 0.00 - 4.00 | Dependent |
| GPA2 | MSU Second Semester GPA | Ratio | 0.00 - 4.00 | Dependent |
| CUMGPA2 | MSU Cumulative GPA after the Second Semester | Ratio | 0.00 - 4.00 | Dependent |
| SEMRET2 | Retention in SEM Status after the First Semester | Nominal | 1 - Retained 0 - Not retained | Dependent |
| SEMRET3 | Retention in SEM Status after the Second Semester | Nominal | 1 - Retained 0 - Not retained | Dependent |

Statistical Design and Analyses

The statistical analyses were performed using SPSS[®] Release 10.5. All statistical analyses use a level of significance (α) equal to .05.

There were two statistical designs used for the statistical analyses. The first design used hierarchical multiple regression analysis with forced entry of the variables to test the hypothesis that attendance at a SEM summer bridge program (ATTPGM) would be a significant predictor of first semester GPA (GPA1), second semester GPA (GPA2), and cumulative GPA after the second semester (CUMGPA2), after controlling for high school GPA (HSGPA), total SAT score (TSAT), and gender (GENDER). This statistical design technique allows the independent variable of interest to be introduced as the last variable in the prediction model and hence, to determine whether it contributes to a significant difference in explained variance of the dependent variable after differences in all prior explanatory variables are controlled.²⁴ This

²³An individual student's high school GPA can sometime exceed 4.00. This can occur when the numerical grades students earn in honor and advance placement courses are greater than 4.00.

²⁴Tabachnick and Fidell, 141-193.

technique is only valid when the dependent variable is measured on a numerically continuous scale.

The second statistical design used hierarchical binary logistic regression analysis with forced entry of the variables to test the hypothesis that attendance at a SEM summer bridge program (ATTPGM) would be a significant predictor of retention in SEM status after the first and second semesters (SEMRET2 and SEMRET3), after controlling for high school GPA (HSGPA), total SAT score (TSAT), and gender (GENDER). This statistical design technique is very similar in concept to hierarchical multiple regression except the dependent variable of interest is dichotomous. Binary logistic regression techniques calculate a probability (between zero and one) for the dependent variable and then assigns to it one of two values, based on a predetermine threshold value.²⁵ The threshold value for this statistical procedure is equal to 0.5.

In addition to the regression techniques previously described, descriptive statistics for the variables were analyzed and compared for the entire sample and subgroups. Investigating the descriptive data highlighted differences in performance of various subgroups.

Academic Performance

Hypothesis One predicts that ATTPGM is a significant predictor in a regression equation for GPA1 after HSGPA, TSAT, and GENDER are first added to the model. This means that once ATTPGM is added, the resulting R^2 change, also called the semipartial correlation coefficient (sr^2), must be significantly greater than zero.²⁶ Statistically stated, Hypothesis One is:

$$\begin{aligned} H_0: (sr^2)_{ATTPGM} &= 0 \\ H_a: (sr^2)_{ATTPGM} &> 0 \end{aligned}$$

Table 2 displays the correlations between the variables, the unstandardized regression coefficients (B) and the intercept, the standardized regression coefficients (β), the semipartial correlations (sr^2), R , R^2 , and the adjusted R^2 after entry of all control variables and the independent variable. R was significantly different from zero at the end of each step. With all independent variables in the equation, $R=.569$, $F(4, 495)=59.209$, $p<.0005$.²⁷

²⁵Tabachnick and Fidell, 270-272.

²⁶SPSS Inc., SPSS® Base 10.0 Applications Guide (Chicago: SPSS Inc., 1999), 189-230; SPSS Inc., SPSS® Base 10.0 User's Guide (Chicago: SPSS Inc., 1999), 300-308; Tabachnick and Fidell, 141-193.

²⁷ Statistical table design from: Tabachnick and Fidell, 187.

Table 2. Hierarchical Regression of First Semester GPA on Attendance at a SEM Summer Bridge Program

| Variables | GPA1 (DV) | HSGPA | TSAT | GENDER | ATTPGM | B | β | sr^2 (incremental) |
|-----------|-----------|--------|--------|--------|-------------|--------|---------|----------------------|
| HSGPA | 0.485 | | | | | 0.655 | .361 | .236** |
| TSAT | 0.470 | 0.420 | | | | 0.003 | .318 | .086** |
| GENDER | -0.054 | -0.235 | -0.054 | | | 0.095 | .049 | .002 |
| ATTPGM | 0.125 | 0.166 | 0.173 | -.042 | | 0.033 | .012 | .000 |
| | | | | | Intercept = | -1.933 | | |
| Means | 2.529 | 3.012 | 981.84 | 0.48 | 0.16 | | | |
| Std. Dev. | 0.974 | 0.537 | 124.86 | 0.50 | 0.37 | | | |
| | | | | | | | $R^2 =$ | .324 |
| | | | | | | Adj. | $R^2 =$ | .318 |
| | | | | | | | $R =$ | .569** |

**p<.0005.

After the last step, with ATTPGM added to the prediction of GPA1, $R^2=.324$ (adjusted $R^2=.318$), $F_{\text{incremental}}(1, 495) = .109$, and $\text{Sig. F Change}=.742$. Addition of ATTPGM to the GPA1 equation did not significantly improve R^2 and $(sr^2)_{\text{ATTPGM}}$ was not significantly greater than zero. The null hypothesis is not rejected and ATTPGM was determined not to be a predictor of GPA1.

Only HSGPA and TSAT were significant predictors of GPA1. The regression equation for GPA1 is:

$$\text{GPA1} = -1.933 + .655 \text{ HSGPA} + .003 \text{ TSAT}$$

Since the final value of $R^2=.324$, the regression equation for GPA1 predicts 32.4% of the variance of GPA1.²⁸

Similar analyses for the second and third hypotheses regarding academic performance yielded similar results. ATTPGM was found not to be a predictor for GPA2 for the entire sample of students. The regression equation for GPA2 is:

$$\text{GPA2} = -2.229 + .784 \text{ HSGPA} + .002 \text{ TSAT}$$

Since the final value of $R^2=.299$, the regression equation for GPA2 predicts 29.9% of the variance of GPA2.²⁹

²⁸Tabachnick and Fidell, 135; SPSS Inc., *SPSS® Base 10.0 Regression Models* (Chicago, SPSS Inc., 1999), 45.

²⁹Tabachnick and Fidell, 135; SPSS Inc., *SPSS® Regression Models 10.0*, 45.

Although not generally true for SEM first-time freshmen, ATTPGM was found to be a predictor of GPA2 for the subgroup of engineering students. The regression equation GPA2 for engineering students is:

$$\text{GPA2}_{\text{engineer}} = -2.69 + .935 \text{ HSGPA} + .002 \text{ TSAT} + .341 \text{ ATTPGM}$$

Similar analysis of the third hypothesis revealed that ATTPGM is not a predictor of CUMGPA2. The regression equation for CUMGPA2 is:

$$\text{CUMGPA2} = -1.836 + .684 \text{ HSGPA} + .002 \text{ TSAT}$$

The final value of $R^2=.392$, hence the regression equation for CUMGPA2 predicts 39.2% of the variance of CUMGPA2.

Retention Status in SEM

Hypothesis Four predicts that ATTPGM is a significant predictor in a binary logistic regression equation for SEMRET2, after GPA1, HSGPA, TSAT, and GENDER are first added to the model. A method of determining whether ATTPGM is a significant predictor in a binary logistic regression equation for SEMRET2, after GPA1, HSGPA, TSAT, and GENDER are first added to the model is to determine whether the coefficient of ATTPGM, B_{ATTPGM} , is equal to zero. If B_{ATTPGM} is equal to zero, then ATTPGM is not a predictor of the probability of SEMRET2. This can be statistically stated as:

$$\begin{aligned} H_0: B_{\text{ATTPGM}} &= 0 \\ H_a: B_{\text{ATTPGM}} &\neq 0 \end{aligned}$$

The statistical method for testing this hypothesis makes use of the Wald statistic.³⁰ Table 3 displays the estimated coefficients (under the column B), the Wald statistic, and other related statistics for the binary logistic regression model of SEMRET2 after ATTPGM has been added as the last variable. The Wald statistic for ATTPGM is equal to 1.585 and is not significant ($p=0.208$). Hence the null hypothesis, that B_{ATTPGM} is equal to zero, is not rejected, meaning that ATTPGM is not a predictor of SEMRET2.

³⁰SPSS Inc., SPSS® Regression Models 10.0, 39-40.

Table 3. Hierarchical Binary Logistic Model of Retention in SEM Status after the First Semester

| | B | S. E. | Wald | Df | Sig. | Exp(B) | 95.0% C. I. For Exp(B) | |
|----------|--------|-------|--------|----|------|--------|------------------------|-------|
| | | | | | | | Lower | Upper |
| GPA1 | .776 | .187 | 17.218 | 1 | .000 | 2.172 | 1.506 | 3.133 |
| HSGPA | -1.121 | .394 | 8.098 | 1 | .004 | .326 | .151 | .706 |
| TSAT | .003 | .002 | 4.091 | 1 | .043 | 1.003 | 1.000 | 1.007 |
| GENDER | -.182 | .342 | .284 | 1 | .594 | .833 | .427 | 1.628 |
| ATTPGM | .799 | .634 | 1.585 | 1 | .208 | 2.222 | .641 | 7.707 |
| Constant | .713 | 1.638 | .190 | 1 | .663 | 2.040 | | |

(DV) – SEMRET2

Table 3 displays the coefficients for the constant and GPA1, HSGPA, and TSAT, the only significant independent variables in predicting SEMRET2. The binary logistic regression equation for the probability of SEMRET2 is:

$$\text{Probability (SEMRET2)} = \frac{1}{(1+e^{-Z})}$$

where $Z = .713 + .776 \text{ GPA1} - 1.121 \text{ HSGPA} + .003 \text{ TSAT}$. This logistic regression model for SEMRET2 explains 14.2% of its variance.

Analyses performed for the male and female subgroups to see if ATTPGM is a predictor of SEMRET2 for either of these subgroups yielded interested differences. ATTPGM is not a predictor of SEMRET2 for either subgroup, but only TSAT is a significant predictor of SEMRET2 for male students. For male students the binary logistic regression equation for the probability of SEMRET2 is:

$$\text{Probability (SEMRET2}_{\text{Male}}) = \frac{1}{(1+e^{-Z})}$$

where $Z = -1.591 + .006 \text{ TSAT}$.

Only GPA1 and HSGPA are significant predictors of SEMRET2 for female students. For female students the binary logistic regression equation for the probability of SEMRET2 is:

$$\text{Probability (SEMRET2}_{\text{Female}}) = \frac{1}{(1+e^{-Z})}$$

where $Z = 4.457 + 1.296 \text{ GPA1} - 1.699 \text{ HSGPA}$.

There were different predictors for SEMRET2 for each of the subgroups of Life Sciences, Physical Science, and Engineering. The coefficients of each of the variables in these subgroup binary logistic regression equations is summarized Table 4.

Table 4. Hierarchical Binary Logistic Model Coefficients of SEMRET2 for SEM Major Groups

| Group | Constant | GPA1 | HSGPA | TSAT |
|-------------------|----------|-------|--------|-------|
| Life Sciences | 4.091 | 0.997 | 0.0 | 0.0 |
| Physical Sciences | 7.370 | 1.283 | -2.602 | 0.0 |
| Engineering | -5.759 | 0.0 | 0.0 | 0.011 |

An analysis for the fifth hypothesis reveals that ATTPGM is also not a predictor of SEMRET3. Only CUMGPA2 is a significant predictor of SEMRET2. The binary logistic regression equation for the probability of SEMRET3 is:

$$\text{Probability (SEMRET3)} = \frac{1}{(1+e^{-Z})}$$

where $Z = -.2471 + .885 \text{ CUMGPA2}$. This logistic regression model for SEMRET3 explains only 18.8% of its variance.

Analysis of male and female students showed that CUMGPA2 was the lone predictor of SEMRET3 for these two subgroups. The same was true for Life Science and Engineering students, but TSAT was the lone predictor of SEMRET3 for Physical Science Students. These results are summarized in the Table 5.

Table 5. Hierarchical Binary Logistic Model Coefficients of SEMRET3 for Gender and SEM Major Groups

| Subgroup | Constant | CUMGPA2 | TSAT |
|-------------------|----------|---------|-------|
| Male | -2.497 | 0.605 | 0.0 |
| Female | -2.333 | 1.142 | 0.0 |
| Life Sciences | 1.580 | 1.193 | 0.0 |
| Physical Sciences | -7.949 | 0.0 | 0.007 |
| Engineering | -3.140 | 0.990 | 0.0 |

Subgroup Comparisons Using Descriptive Statistics

Descriptive statistics were examined for the entire sample and comparisons were made between SEM summer bridge program participants and non-participants, between male and female, and between life science, physical science and engineering students. Table 6 summarizes the descriptive data for all of the variables for each subgroup.

Table 6. Descriptive Statistics for Subgroups

| Variables | All | Non-Participants | Participants | Male | Female | Life Science | Physical Science | Engineering |
|-----------|-------|------------------|--------------|-------|--------|--------------|------------------|-------------|
| N= | 500 | 419 | 81 | 240 | 260 | 151 | 132 | 217 |
| HSGPA | 3.01 | 2.97 | 3.21 | 2.88 | 3.13 | 3.01 | 3.03 | 3.01 |
| TSAT | 982 | 972 | 1031 | 975 | 988 | 978 | 974 | 989 |
| GPA1 | 2.529 | 2.476 | 2.807 | 2.475 | 2.580 | 2.523 | 2.469 | 2.571 |
| GPA2 | 2.311 | 2.225 | 2.728 | 2.168 | 2.442 | 2.341 | 2.337 | 2.276 |
| CUMGPA2 | 2.510 | 2.443 | 2.835 | 2.388 | 2.623 | 2.553 | 2.484 | 2.497 |
| SEMRET2 | 0.91 | 0.90 | 0.96 | 0.91 | 0.92 | 0.89 | 0.90 | 0.94 |
| SEMRET3 | 0.75 | 0.72 | 0.89 | 0.75 | 0.75 | 0.72 | 0.72 | 0.78 |

Entering SEM freshman had an average high school GPA of 3.01 and an average total SAT score of 982. The average first semester GPA was 2.529, the second 2.311, and the cumulative after the second semester was 2.510. Ninety-one percent of these freshmen were retained in SEM after the first semester and 75% were retained in SEM after the second.

Eighty-one (16.2%) of the freshmen were participants in a SEM summer bridge program. On average, they matriculate into MSU with higher high school GPAs than non-participants did (3.21 versus 2.97) and total SAT scores (1031 versus 972). Participants, on average, performed better academically and were retained in SEM at higher levels at the end of both semesters.

Two hundred-forty (48%) of the freshmen are male and 260 (52%) are female. Female freshmen, on average, matriculated into MSU with higher high school GPAs and total SAT scores. Although females had higher GPAs than the males each semester of the first year of college, they were retained in SEM at virtually identical rates as the males.

One hundred fifty-one (30.2%) of the entering freshmen were Life Science majors, 132 (26.4%) were Physical Science majors, and 217 (43.4%) Engineering majors. All three groups matriculated into MSU with virtually identical high school GPAs. Engineering freshmen had slightly higher total SAT scores than the other two groups, whose scores were almost equal. All three groups exhibited similar academic performance as measured by first and second semester GPAs, but Engineering majors were retained in SEM at slightly higher rates after the first and second semesters than Life and Physical Science majors.

Discussion

The data from this study found that, on average, participants of SEM summer bridge programs had more successful first years in college, but attending a SEM summer bridge program was not a predictor of academic performance (except for engineering majors for the second semester) or retention status in SEM. This result is somewhat mitigated by the following factors. First, most bridge programs compare differences in performance between poorly prepared summer bridge program participants and well prepared college students.³¹ Unlike

³¹Susan Ackerman, "The Benefits of Summer Bridge Programs for Underrepresented and Low-Income
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students in other studies, the participants of the MSU SEM summer bridge programs were average to superior high school students. For the most part, these were not low achieving students who needed intense remedial help and who could benefit the most from attending a bridge program. Second, since SEM summer bridge program participants had superior pre-college academic credentials, it is impossible without additional data to discern to what extent their superior first-year college academic performance and retention in SEM were attributed to attending the bridge programs versus their superior pre-college preparation. The last factor is that during 1994 to 1998, MSU conducted another summer program to provide help to students needing remedial help. No doubt some of these student were helped in improving their first-year academic performance, hence decreasing the difference between themselves the students who attended the SEM summer bridge programs.

Although attendance at a summer bridge program was found statistically not to be predictor of academic performance or retention in SEM status during the first academic year, except for engineering majors, it should not be concluded that they are of no benefit. Over three years, 70% of the participants of the AMP Math Bridge Program thought the program was beneficial and indicated they would recommend it to other entering freshmen.³² This positive evaluation by the participants should not be ignored and " common sense is to be exercised when making distinctions between results that are not statistically significant versus those that are practically important."³³

This study supports the conclusion, well documented in the literature, that high school GPA and SAT scores are the best predictors of college GPA.³⁴ The study's conclusions that first-semester GPA is one of the best predictors of retention in SEM status after the first semester (SEMRET2), and cumulative GPA after the second semester is the best predictor of retention in SEM status after the second semester are strongly supported in the literature by Spady, Tinto, and Bean's theories on retention.³⁵

Students," Community/Junior College Quarterly of Research and Practice 15 (April-June 1991): 201-208; Ron Simmons, "Precollege Programs: A Contributing Factor to University Student Retention," Journal of Developmental Education 17 (Spring 1994): 42-45; Ellen R. Robert and Gregg Thomson, "Learning Assistance and the Success of Underrepresented Students at Berkeley," Journal of Developmental Education 17 (Spring 1994): 4-14; Millicent Roth and Michael Weiner, "A Summer Program for Freshman Science and Engineering Students," in The Freshman Year Experience-Special Year Focus Conference on Urban Campuses: Conference Program and Proceedings Held in Charleston, SC, 4 February 1994, 35-36; Prather, "Better Than the SAT," 115-117; Al Hesser and Lloyd Lewis, "Evaluation of a Summer Prematriculation Program for Black and Other Nontraditional Students," Academic Medicine 67, no. 4 (April 1992): 270-272.

³²Only the student evaluations of the AMP Math Bridge Program from 1994, 1996, and 1997 were available when this study was conducted.

³³Hesser and Lewis, "Evaluation of a Summer Prematriculation Program for Black and other Nontraditional Students," 272.

³⁴John P. Bean, "Dropout and Turnover: The Synthesis and Test of a Causal Model of Student Attrition," Research in Higher Education 12, no. 2 (1980): 173-177; Astin, Minorities in American Higher Education, 111

³⁵Spady, "Dropouts From Higher Education: An Interdisciplinary Review and Synthesis," 77-79; Tinto, Leaving College, 99-110; Bean and Metzner, "A Conceptual Model of Nontraditional Undergraduate Student Proceedings of the 2002 American Society for Engineering Annual Conference & Exposition

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Total SAT score was found to be a significant predictor of retention status in SEM after the first semester of college. It is the only predictor of retention in SEM status after the first semester for males and a significant predictor for engineering students. Total SAT score was also the only significant predictor of retention in SEM status after the first year of college for physical science majors. Clearly, there is a relationship between SAT scores and the retention of SEM student at MSU during the first year. This may be especially true for Engineering and Physical Science students that are required to take more difficult mathematics and math based science courses. SAT scores may be a measure of what students know and can do in mathematics. A low total SAT score may highlight deficiencies that will affect a student's performance in mathematics and in math based science courses. For some students, it is very difficult to overcome these deficiencies in a new college environment, especially if they do not come to college with good study habits and skills. They often have to learn how to become good students before they can master the material in these demanding courses. Hence, engineering and physical science students may be more prone to drop out of SEM when total SAT score is low.

High school GPA was found to have a negative relationship with retention in SEM status after the first semester. This is somewhat counter intuitive, but does find support in the literature.³⁶ If students perceive that there is too much of a drop in college GPA compared to high school GPA, they are more likely to dropout. This is more likely to happen to students that attend high schools where the curriculums are not as demanding and academically challenging. Many students who graduate from these schools do not have to exert themselves much to earn acceptable grades. They do not or cannot take challenging courses that will help them grow intellectually and force them to develop good study habits and skills. When they arrive at college with that background and the attitude that college is only slightly more difficult than high school, they can easily become discouraged when they do not maintain the same GPA they had in high school. They often find it too difficult to bridge the "academic gap" and decide to change their major.

It is very interesting that even though females enter MSU with better pre-college academic credentials and perform better academically once in college, their retention in SEM rate is identical to that for males. Females with their superior academic performance compared to males might be expected to persist in SEM at a higher rate. It appears that the reasons why females drop out of SEM are different than the reasons why males drop out. This is conclusion supported in the literature.

Bean partially explains this phenomenon when he stated, "Men and women drop out of college for different reasons."³⁷ His explanation for his conclusion was that *institutional*

Attrition," 485-488; Studies have verified that college GPA is an important factor in explaining student attrition.

³⁶ Getzalaf, Sedlacek, Kearny, and Blackwell, "Two Types of Voluntary Undergraduate Attrition," 265-267.

³⁷ Bean, "Dropout and Turnover: The Synthesis and Test of a Causal Model of Student Attrition," 183.

commitment was the key variable in deciding *dropout* (another variable) for both sexes. He found that men left the university even when they were satisfied, whereas women who were more satisfied were more committed to the institution and were less likely to leave. Tinto agreed with this position when he wrote that evidence suggests the experience of females in college is somewhat different from that of males. “Females generally, and certainly those from specific ethnic groups, are more likely than males to face external pressures which constrain their educational participation.” He also stated, “Female departure, relative to that of males, is more determined by social forces than academic ones and therefore is influenced more by forms of social integration.” Finally, he noted that females are more likely to depart voluntarily than males, who are more likely to stay until forced to depart for academic reasons.³⁸ Female students majoring in SEM may perceive themselves to be in an environment where they experience difficulties related to their gender and where support systems do not work as well for them as they do for the general student body.³⁹ Finally, difference in gender academic performance can be partially explained by the fact that women generally mature sooner than men do.⁴⁰

The equations that predict academic performance and retention in SEM status explain very little of the variance for those variables. Obviously, other factors help to determine the academic success of African-Americans SEM students in college. It is important that these factors are studied and understood, especially at HBCUs, which have been successful in producing disproportionate numbers of African-American scientists and engineers.

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³⁸Tinto, Leaving College, 77.

³⁹McAnulty and O'Connor, "The Experience of Black Engineering Graduates," 548.

⁴⁰Jordon-Cox, "Psychosocial Development of Students in Traditionally Black Institutions," 507-511.

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