AC 2007-1231: EVALUATION OF THE NC-LSAMP PROJECT USING GRADUATION RATE AND GATEKEEPING COURSE PERFORMANCE

Gerald Watson, North Carolina A&T State University

Jerry Watson is a Ph.D. candidate in Industrial Engineering at North Carolina A&T State University.

Xiaochun Jiang, North Carolina A&T State University

Xiaochun Jiang is an Assistant Professor in the Department of Industrial and Systems Engineering at North Carolina A&T State University. He received his Ph.D. in Industrial Engineering with a minor in experimental statistics from Clemson University in 2001. He is a member of ASEE, IIE, SME, and HFES.

Marcia Williams, North Carolina A&T State University

Marcia Williams is the Coordinator of Sponsored Programs for the College of Engineering at North Carolina A&T State University and Statewide Coordinator for the NC Louis Stokes Alliance for Minority Participation (NC-LSAMP). She received a B.S. in Industrial Technology (Manufacturing) from North Carolina A&T State University, and a MBA from Wake Forest University. She has sixteen years of experience in sponsored program administration.

Sanjiv Sarin, North Carolina A&T State University

Sanjiv Sarin is the Associate Dean of the College of Engineering at North Carolina A&T State University. He received a B.Tech. in Chemical Engineering from the Indian Institute of Technology, New Delhi and a Ph.D. in Industrial Engineering from the State University of New York at Buffalo. He is a member of ASEE and IIE, and is a registered Professional Engineer in North Carolina.

Evaluation of the NC-LSAMP Project
Using Graduation Rate and Gate-keeping Course Performance

Abstract

Aiming to substantially increase the number of underrepresented minorities who will contribute significantly in science, technology, engineering and mathematics, engineering, and technology (STEM) areas, especially in graduate degree programs, the North Carolina Louis Stokes Alliance for Minority Participation (NC-LSAMP) project has seen a positive impact in the past few years. A longitudinal study has been carefully planned and data are being collected. So far, academic performance has been evaluated by comparing student GPA between the control group and the experimental group for the past two years. However, there are some other factors that can help assess the effectiveness of the project. In this study, two important factors were chosen to assist the evaluation of the NC-LSAMP Project: graduation rate and gate-keeping course performance. Results from the Wilcoxon Rank Sum Test revealed that students in the experimental group performed significantly better than those in the control group for both measures. Once again, strong evidence from the statistical analysis indicated that the NC-LSAMP project has the potential to significantly impact the retention and graduation rates of underrepresented STEM students.

1. Introduction

Studies have shown that diversity has a positive impact on the workplace, and the competitiveness of corporations in the global market[1]. According to the US Census Bureau, by year 2050, it is projected that the minority population will represent about 50% of the total U. S. population (US Census Bureau). Consequently, the minority labor force will be an important source of labor in the 21st century. However, shortage in minority students majoring in science and engineering has been an ongoing challenge for engineering educators [2, 3]. It is in America's best interest to recruit more ethnically and racially diverse students to study science, technology, engineering, and mathematics (STEM) disciplines and to prepare minority students to enter professional careers.

In North Carolina, a comprehensive, multidisciplinary, undergraduate program, the National Science Foundation's Louis Stokes Alliances for Minority Participation (NC-LSAMP), is designed to substantially increase the quantity and quality of minority students, especially African American, Hispanic, and Native American students, who successfully complete STEM baccalaureate degree programs, and increase the number of students interested in, and academically qualified for and matriculating into programs of graduate study[4]. The NC-LSAMP project has eight partner institutions (four minority schools and four majority schools) within the University of North Carolina system: North Carolina A&T State University (NCA&T), Fayetteville State University, North Carolina Central University, North Carolina State University, University of North Carolina at Chapel Hill, University of North Carolina at Charlotte, University of North Carolina at Pembroke and Winston-Salem State University. Over the years, the Alliance has systematically enhanced recruitment, retention, access, and opportunities to education, internships, and research in these fields, and has resulted in a variety of programs and

activities geared towards enhancing overall student success. Major initiatives include supplemental instruction, bridge programs, undergraduate research, and internships. In addition, an annual research conference sponsored by the Alliance showcases faculty-mentored research projects completed by students [5].

The lead institute, NCA&T, a public, comprehensive, land grant university, is located in Greensboro, North Carolina and was established in 1891. NCA&T is a Historically Black College and University (HBCU), and enrolls over 10,000 students with about 89% of them being African Americans. It is committed to fulfilling its fundamental purposes through exemplary undergraduate and graduate instruction, scholarly and creative research, and effective public service. NCA&T is the leading producer of African-American engineers in the nation. Preliminary results from the NC-LSAMP Project have shown a positive impact in the past a few years[6]. In that study, academic performance has been evaluated by comparing student GPA between the control group and the experimental group for the past two years. However, there are some other factors that can help assess the effectiveness of the project. For instance, graduation rate and gatekeeping course performance are also good indications of effectiveness of the program. Graduation is the result of a complex set of factors that vary by individual student and individual institution. Some of those factors include people, policy, teaching/curriculum, and resources. For instance, the "people" factor may include student preparedness, financial situation, and faculty teaching method. Student success is more a product of an overarching shared culture than it is of the results of a more narrowly-conceived deliberate 'retention' or 'graduation' effort and more attention needs to be given to graduation data[7].

Closely related to graduation rate is gatekeeping course performance. Gatekeeping courses are the critical courses that will enable students to proceed to the next level when they successfully complete them. Gatekeeping courses occur at all levels of education and in all fields. It had been shown that enrollment in gatekeeping courses in high school help students reach higher levels in math. Students who enrolled in algebra in the 8th grade were more likely to reach high-level math courses in high school than those who did not. Students who had algebra in the 8th grade were almost twice as likely to attend college (72% vs. 41%)[8]. In college, students, especially minority students, rarely are successful in their first attempt in introductory courses at the gateway to science, math, and business. As a result, the greatest attrition among STEM students occurs in the freshmen and sophomore years. More than a third (35%) of students who select stem majors switch out of them or leave college altogether between the freshman and sophomore years, among minority students, the percent is much higher[9]. Gatekeeping courses at colleges usually were described as those that can be a stumbling block. It is, therefore, necessary to use graduate rate and gatekeeping course performance to accompany grade point average to assist the assessment. As an ongoing effort to assess the effectiveness of the NC-LSAMP project, this paper describes the assessment effort of using graduation rate and gatekeeping course performance.

2. Method

As part of the assessment effort, a longitudinal study is being, and will continue to be, conducted at NCA&T[4]. In this study, five separate cohort groups from NCA&T will be tracked over a five-year period – Freshmen, Sophomore, Junior, Senior undergraduate students and first year

graduate students. These students are considered as experimental groups. Demographic information such as age, gender, and race, and academic information such as SAT score, High school GPA as well as GPA for each semester of all students participating in the project at NCA&T for years 2003-2004, 2004-2005, and 2005-2006, has been entered to a database developed to help the assessment[4]. Furthermore, for each year of student participation, details of NC-LSAMP activities involved have been recorded.

In order to assess the effectiveness of the project, control groups consisting of students that have no involvement in the project have been established to compare with the experimental group. Control groups were carefully chosen to match the experimental group. Statistical analysis was performed to ensure the compatibility between the control groups and the experimental groups. Specifically, demographic data similarities between the two groups were established using the Fisher's Exact Test, while academic credentials similarities were compared using the Wilcoxon rank-sum test. A preliminary study reported the formation of the control and experimental groups for years 2003-2004, and 2004-2005[6]. For both years, the statistical analysis revealed that the control group and the experimental group were not significantly different in terms of both demographic background and academic credentials indicating the two groups are compatible. Interested readers can refer to our previous paper for more details[6]. The following sections will report the analysis on year 2005-2006 data.

2.1 Descriptive statistics

Table 2.1.1 summarizes the basic statistics for both control and experimental groups for year 2005-2006.

Table 2.1.1 Statistics for control and experimental groups for year 2005-2006

Experimental Group						
		Freshman	**Sophomore**	**Junior**	**Senior**	**Total**
Gender	**M**	0	2	4	7	31
	F	1	3	7	7	
Ethnicity	**AA***	1	5	11	12	
	CA*	0	0	0	1	
	HA*	0	0	0	1	
						Mean
HSGPA		3.64	3.512	3.684	3.496	3.43
SAT		N/A	968	1029	954	983
Control Group						
		Freshman	**Sophomore**	**Junior**	**Senior**	**Total**
Gender	**M**	0	2	4	7	31
	F	1	3	7	7	
Ethnicity	**AA***	1	5	11	12	
	CA*	0	0	0	1	
	HA*	0	0	0	1	
						Mean
HSGPA		3.68	3.418	3.603	2.926	3.27
SAT		N/A	960	1021	956	980

- AA – African American

- CA- Caucasian American
- HA—Hispanic American

2.2 Statistical analysis of the compatibility of the control group and the experimental group

Ethnicity and gender are discrete variables. To evaluate the compatibility of the control and experimental groups for their ethnicity background and gender, Fisher's Exact Test was used. Unlike ethnicity and gender, academic performance such as high school GPA, and SAT score are continuous variables. Hence, the Wilcoxon Rank Sum Test was used to assess the academic compatibility of the two groups. Analyses were performed on data from year 2003-2004, to year 2005-2006 to ensure compatibility of the control group and the experimental group.

First, the Fisher's Exact Test was performed on entire groups and results indicated there is no statistical difference between the control group and the experimental group ($p=1.0$). A histogram is provided in Figure 2.2.1. Fisher's Exact Test then was performed for each of the five cohorts and no statistical difference was found for the cohorts in their ethnicity background: freshman ($p=1.0$), sophomore ($p=1.0$), junior ($p=1.0$), senior ($p=1.0$), and first year graduate student (no members in this cohort). Figure 2.2.2 provides ethnic information for junior students.

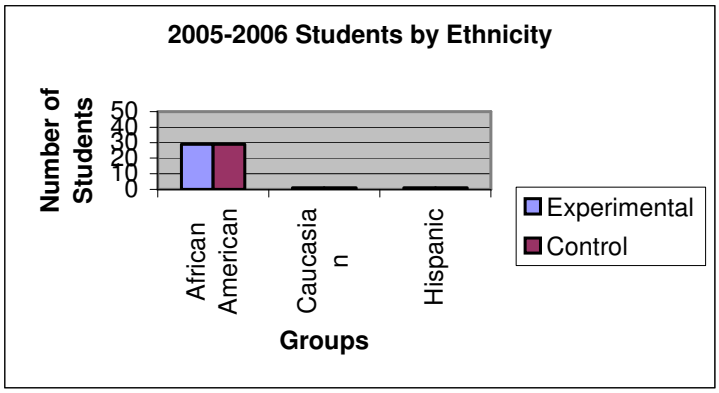

Figure 2.2.1 Students by Ethnicity

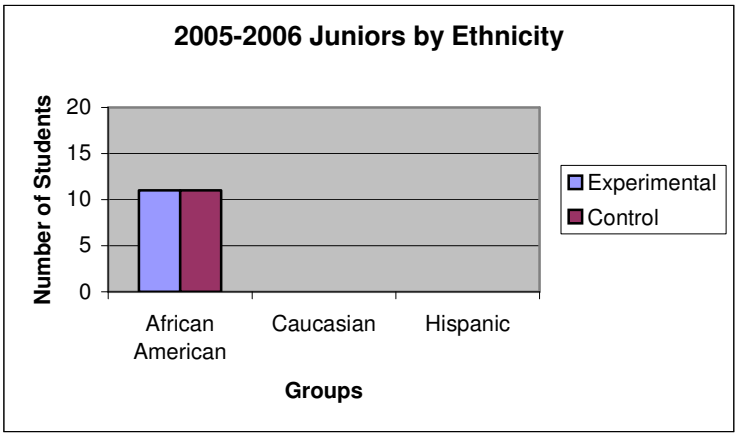

Figure 2.2.2 Junior Students by Ethnicity

Next, Fisher's Exact Test was performed on data based on gender, and results can be seen from Figures 2.2.3 and 2.2.4. No statistical difference was found for all students (*p=1.0*), or each of the five cohorts: freshman (no members in this cohort), sophomore (*p=1.0*), junior (*p=1.0*), senior (*p=1.0*), and first year graduate student (*p=1.0*).

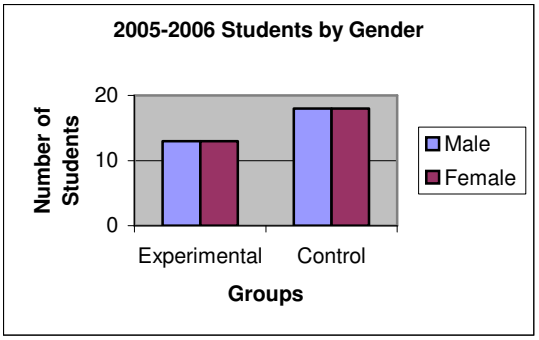

Figure 2.2.3 Students by Gender

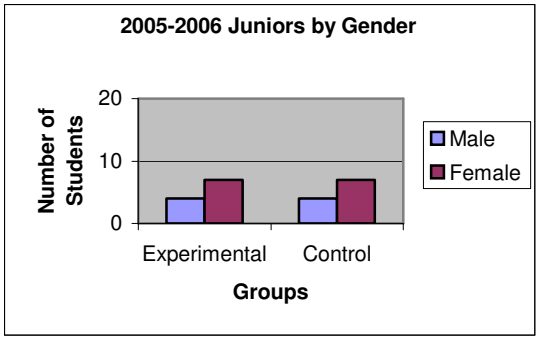

Figure 2.2.4 Junior Students by Gender

The Wilcoxon Rank Sum Test on entire groups was performed on high school GPA (HSGPA) and results indicated there is no statistical difference between the control group and the experimental group (*p=0.1960*). A histogram is provided in Figure 2.2.5. The Wilcoxon Rank Sum Test then was performed for each of the five cohorts and no statistical difference was found at the 0.05 significance level for the cohorts in their high school GPA: freshman (*p=0.2703*), sophomore (*p=0.3802*), junior (*p=0.3982*), senior (*p=0.0862*), and first year graduate student (no members in this cohort). Figure 2.2.6 provides high school GPA information for senior students.

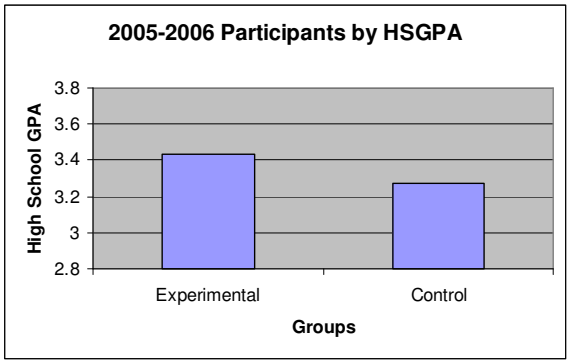

Figure 2.2.5 High School GPA

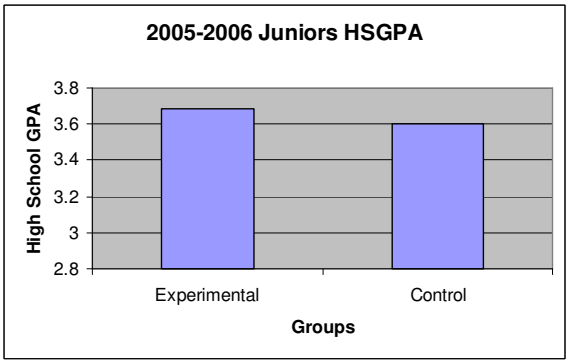

Figure 2.2.6 Junior Students HSGPA

The Wilcoxon Rank Sum Test on entire groups was performed on SAT scores, and results indicated there is no statistical difference between the control group and the experimental group (*p=0.5000*). A histogram is provided in Figure 2.2.7. The Wilcoxon Rank Sum Test then was performed for each of the five cohorts and no statistical difference was found for the cohorts in their high school GPA: freshman (no data available), sophomore (*p=0.5000*), junior (*p=0.5000*), senior (*p=0.4886*), and first year graduate student (no members in this cohort). Figure 2.2.8 provides SAT information for senior students.

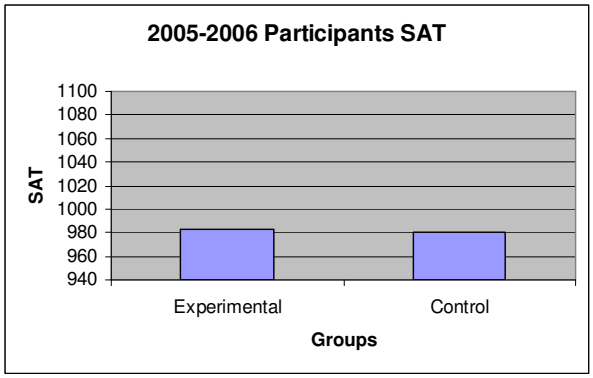

Figure 2.2.7 Participants SAT

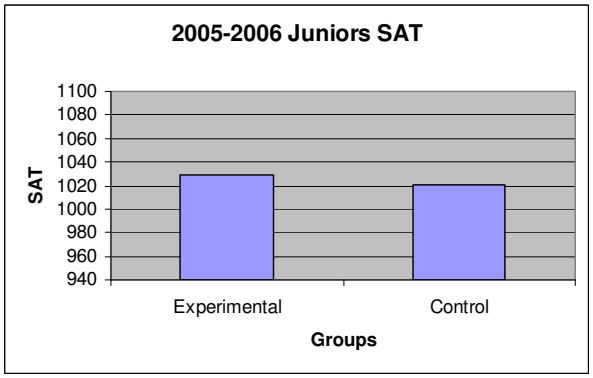

Figure 2.2.8 Junior Participants SAT

2.3 Graduation Rate and Gatekeeping Courses

The graduation rate is measured using the number of students who graduate from NCA&T in the standard number of years. A 6 year graduation rate is commonly used in assessment, and hence, was chosen in this study. The Dean of College of Engineering at NCA&T helped identify gatekeeping courses. Those courses include: Chemistry 106 (General Chemistry VI), 116(General Chemistry VI Laboratory), 107(General Chemistry VII), 117(General Chemistry VII Laboratory), Math 131 (Calculus I), 132 (Calculus II), 231 (Calculus III), 431(Introduction to Differential Equation), Physics 241(General physics I), 242(General physics I Laboratory), 251 (General physics II), 252(General physics II Laboratory).

3. Assessment Results

3.1 Graduation Rate

Both descriptive statistics and inferential statistics were used to assess the graduation rate. Table 3.1.1 provides graduation rate for both the experimental group and control group. Results indicated that the graduation rate in the experimental group is higher than the control group for all three categories (graduated within 4, 5, or 6 years). In addition, mean years to graduation was also computed for both experimental and control group as shown in Table 3.1.2 and Figure 3.1.1. Once again, the experimental group spent less time to graduation than those in the control group.

Table 3.1.1 Graduation rate for both experimental and control group

	Experimental	**Control**
Graduated in 6 years or less	100%	95.8%
Graduated in 5 years or less	96.3%	88.7%
Graduated in 4 years or less	71.1%	43.7%

Table 3.1.2 Mean years to graduation for both experimental and control group

	Experimental	**Control**
Mean years to graduation	4.06	4.51
Standard deviation	0.57	0.78

To investigate the statistical difference between the experimental group and the control group, the Wicoxon Rank Sum Test was performed on years to graduation. Results verified the above conclusion and proved that students in the experimental group spent significantly less time to graduate than those in the control group ($p<0.05$).

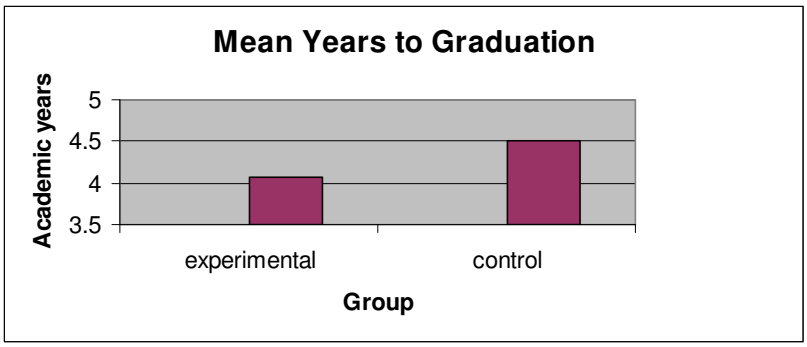

Figure 2.1.1 Mean years to graduation for both experimental and control group

3.2 Gatekeeping courses

Both descriptive statistics and inferential statistics were used to assess gatekeeping course performance. Table 3.2.1 provides student performance in the gatekeeping courses. It is clear that students in the experimental group performed better than their counterpart in the control group for each chemistry, math, and physics course. This can be seen in Figure 3.2.1 which provides a histogram of student performance in math gatekeeping courses, and Figure 3.2.2 which provides a histogram of student performance in chemistry and physics gatekeeping courses.

Table 3.2.1 Descriptive statistics of gatekeeping course performance

Course Name	Course Number	Number of Students	Experimental Group		Control Group	
			Mean	Std. Dev.	Mean	Std. Dev.
Chemistry	106	75	2.973	0.86	2.493	0.85
Chemistry	116	76	3.447	0.51	3.211	0.80
Chemistry	107	15	2.933	0.82	1.600	2.00
Chemistry	117	15	3.467	0.20	2.867	1.50
Math	131	95	3.400	0.99	2.695	1.20
Math	132	91	3.022	1.16	2.560	1.06
Math	231	60	2.883	0.89	2.467	1.48
Math	431	53	2.811	0.94	2.321	1.03
Physics	241	91	2.824	1.15	2.473	1.49
Physics	251	94	3.266	0.70	2.979	1.07
Physics	242	81	3.111	0.71	2.543	0.53
Physics	252	79	3.392	0.90	2.835	0.82

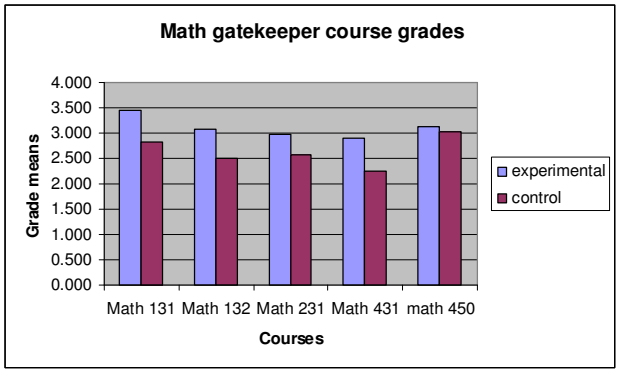

Figure 3.2.1 Means grades of math gatekeeper courses

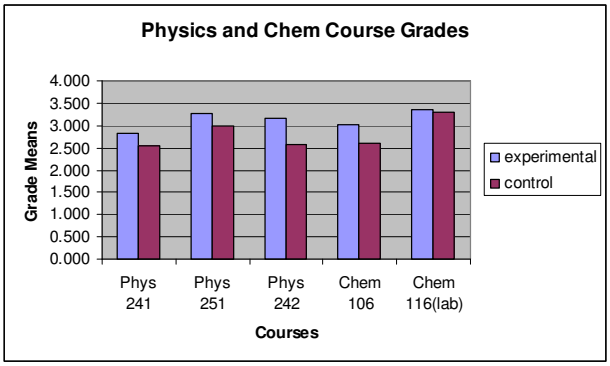

Figure 3.2.2 Mean grades of physics and chemistry courses

To investigate the statistical difference between the experimental group and the control group in terms of gatekeeping course performance, the Wicoxon Rank Sum Test was performed on student performance in each gatekeeping course. Results are shown in Table 3.2.2.

Table 3.2.2 Wilcoxon Rank Sum Test on Gatekeeping Courses

Course Name	Course Number	Experimental Group Mean	Control Group Mean	Wilcoxon Rank Sum Test P value
Chemistry	106	2.973	2.493	0.0021
Chemistry	116	3.447	3.211	0.0931
Chemistry	107	2.933	1.600	0.0025
Chemistry	117	3.467	2.867	0.1529
Math	131	3.400	2.695	0.0001
Math	132	3.022	2.560	0.0005
Math	231	2.883	2.467	0.0119
Math	431	2.811	2.321	0.0049
Physics	241	2.824	2.473	0.0242
Physics	251	3.266	2.979	0.0126
Physics	242	3.111	2.543	0.0001
Physics	252	3.392	2.835	0.0001

Using a significance level of 0.05, results indicated that students in the experimental group — those who were supported by NC-LSAMP project performed significantly better than those in the control group for Chemistry 106, 107, Math 131, 132, 231, 431, and Physics 241, 251, 242, 252. Students in both groups performed the same, statistically, in Chemistry 116 and Chemistry 117 — two laboratory courses that accompany Chemistry 106 and Chemistry 107 respectively.

4. Conclusion

Graduation rate and gate keeping course performance were used as the metrics to assess the NC-LSMAP Project. Statistical analysis results indicated that students in the experimental group— those who were supported by NC-LSAMP project -- performed better than those in the control group. Therefore, it can be concluded that, the NC-LSAMP project is working very well. However, in order to fully assess the effectiveness of the program, we need to continue to follow student performance and collect longitudinal data for analysis upon completion of the project. Nevertheless, it is safe to say this project is very promising. Furthermore, although the NC-LSAMP project is still ongoing, it has the potential to significantly impact the retention and graduation rates of underrepresented STEM students. This project will have a positive impact on the number of underrepresented STEM students who enroll in the graduate programs.

5. Acknowledgement

We would like to acknowledge the National Science Foundation for supporting the NC-LSAMP project.

6. References

1. Carnevale, A. P., and Fry, R. A. (2000), "Crossing the great divide: Can we achieve equity when generation Y goes to college?" Princeton, NJ: Educational Testing Service.
2. Oguntimein, G. B., Leigh-Mack, P., Davy, B., and Wheatland, J., (2004), "Research experience program for undergraduates in a Historically Black College and University." Proceedings of the 2004 American Society for engineering Education Annual Conference & Exposition.
3. Mervis, J. (1998), "Wanted: A better Way to boost number of minority Ph.D.s", Science, 281, 1268-1270.
4. NSF LSAMP Program: http://www.ehr.nsf.gov/hrd/amp.asp
5. Jiang, X., Sarin, S., and Williams, M. (2005), "Assessment of NC-LSAMP project: A longitudinal Study", Proceedings of the 2005 American Society for engineering Education Annual Conference & Exposition, Portland, OR.
6. Williams, M., Watson, J., Jiang, X., and Sarin, S., "Preliminary Results of the NC-LSAMP project", Proceedings of the 2006 American Society for engineering Education Annual Conference & Exposition, Chicago, IL.
7. Joanne, G., and Williamson, E., "Fostering student success in Quantitative Gateway courses." New Directions for Teaching and Learning, number 61, Spring 1995.
8. National Center for Education Statistics, March 1999. NCES-1999-303.
9. Smith, S. (1999), Working recruitment miracles. Black Issues in Higher Education, 16 (170), 40-41.