

AC 2010-584: IMPACT AND MERIT OF THE VSU HBCU-UP ON THE UNDERGRADUATE STEM EDUCATION

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Abstract

The article presents the overall impact of a NSF grant under the Historically Black Universities and Colleges Undergraduate Program (HBCU-UP). The alignment between the goals of the University's Strategic Plan and then objectives of the HBCU-UP project is analyzed. The project outcomes are listed. Lessons learned from this project at VSU as well as the intellectual merit of the program are outlined. The broader impact of the project is discussed.

Introduction

In 2005, the National Science Foundation awarded a Historically Black Colleges and University Undergraduate Program (HBCU-UP) Implementation grant to the Virginia State University (VSU).

The HBCU-UP Implementation Project provides support to implement a comprehensive institutional project to strengthen STEM education and research. The strategies should be the result of an institutional STEM self-analysis, address institutional and NSF goals, and have the potential to result in significant and sustainable improvements in STEM program offerings ¹.

The University

Virginia State University is a comprehensive, educational land-grant institution founded in 1882, located in Petersburg, 20 miles south of Richmond, VA. VSU is the first fully state supported four-year institution for higher learning for African-American students. VSU has a strong record of attracting out-of-state minority students. The University offers 52 baccalaureate, masters and doctoral degree programs and a certificate of advance study within four schools (18 masters, 2 certificates, and 2 doctorates). VSU is accredited by the Southern Association of Colleges and Schools (SACS), the National Council of Accreditation of Teacher Education (NCATE), Accreditation Board for Engineering and Technology (ABET), Association to Advance Collegiate Schools of Business (AACSB), and the Virginia State Board of Education. The VSU enrollment is about 4700 undergraduate and 500 graduate students. The number of full-time instructional faculty is 206 and number of full-time research and public service faculty is 48. VSU also has about 105 part-time faculty members ².

Needs

A study by Howard University reveals that the representation of minority in science, technology, engineering, and mathematics (STEM) professionals is significantly disproportionate to minority representation in the U.S. general population and workforce ³. Minorities, particularly African Americans, are showing an increase in enrollment and subsequent degree attainment in science and engineering (S&E) (US Census Bureau, 2006). However, little increase has been seen at the masters and doctoral levels ³.

The National Science Board has concluded that the number of native-born S&E graduates entering the workforce is likely to decline unless the nation intervenes to improve success in

educating S&E students from all demographic groups, especially those that have been underrepresented in S&E careers ⁴.

National Science Foundation data also shows that in 2005, a total of 466,003 S&E degrees were awarded to US citizens and permanent residents. African-Americans earned 39,283 (8%) of the awarded Bachelor of Science degrees, yet they composed 15% of the population. The NSF data showed that African-Americans earned 5% of awarded Bachelor of Science degrees and 4.3% of Master of Science degrees in engineering ⁵.

Proposed Objectives

VSU proposed a Trojan STEM (T-STEM) project to address the aforementioned needs. T-STEM (VSU HBCU-UP) is a five year project with the following objectives:

1. To increase the number of graduates in VSU STEM degree programs from the average of about 73 to an average of 140, within five years.
2. To increase the academic performance of the STEM students. We expect to increase their average GPA from 2.6 to 2.8 or higher, within 5 years.
3. To increase the number of students who competitively gain admission to STEM graduate degree programs by 100% in the next five years

The above objectives are inline with the VSU Strategic Plan. The VSU 20/20 Strategic Plan can be seen at www.vsu.edu. Beginning in the year 2005, the transformation of Virginia State University documented in the 20/20 Vision Plan and Master Plan. This essentially elevates the VSU standing within the Commonwealth of Virginia and the nation, in its effort to ensure the quality education. The 20/20 Vision Plan initiative will strengthen and enhance all components of the university as it strives to become a SACS Level 6 institution, a Carnegie Doctoral/Research Intensive university, and move to the upper echelon of Tier 2 in the U.S. News and World Report rankings. This plan is comprised of Action Items that will enable VSU to measure each goal or accomplishment.

Intellectual Merit and Broader Impact

The National Science Foundation (NSF) utilizes two merit criteria for the review of proposals: Intellectual Merit, and Broader Impact. NSF has defined these merits as follow ⁶:

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the

participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

VSU HBCU UP Project

This is the fifth year of the T-STEM project at VSU. The data for the past four years is available for analysis. The project was designed and carried out in four phases: Undergraduate Bridge; Graduate Bridge; Course Restructuring and Reform; and Faculty and Student Development.

Intellectual Merit

The aim of the T-STEM is to implement a program that provides access to science and technology and opportunities that will remove some existing barriers for competing and for participation in STEM arenas. Strategies focus on:

- Learning through research
- Emphasis on content and pedagogy, not just hardware
- Emphasis on closing life-long learning, oral, and written competency gaps through academic and professional enhancement
- Promoting graduate education through scientific research

The concern for addressing the problems cited above is a national issue that requires further intervention by the academic community, industry, and the federal sector in order to ensure the participation of underrepresented groups in the workforce 2011 and beyond. Pre-college and undergraduate student participation in the sciences, particularly in research, is a major challenge. Some of the most challenging and exciting research topics today are found at the intersections of disciplines and sub-disciplines. We, therefore, provided opportunities for students to become engaged in interdisciplinary scientific research projects within the broader domains of the arts and sciences areas at this institution.

As a result, the undergraduate research at VSU is growing. There is a fine record of publications and conference presentations coming out of the undergraduate research. The STEM departments at VSU are clearly committed to the goal of the program. There is an increase in the number of students who pursue graduate education in STEM.

Broader Impact

The broader aim of the T-STEM is to expand the participation of African-Americans in STEM disciplines. This will:

1) Advance Discovery and Understanding While Promoting Teaching, Training and Learning

- Integrate research into the teaching at high school and undergraduate level
- Include high school students and undergraduates in research, teaching, and mentoring

- Develop online assessment/tracking tools utilizing Qualtrics useful in tracking students' progress
- Encourage student to participate in the conferences
- Establish mentoring programs for high school and undergraduate students
- Involve graduate mathematics students in undergraduate teaching activities
- Adopt and disseminate ESP

2) *Broaden Participation of Underrepresented Groups*

- Include African American students as participants in research and education activities

3) *Enhance Infrastructure for Research and Education*

- Collaborations with BNL, ORAU, VTech, VCU, Honeywell, etc.
- Broad Dissemination to Enhance Scientific and Technological Understanding
- Involve Honeywell, DuPont, VDOT, in research internship and pre-college education
- Presenting the STEM program in the website, high schools, local papers, and VSU Radio
- Make data available in a timely manner by means of database
- Publish the program in the VSU HBCU-UP website for the general public
- Present research and education results to the NSF in a timely manner.
- Participate in ASEE, HBCU-UP, VSU, LS-AMP workshops and conferences
- Integrate research with education activities

4) *Benefits to Society*

- Close the gender/ethnic human resources gap that exists in national STEM workforce.
- Increase the diversity of nation's STEM workforce

The intent of the VSU HBCU-UP is to provide faculty and students with close interactions (mentoring) that foster the academic potential of the minorities in the STEM fields. Furthermore, the goal is to provide minorities with opportunity to interact with other students from larger institutions. Such interactions reduce the barrier of minorities to participate in graduate programs at the research intensive institutions. The program exposes students to modern teaching techniques and learning experience in gatekeeper courses.

The Program Outputs

Recruitment

The Undergraduate Bridge is composed of four STEM programs. Two of these programs are fully funded by the HBCU-UP, one is jointly funded by the HBCU-UP and DuPont, and one is funded by the Federal Highway Administration. All of these programs are four-week residential programs and are managed by the T-STEM. The programs consist of lectures, hands-on laboratory sessions, field trips, guest lecturers, SAT preparation course, time management workshops, and recreational activities. The programs are as follow:

Summer Transition and Enhancement Program (STEP) - STEP is designed to recruit high achieving rising college freshmen. These students earn six college credit courses in Mathematics and English. .

High School Senior Enrichment Program (HSSE) - HSSU is designed for high school rising seniors. This is a pipeline for admission to the STEP. In addition to STEM activities, the curriculum includes a full (30 hours) SAT Preparation course.

NSF-DuPont Summer Science and Engineering Program (Partially supported by NSF)

This program is designed for high school rising juniors. This is a pipeline for admission to the HSSE. This program also includes an SAT Prep course.

Summer Transportation Institute (STIP) (Funded by FHWA) - This program is designed for rising ninth and tenth graders. The curriculum for the STIP mostly includes hands-on engineering activities as well as career awareness in the transportation field. STIP is a feeder to the DuPont program.

Table 1 illustrates data on the participants to these programs. The table also shows the number of the students that were recruited to VSU from these programs. The last row indicates the retention rate for these students.

Table 1- Recruitment Data

Program		2006	2007	2008	2009
STEP		26	34	36	41
HSSE		14	24	20	14
DuPont		23	23	11	21
STIP		15	15	16	16
VSU	STEM	19	19	20	31
	Non-STEM	6	13	14	10
	RET-STEM	9	17	15	Not Available

Faculty and Student Development

Undergraduate Research Mentoring Program (URMP)

In 2006, T-STEM established an Undergraduate Research Committee (URC) to promote and evaluate undergraduate research infrastructure at VSU. This committee proposed and managed a VSU Annual Undergraduate Research Conference. The committee also recommended an Undergraduate Research Mentoring program with a measurable set of expectations to support the goal and objectives of the VSU HBCU-UP.

Table 2 shows the summary of the activities for the URMP for the past two years. The data for this year is not available at this time since the VSU URMP is at early stage. However, there is an early indication of growing faculty and student interest in this program.

Table 2- Data on Undergraduate Research Mentoring Program

Summary	Yr1	Yr2	Summary	Yr1	Yr2
Faculty	11	22	Biology	6	4
Number of projects	21	21	Mathematics	3	5
Collaborative Projects	8	3	Computer Science	7	
Applications for External Summer Programs	8	7	Computer Engineering	15	17
External Summer Programs Attended	6	4	Manufacturing Engineering	9	9
Application for Graduate Programs	11	4	Chemistry	2	10
Admissions to Graduate Programs	7	3	Number of Projects	21	
Attended a Graduate	2	0	Professional Meetings, Attended (External)	33	36
Psychology	11	23	Professional Presentations	22	48
Physics	2	2	Peer Reviewed Publications	6	3

One of the issues that we faced with was the collection and tabulation of data for the assessment purpose. We used an instrument to collect data on mentors and students' accomplishments. We utilize an Excel worksheet to tabulate the data. This is a time consuming and cumbersome process, and leave the door open for human error. Currently, we are collaborating with the VSU Office Information Technology to utilize Qualtrics as an instrument for online data collection. This will greatly reduce some of the challenges that were faced in the data collection.

The Qualtrics Research Suite is an online toolset that incorporates Survey Design, Distribution Management, Data Management, and Reporting and Analysis. This toolset has been deployed to the entire Virginia State University community and has been used for a wide range of functions, including student surveys, community outreach, class evaluations, testing and other administrative activities. In addition, Qualtrics has been incorporated into part of the curriculum for use in marketing classes and in support of thesis/dissertation research.

Upon the completion, The VSU HBCU-UP Qualtrics evaluation tool set will be available to the VSU community for the evaluation and assessment of any funded projects. In the near future, this will provide a uniform standard for the assessment and evaluation of research and development projects at VSU. As a result, this will contribute to the enhancement of VSU's research infrastructure.

Data on Undergraduate Research

There were not any accurate baseline data available on undergraduate research activities prior to 2005. The data on undergraduate research for 2004-2005 was collected with an on the survey questionnaire that was distributed to the STEM faculty in 2005-2006. Less than 10% of the STEM faculty responded to the survey questionnaire. Since 2005, T-STEM has tried to maintain accurate data on undergraduate research at VSU. Students' presentations in conferences, assisting faculty in research projects, and participations in summer research internships are the basis for this data. Table 3 shows the summary of historical data on STEM Undergraduate

Research at VSU. In 2005-2006, the T-STEM supported eight students in their research project. In 2007-2008, we began a structured research program under the URMP.

Table 3- Historical Data on Undergraduate Research

	Before T-STEM	Supported by T-STEM	Not Sup. T-STEM	Sup. by T-STEM	Not Sup. T-STEM	Sup. by T-STEM	Not Sup. T-STEM
Year	04-05	05-06	05-06	07-08	07-08	08-09	08-09
Agriculture	1	0	8	0	5	0	0
Chemistry	1	0	5	3	2	17	8
Computer Science	0	2	10	2	0	12	30
Engineering	0	5	0	11	17	11	19
Life Science	0	0	0	1	11	8	4
Mathematics	0	1	0	2	1	6	7
Physics	0	0	0	1	1	1	0
Total	2	8	23	20	37	55	68

Sample of Workshops

The Algebra Project Training: June 13-16, 2006. This was a training on the pedagogy developed by the Algebra Project, a national organization. This led to the Submission of the Education Research Proposal, which was funded by NSF. The Education Research project is \$1M three-year project. This project is led by Dr. Oliver Hill from the Department of Psychology and has provided training on Algebra Pedagogy to 35 mathematics teachers, 30 Virginia State University Students, and 10 Petersburg high school students to be math literacy workers. After-school programs were established at two middle schools and one elementary school.

Directing Undergraduate Research: T-STEM organized a two-day workshop on March 29-30, 2007, to introduce the expectation and best practices on mentoring undergraduate research to VSU STEM faculty. Twenty-two (22) STEM faculty members participated in this workshop. This led to the establishment of the following expectations for the Undergraduate Research Mentoring Program:

Expectations (from Mentors)

- Provide supervision to at least two undergraduate students
- Evaluate students' research and presentations
- Assist the mentees to apply for summer internships
- Assist the mentees to apply for suitable graduate programs
- Monitor mentees' progress
- Participate in two meetings (one at the end of each semester) to share their experiences and views on the mentoring program and assist in evaluation and improvement

Expectations (from Students)

- Present at two Undergraduate Research Conferences
- Participate in the assessment and evaluation of the mentoring program
- Each research project should be above and beyond the requirements for completing a course
- Participate in all HBCU-UP research activities
- Prior to graduation, apply to a graduate program in a STEM

Hands-on Workshops on Outcome Assessment and Continuous Improvement

This led to the development of a strategic plan for the department to obtain ABET accreditation for computer engineering, manufacturing engineering, and re-accreditation for electronics engineering technology and mechanical engineering technology programs. Twenty-nine (29) faculty members were directly involved in the process.

Our faculty made a presentation in the Best Assessment Practices at Rose-Hulman Institute of Technology. This directly impacted more than fifty faculty members from other institutions. Our team also published five articles in the ASEE Proceedings and one in proceeding of IJME – INTERTECH on outcomes associated with capstone projects during the past four years

Oak Ridge Associated Universities (ORAU) and Network for Earthquake Engineering Simulation (NEES)

NEES and ORAU collaborated with the VSU and conducted a workshop on January 11, 2008 to thirty-five (35) VSU STEM faculty members. Twelve of our faculty members continued to work with NEES in identifying research opportunities on earthquake. As a result, two VSU faculty members collaborated with the University of California at Los Angeles (UCLA) and submitted a proposal to the NSF under NEES. Two faculty members also wrote a joint proposal with the University of Nevada, Reno, NV to NSF under the same program.

Seminars and Conferences

The following is the summary of the participations in the seminars and conferences during the past four years:

On Campus Seminars and Conferences

- Number of Seminars/Conferences = 21
- Faculty Participations = 202
- Student Participations = 429

Off Campus Conference Attendance

- Number of Conference =15
- Faculty Participations = 26
- Student Participations = 263

Graduate Bridge

The T-STEM Graduate Bridge program activities include: GRE Preparation, Graduate School Visitation, Summer Research, and Graduate School Application workshops.

GRE Preparation

T-STEM has conducted four GRE preparation courses. Each of these sessions are five (5) Saturdays and four (4) hours each day. The Cambridge Course Materials are used for these courses, which were open to all VSU and non-VSU students. This activity was coordinated with the VSU Office of Outreach and VSU Graduate Office. VSU Office of Graduate Admission waives the admission fee to the participants in this course. In addition, T-STEM organized a graduate school application workshop for the participants. The following is the summary of participation in this program. The table also summarized the number of the participants in the program who enrolled at the VSU graduate program.

Table 4 – Summary of Participation in GRE Prep

Sessions	# of Students participated	# of Students to Grad School	
		Non-STEM	STEM
Spring 2007	17	3	4
Fall 2008	16	6	4
Spring 2009 -1	16	6	1
Spring 2009 - 2	22	4	5
Total	71	19	14

Graduate School Visitation (GSV)

During the past three years, VSU has conducted annual graduate fairs on its campus, in which, many universities have been participating each year.

Last year, VSU began collaboration with the Educational Advancement Alliance (EAA) to expose our students to the benefits of STEM graduate education. EAA is an educational non-profit organization that administrates the HBCU STEM Fellowship Program. This program provides fellowships and stipends to graduates of Historically Black Colleges and Universities (HBCU) who have gained admission into masters programs in STEM at schools in Pennsylvania, New Jersey, Delaware or Washington, DC. In addition to providing financial support, student progress is monitored to ensure success and to nurture the next generation of scientists, researchers and engineers. As a result of this collaboration, 110 VSU students attended Fattah Conference on Higher Education in February of 2009 in Philadelphia, PA. This three-day conference is designed to increase enrollment of minority students in graduate and professional schools.

Historical Data on VSU STEM Graduates Pursuing Graduate Education

Table 5 shows the historical data for the VSU STEM Graduates attending a STEM graduate program. The data was collected from the STEM Departments who track their graduates. The data excludes Psychology graduates and attendance to non-STEM programs such as medical, dental, or pharmacy schools. The first column indicates the graduation year from an undergraduate STEM program, the second column is for the total number that have enrolled in a

graduate program until now, the third column shows the range of the years after graduation to attend a graduate school, the fifth column indicates the number of graduates that attended a graduate school immediately after their graduation, and the last column shows the number of students who enrolled in the STEM graduate program within a year of their graduation.

Table 5- Historical Data on Graduate School Attendance

Grad Year	No. Go Grad	Range Academic Yr	Range Years	Immediate Semester	Within a Year
2001	9	2001-2006	5	1	1
2002	8	2002-2006	4	1	2
2003	7	2004-2006	3	0	3
2004	7	2005-2006	2	0	1
2005	5	2005-2006	1	2	4
2006	1	2006	0	1	1
2007	7	2008-2009	2	7	7
2008	8	2009	1	7	8

Data on Assessment

Table 6 shows the summary VSU historical data on undergraduate STEM enrollment, graduation rates, university-wide and for STEM disciplines, total number of graduates from an undergraduate STEM disciplines that attended a graduate STEM program, and number of the graduates that enrolled in a STEM graduate program within a year of their graduation.

Table 6 – Summary of Undergraduate Historical Data

Year	Undergraduate STEM				All Majors Undergraduate		After BS Degree Attended Grad. STEM	
	Enrollment	Graduation Rate			Graduation Rate		Total	Within a Year
		Overall	Minority	GPA				
2000-1	411	69	61	2.575	498	477	9	1
2001-2	495	68	68	2.607	543	520	8	2
2002-3	553	82	80	2.568	642	617	7	3
2003-4	550	112	53	2.804	542	529	7	1
2004-5	749	107	103	2.686	727	703	5	4
2005-6	752	95	95	2.846	689	669	1	1
2006-7	710	102	98	2.840	720	695	7	7
2007-8	627	85	83	2.818	613	592	8	8
2008-9	679	88	82		617	598		

Impact

Analysis with respect to the objectives of the program shows the following results:

- 1) The average of grade point average (GPA) of STEM graduates increased from 2.64 (for 2001-2005) to 2.83 (for 2006-2008).
- 2) The average number of minority student graduates in the STEM field increased from 73 (for 2001-2005) to 89.5 (for 2006-2009). For all STEM graduates the increase was from 87.6 to 92.5.
- 3) The average number of STEM graduates enrolled in a STEM graduate program within a year of their graduation increased from 2.2 (for 2001-2005) to 5.33 (for 2006-2008).

Even though the third objective of this project measures the effectiveness of the Graduate Bridge Program by the “number of students who competitively gain admission to STEM graduate degree programs”, during the course of the project, the management and the Undergraduate Research Committee improved this objective to the “number of students that enroll in a STEM graduate program within a year of their graduation.”

In addition, T-STEM developed a unit with a clear strategy, expectations, and assessment to measure the effectiveness of partnership among funded programs such as HBCU-UP (NSF), Minority Science and Engineering Improvement Program (MSEIP) (Department of Education), STIP (Federal Highway Administration), and Research Infrastructure Minority Institutions (National Institute of Health). This includes administration, education, and research. The goal is the efficient utilization of the federal funds.

The implementation of the HBCU-UP has significantly impacted VSU's strategies for improving the quality of STEM education and has enhanced the institution's capability to move toward a level 6 institution status.

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