

## Value Added: Integrating NSBE Jr. Chapters Into High School Mathematics and Science Curricula

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### Introduction

Research studies show that Georgia's present and future workforce is unprepared for the scientific and technological challenges facing them. Georgia's middle and high school students lag far behind the national average in science and math scores. Specifically,

- *The Fordham Foundation gave Georgia a grade "F" in science.*
- *Over half of Georgia 8<sup>th</sup> grade students scored at the lowest science achievement level in the 1996 National Assessment of Educational Progress study.<sup>1</sup>*
- *One out of every four Georgia high school students fails the science portion of the Georgia High School Graduation Test on his or her first attempt.<sup>2</sup>*
- *Georgia ranked dead last nationally in Scholastic Assessment Test (SAT) scores in 2002.*

As part of a National Science Foundation (NSF)-supported GK-12 program, the Student and Teacher Enhancement Partnership (STEP) Program, Georgia Tech has initiated partnerships with three metro-area high schools with high percentages of under-represented minorities. These three schools have historically performed substantially even worse than Georgia does as a whole. They are primarily African-American schools (87-99% black) that draw from a mixture of middle and lower income neighborhoods where 33-43% of the students are eligible for free or reduced lunch. Both the average cumulative SAT scores (between 852 and 902 for the three schools) and percent of students scoring 3 or higher on the Advanced Placement exams (between 11% and 15%) are substantially below the state averages of 991 (SAT) and 52% (A.P. passing rate), making them low performers in a low performing state<sup>3</sup>.

This low academic performance level effectively closes off the opportunity for most of these students to pursue careers in science and engineering. Georgia Tech is the premier engineering institution in the southeast United States, and is a leader in educating minority engineers. However of the over 7,500 applications received for admission to the university in 1997, only 34 came from these three local high schools, with the majority (23) submitted by students from the a Mathematics and Science Magnet Program. Though 61% of all applicants to Georgia Tech that year were accepted, only 35% of the applicants (12) from these majority African-American schools were offered admission, and only seven chose to come. Six of these seven enrolled in schools within the College of Engineering.

Once at Georgia Tech, underrepresented minority students perform slightly poorer academically than the institute average (1<sup>st</sup> year cumulative GPA of 2.7 for minorities, vs. 2.8 for the institute as a whole in 2001), and the graduation rate lags behind the institute average. However minority students who participate in the minority academic support programs offered by the university ultimately graduate at a rate that equals their majority peers. Therefore the pipeline of minority engineers is not limited primarily by the success rate of students enrolled at institutions such as Georgia Tech—it is dramatically limited by the low achievement of students in our minority K-12 schools, by the low number of students applying for admission, and by the low acceptance rate. One strategy, discussed in this paper, to help change these current facts is by increasing the presence of black engineers at these schools by implementing junior chapters of the National Society of Black Engineers (NSBE).

### **The National Society of Black Engineers**

The National Society of Black Engineers (NSBE) is the largest student-managed organization in the United States<sup>4</sup>. It was founded in 1975 on the campus of Purdue University; it now serves over 10,000 collegiate members at over 300 colleges and universities. NSBE's mission is to increase the number of culturally responsible black engineers who excel academically, succeed professionally, and positively impact the community. NSBE also has a large professional membership of approximately 3000 alumni members who provide support to the current collegiate members, and a significant pre-college membership that includes students from grades seven through twelve. So far NSBE has established 70 official NSBE Jr. chapters at high schools and with its Pre-College Initiative (PCI) program, aims to aid the entire engineering pipeline by preparing highly motivated and skilled high school students for the rigors of a math, science, and engineering curriculum at colleges and universities. The NSBE Jr. programs at the three high schools addressed in this paper are part of this effort, and are a joint project of the Georgia Tech Society of Black Engineers (GTSBE), and the NSF-supported GK-12 STEP program<sup>5</sup>.

### **The Student and Teacher Enhancement Partnership (STEP) Program**

In 1999, the National Science Foundation initiated a new type of graduate student support through the *NSF Graduate Teaching Fellows in K-12 Education (GK-12)* program. Students receiving GK-12 fellowships are required to interact directly with K-12 teachers in an attempt to improve both K-12 education and the pedagogical and communication skills of the Fellows. In return, graduate Fellows receive an annual stipend and a tuition waiver. In the spring of 2001, Georgia Tech received a GK-12 grant to support its Student and Teacher Enhancement Partnership (STEP) program and to place twelve graduate students per year in Atlanta area high schools.

The broad goals of the GK-12 initiative and of the STEP program are:

- (1) To broaden the education of science, technology, engineering, and mathematics (STEM) graduate students to include intensive experiences in educational pedagogy and process;
- (2) To encourage the participation of STEM faculty and students in the difficult issues facing K-12 educators through the nurturing of university-school partnerships;
- (3) To assist K-12 teachers in their endeavor to improve classroom instruction; and
- (4) To help schools improve K-12 student achievement in STEM.

To address these goals, STEP forms partnership teams at each of six metro-Atlanta high schools that consist of two Georgia Tech graduate STEP Fellows, a teacher STEP coordinator, and additional teachers and administrators from the school. Each STEP team then designs an action plan for the year based on the needs of the school, and the talents and interests of the particular STEP Fellows. During the 2002-2003 school year, three of these STEP teams chose to augment the opportunities offered to students at those schools by initiating or resurrecting NSBE Jr. chapters. This paper describes the results of this initiative, and provides the lessons learned in the process. It is our hope that Georgia Tech's experience can assist other universities in forming similar partnerships with local schools.

## **Mechanisms: Creating NSBE Jr. Chapters**

### **Creating and Chartering a New Chapter**

One factor that often limits the creation of successful programs such as NSBE Jr. in high schools is that even when the schools' administrative personnel and teachers have heard about and are interested in starting the program, many of the schools lack the human resources to devote time for this sort of project. Initiatives such as the NSF GK-12 program help solve this problem because the Georgia Tech graduate STEP Fellows provided the initial presentation about NSBE Jr. and created the interest within the high school student population. The connection between the goals of NSBE and STEP are clear and complementary—both seek to create more interest in math, science, and engineering among underrepresented groups, and to build partnerships between universities and high schools. For the STEP Fellows, augmenting math and science education with NSBE Jr. was a natural step since most had been, or are currently, members of NSBE. Even with the STEP Fellows, however, a successful NSBE Jr. chapter requires an active teacher advisor, and support from the school administration.

The actual process of creating a new NSBE Jr. chapter is quite simple, requiring only an associated collegiate chapter, written approval by the principal, five student members, and one advisor. To generate interest, STEP fellows presented talks about NSBE Jr. to classes of juniors and seniors. These talks were sufficient to interest nearly all of the students in starting a NSBE Jr. chapter. At one school, membership in NSBE Jr. was a requirement for students in the Introduction to Engineering class, taught by one of the co-Advisors of NSBE Jr. Therefore, NSBE Jr. was directly linked to class activities and provided an outlet for class applications. Dissemination of information was also simplified because of this connection with a school course. Because NSBE is specifically a student-managed organization, the high school students themselves acquired all necessary information required by NSBE national headquarters in order

to start a new chapter, and held elections for officers. After the paperwork was processed by the national NSBE organization, students registered on-line to become official NSBE Jr. members at their respective chapters. The process of creating a chapter is just the beginning, however, and does not guarantee a sustainable chapter.

### **Revitalizing a NSBE Jr. Chapter**

The situation at one of the STEP schools was common nationwide--a NSBE Jr. chapter had been chartered, but it had since become defunct. The initial effort was therefore to identify the reasons for the chapter's failure, to revitalize the chapter and to make it attractive to students. It quickly became apparent that most students and teachers were completely unaware of the existence of a NSBE Jr. chapter and had no sense of the purpose that such an organization would serve. Therefore an educational campaign within the school would be central to reestablishing a viable chapter, and a teacher would need to take on the role of faculty advisor for the organization and serve as the faculty point of contact. In addition, the charter would have to be officially reestablished by filing the necessary paperwork.

Having a chapter on paper does not guarantee that the chapter will actually become functional or useful. In order to maintain a chapter, a commitment must be made by both teachers and students. At least one teacher must manage the overhead activities associated with maintaining a chapter and lead the student activities and interactions. The students must also be committed to making the chapter work for themselves and through themselves. Generating the necessary enthusiasm often requires concerted marketing, made easier in this case by the presence of the STEP Fellows.

The marketing of the organization to students was accomplished via announcements to the general student body, in-class announcements from teachers within the math and science departments, fliers around the school, and direct conversations between STEP Fellows and students. Once the paper work had been filed with the affiliate chapter, students who had mentioned an interest in engineering and the sciences, as well as students who demonstrated an affinity towards those disciplines, were sought out and encouraged to take an active role in the organization. Because the STEP Fellows were members of NSBE during their undergraduate tenure, and maintained an affiliation with and working knowledge of NSBE, they were able to provide knowledgeable experiential advice as to the advantages that NSBE and NSBE Jr. could offer.

Not only can current and former dedicated NSBE members play an instrumental role in creating and sustaining NSBE Jr. chapters, but collegiate NSBE chapters at the associated colleges or universities have a very large impact on the success and viability of NSBE Jr. chapters. Much of the direction, guidance, and interaction comes from a NSBE Jr.'s collegiate mother chapter.

### **The Role of the Collegiate Chapter**

The collegiate NSBE chapters serve an integral role in the creation and continuation of NSBE Jr. chapters. The Georgia Tech Society of Black Engineers (GTSBE) serves as the mother chapter for the NSBE Jr. chapters highlighted here. Within the National Organization, each of these junior chapters is therefore formally associated with GTSBE. However, GTSBE's role in the creation and continued viability of these chapters is more than a mere formality. GTSBE's

student officers came to the schools to present information to the high school students about the history of NSBE, the role of NSBE Jr., the role of GTSBE, and about GTSBE itself. GTSBE also aided with some of the paperwork necessary to charter the chapters and has provided financial assistance in the chartering process. As the collegiate chapter representing these high schools, GTSBE is responsible for planning programs, events, and activities that cater to the high school students. GTSBE also provides mentors and access to a leading research institution that otherwise would not be available.

Although GTSBE does programmatic planning for the NSBE Jr. chapters, it is the goal of the organization to have independent and self-sustaining NSBE Jr. chapters at local high schools. The collegiate mother chapter, ideally, should only serve as a guide and advisor. The NSBE Jr. chapters aim to replicate the structure, mission, and programs of the collegiate chapters, which includes active planning and ownership by the students themselves.

## **Implementation: What does NSBE Jr. do?**

### **Structure**

NSBE Jr. at the collegiate and alumni level serves as a professional organization with officers, budgets, and business meetings. For example, GTSBE is a 200-member organization that is managed by student volunteers. The purpose of a NSBE Jr. chapter is to replicate the collegiate model, hence a president, secretary, treasurer, and other officers are elected, meetings are held, funds are raised, and budgets are tight.

Even though every attempt has been made to replicate the collegiate model, the high school atmosphere is entirely different. Students are in class all day, and NSBE Jr. is not a professional organization, but an extracurricular activity for them. All of the students are involved in other organizations, after-school activities, or work, making it impossible for everyone to attend every meeting. In order to minimize the burden on the students, general meetings are held once a week and are an hour long; however, the executive board meets one additional time during the week to plan for the general meeting. At least one advisor attends each event and meeting. It is important for the long-term sustainability of the chapter that at least one teacher serve as an active advisor. It is the advisor's task to help plan and implement programs for the NSBE Jr. chapter.

### **Activities, Events, and Programs**

NSBE, as an organization, is program driven, meaning there are large numbers of events and programs for the students. Some are designed and developed by the National Organization, some come from GTSBE, and some are planned by the NSBE Jr. chapter itself. These activities are fun, provide an understanding of engineering principles, improve math and science skills, establish communication and leadership skills among members, and help the greater community.

During the past year, the STEP NSBE Jr. chapters:

- Organized and planned chapter meetings,
- Created posters that explained fundamental skills needed to pass the science portion of the Georgia High School Graduation Test,
- Created science-related demonstrations for elementary and middle school students,
- Attended ACT/SAT preparatory workshops,

- Listened to industry and academic speakers,
- Traveled to Florida for the Region 3 Fall Conference, and to California for the National Convention,
- Competed in a variety of academic competitions sponsored by NSBE, such as engineering design and mathematics competitions,
- Learned about the fundamentals of computer programming, web page design, and Deoxyribonucleic Acid (DNA) testing,
- Competed in a Lego Mindstorm Challenge at Georgia Tech,
- Organized a NSBE Parent Night,
- Developed a school-wide 'Science Olympics', and
- Raised funds by selling member-designed T-shirts.

In addition to providing rich experiences outside of class, NSBE Jr. can also be very beneficial within the actual classroom.

### **The High School Teacher's Perspective: What is the value added to classroom experience?**

One of the STEP partner schools offers an Introduction to Engineering course. Students in this course learn about the history of engineering, engineering disciplines, the engineering method, and application of this method to various projects throughout the course. As a project-based class it focuses on student interaction and demonstration of achievement.

NSBE Jr. enhances this course by providing:

- An environment where other students learn the value of this information
- College role models that speak to students on engineering school and life skills
- Role models that speak to students on their engineering discipline and life skills
- Competitions where students can apply what they have learned in class

Students in the Introduction to Engineering course are expected to give presentations and facilitate an associated activity on a specific field of engineering at NSBE Jr. meetings. By having an audience outside of class it forces the students to gain deeper understanding of the field because they have to explain it in laymen's terms. In addition, by developing an activity they have to demonstrate an understanding of the application of math and science in engineering.

In addition, NSBE Jr. provides college and professional role models that motivate the students. In particular the female college role models have inspired female students not to see engineering as an all-male profession. The professional role models have also inspired students to see themselves as technology producers, not just consumers.

Lastly, NSBE Jr. has added an element to the Introduction to Engineering course that has demonstrated the value of what they are learning. By participating in and winning the NSBE Jr. design competition at the Region 3 Fall Conference, students have come to value the use of the engineering method and a systems perspective beyond engineering, and are applying this systems analysis philosophy to other areas of their lives.

NSBE Jr. adds inspiration to the information provided in the Introduction to Engineering course. This inspiration is the fuel that keeps the students motivated to achieve.

## **Conclusion and Benefits: What can everyone gain?**

Georgia Tech was able to successfully initiate NSBE Jr. chapters in these three partner schools because of the presence in the schools of Georgia Tech graduate students. Although the chapters are still in their infancy and long-term evaluation data is not yet in, all of the direct participants—the graduate students, teachers, high school students, and school administrators—report that the NSBE Jr. chapters provide them with very valuable experiences. Because of the national trend towards emphasizing school-university partnerships, it is useful to reflect on what benefits are obtained from these NSBE Jr. experiences as we try to build bridges between the K-12 and higher education communities.

### **For High School Students**

The high school students benefit from a NSBE Jr. chapter at their high school in a variety of ways. However, they mainly benefit from the link between classroom instruction and applying this knowledge through the various NSBE Jr. activities. By applying the classroom knowledge through projects, presentations, and competitions outside of the classroom, students are motivated to gain further knowledge about math, science, and engineering. With the involvement of STEP Fellows and members of GTSBE in the NSBE Jr. chapters, the students have access to mentors and resources not afforded to most high school students. The high school students are also exposed to college life and expectation early in the decision process, and involvement with NSBE Jr. opens channels for easy access to information about math, science, and engineering curricula and university admission.

### **For High School**

Through the implementation of NSBE Jr. chapters the high school gains an additional academic and extracurricular outlet for its students, more motivated students, and a forum within which teachers can make the material relevant to the students. The high school is also able to form a relationship with the university associated with the NSBE chapter. This relationship is beneficial for the high school in terms of additional resources, access to information, and a closer relationship with the Office of Admissions.

### **For Graduate Students and GTSBE**

The most rewarding aspect of the involvement with the NSBE Jr. chapters for the graduate students and the members of GTSBE is the ability to share knowledge and experience with the high school students in an effort to aid them in making decisions and choices in their lives. Another important aspect is the ability to create interest within the high school students in their fields of study and to make these fields relevant to the life of the high school students.

For the graduate students explicitly, working with NSBE Jr. chapters is also a chance to impact students lives. For some of the Fellows, that in and of itself is enough. However, there are some STEP Fellows who intend to pursue academia as a career. Activities like NSBE Jr. afford them the opportunity to get acclimated to the types of service activities that faculty members undertake

before joining a faculty. Having a structured and positive situation like NSBE Jr. ingrains in the STEP Fellow a commitment to continued service, and indirectly bolsters the academy, as the Fellows take that commitment with them as they enter.

For GTSBE, as an organization, creating and sustaining NSBE Jr. chapters is instrumental in providing a continued stream of members for their organization. By having the junior chapters, the organization is feeding its own pipeline with the hope that the high school students will matriculate to an engineering program and help sustain the organization at the collegiate level.

### **For the University**

The university gains highly skilled and motivated students who will be eager to attend the school associated with their NSBE Jr. chapter. Essentially, NSBE Jr. does an excellent job recruiting quality students for the university. At the same time, participation with the NSBE Jr. activities offers a valuable service opportunity for faculty members. Finally, participation from the university exemplifies the universities commitment to strengthening the state of education in the surrounding community.

There are numerous educational opportunities, such as NSBE Jr., available to K-12 schools if the teachers and administrators have the time and energy to pursue them. Judging by our experiences with the STEP program's involvement with NSBE Jr., one of the most valuable contributions that university students, be they graduate students or undergraduate students, can make to a local school is to help locate and coordinate educational opportunities for the school community. Therefore, the efforts of one student, with the involvement of a NSBE Jr. chapter, can greatly augment the educational system and benefits for all.

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