Engineering Outreach by High School Students in NSBE Jr.

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Abstract – The Tri-Cities High School engineering club, which is very active in the East Point, Georgia community, is a part of a larger organization, the National Society of Black Engineers (NSBE), under NSBE's Pre Collegiate Initiative. The NSBE Jr. Club meets every week and participates in activities and projects centered around science and engineering. Graduate students that participated in the Georgia Tech Student and Teacher Enhancement Partnership (STEP) program, which is an NSF funded GK-12 initiative, serve as NSBE Jr. advisers and mentors. While working with the STEP Fellows, the high school students enhanced their leadership and technical skills, and impacted the community by planning and implementing a variety of elementary, middle and high school outreach events. This paper will present the specific activities used in the outreach programs, and lessons learned regarding engineering outreach in low income, minority communities.

Keywords: NSBE, outreach, STEP, engineering, K-12.

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INTRODUCTION

The Georgia Institute of Technology Student Teacher Enhancement Partnership (STEP) Program is a NSF funded program that partners advanced undergraduate and graduate fellows with metro-Atlanta area high school teachers. The goal of the STEP Program is to improve the teaching-related communication and leadership skills of Georgia Tech students and to take advantage of the fellows' scholarly expertise to increase the mathematics and science performance of Atlanta-area school students. The primary benefit anticipated for the STEP fellows is that they have an opportunity to increase their skills as it related to science and mathematics teaching, communication, and leadership. The STEP fellows also gain a deeper understanding of the educational challenges that affect the country's production of scientist, mathematicians, and engineers. The high school students benefit by having a classroom mentor who has chosen to pursue science, mathematics or engineering as their career. Most importantly, the high school teachers benefit by obtaining new content knowledge and an improved understanding of science, the scientific process, and the integrated nature of knowledge [5].

Along with working in the classroom, STEP fellows also participate in afterschool science and engineering clubs. Some fellows have even started chapters of National Society of Black Engineers (NSBE) and Engineers Without Borders clubs. At Tri-cities High School, NSBE Jr. engineering club was started by a STEP fellow in 2002 and has been maintained by STEP fellow since its interception. This study focuses on the Tri-cities NSBE Jr. engineering club and its impact on the high school members and the STEP fellows.

Tri-Cities High School Demographics

Tri-Cities High School (TCHS), located in Eastpoint, GA, has a total student enrollment of 1,785 students, with a student to teacher ratio of 14:1 [6]. In the state of Georgia, schools are graded on whether they make Adequate Yearly Progress (AYP) in nine categories. In the 2006-2007 academic school year, TCHS made AYP in all nine categories [1]. For the 2007-2008 academic school year, TCHS made AYP in six of the nine categories [2]. AYP is part of the No Child Left Behind Act that was designed to hold schools accountable for their students' academic performance. The racial demographics of Tri-Cities High School and of the after school engineering club can be seen in Table 1 [6]. The make up of the engineering club by gender and race for the most part accurately reflect the make up of the school.

Table 1. Race and sex demographic by percentage

	TCHS	Club
Race		
Black	82%	85%
Hispanic	13%	5%
Asian	2%	10%
White	2%	0%
Multiracial	1%	0%
Sex		
Male	47%	45%
Female	53%	55%

Table 1. Race and sex demographics of Tri-Cities High School and of the students that participate in the after school engineering club.

Structure of Engineering Club

The Tri-Cities High School engineering club is part of the National Society of Black Engineers (NSBE) Pre-College Initiative (PCI) program. NSBE was started at Purdue University in 1975 and is the largest student managed

organization. The mission of NSBE *is to increase the number of culturally responsible black engineers, who excel academically, succeed professionally, and positively impact the community*. The PCI Program is designed to stimulate the interest in science, technology, engineering, and mathematics (STEM) fields and encourage K-12 students to pursue technical degrees [4]. The PCI program provides activities to help students discover firsthand how engineering and technology relate to the world around them and discover the excitement of academic excellence, leadership, technical development, and teamwork.

At Tri-cities High School, 20 students participate in the NSBE Jr. engineering club. These students, along with a teacher advisor, work to fulfill the NSBE mission and learn more about engineering. The students are given opportunity to fill leadership positions, such as president, vice-president, treasurer, and secretary. These positions require the students to maintain a certain level of involvement and responsibility. These leadership roles keep the students actively engaged and gives them a sense of ownership over the organization. The students also attend NSBE conferences, where they are given and opportunity to network with other NSBE Jr. students and are exposed to companies and colleges. The students are the best recruiters for the organization. They invite their friends and classmates to join the club and they motivate each other to actively participate in meetings and conferences. STEP fellows also invite students in their classes who have an interest in STEM careers to join NSBE Jr.

While Tri-Cities High School has NSBE Jr to expose students to STEM fields, there many other engineering and science clubs whose mission is to motivate students to pursue technological fields. Two such organizations are Engineers with Borders (EWB) and SECME. EWB exposes students to engineering and its use in solving humanitarian crisis. SECME hosts engineering competitions each year for students to display their engineering skills and compete against other students. Both organizations, as well as NSBE, seek to give students a glimpse of the engineering field and allow students to have hands on experience. NSBE differs because it seeks to increase the number of engineers in a specific demographic, which is historically represented. Students can benefit from joining any of three organizations to get an idea of the importance of STEM careers.

DISCUSSION

The goal of the Tri-cities NSBE Jr. club is to stimulate interest in science and math through active outreach into the community. This goal was approached in a very diverse way with a variety of programs. The engineering club students participated in K.I.D.S. Club, a Georgia Tech Saturday program designed to enhance and encourage curiosity and enthusiasm for STEM fields, where they used a fun activity to teach an introductory industrial engineering concept on assembly line efficiency. The students also attended NSBE's Region 3 Fall Regional Conference (FRC) for the past two years and presented a workshop to other K-12 students. Tri-Cities' first annual NSBE Jr. STEM Day was introduced by this engineering club, where the high school students presented demonstrations to encourage local 4^{th} and 5^{th} grade students to pursue technical careers. These outreach activities are aimed to share science and technology with students in their community while increasing their own understanding and interest in science and technology.

KIDS Club

The Center for Education Integrating Science, Mathematics, and Computing (CEISMC) is a partnership uniting Georgia Tech with many other educational groups, schools, corporations, and opinion leaders throughout the state of Georgia, toward one common goal: to ensure that K-12 students in Georgia receive the best possible preparation in science, mathematics, and technology as they seek their place in the modern world [7]. Georgia Tech's Kids Interesting in Discovering Science (KIDS) Club is a CEISMC program designed to enhance and encourage curiosity and enthusiasm for science, mathematics, engineering and technology [3]. Students in grades 2-5 are invited to join the student-centered, hands-on discovery sessions on Saturday mornings.

The TCHS NSBE Jr. Chapter participated in KIDS Club in two different capacities. First, the chapter used KIDS Club as a fundraising opportunity by selling refreshments to the participants during the breaks. The second, and more focused capacity, was as an outreach opportunity with 4th and 5th grade participants. The workshop session was titled "Revolutionizing the Cookie Industry". In this session, the elementary school students learned how

product output was revolutionized during the industrial age by operating an assembly line to run their own cookie company. At the end of the session the 4th and 5th graders were able to take their finished products home.

The NSBE Jr. students prepared for this session by familiarizing themselves with the engineering field, and more specifically industrial engineering. They prepared a PowerPoint presentation that gave to the 4th and 5th graders an introduction to engineering and a more in-dept discussion on industrial engineering. Afterwards the 4th and 5th graders attempted to produce a number of decorated cookies with limited direction. The NSBE Jr. students later instructed the 4^{th} and 5^{th} graders on how an assembly line would increase production efficiency. With this new knowledge and direction, the 4^{th} and 5^{th} graders successfully completed the cookie decorating activity in the allotted time. Following the activity, the NSBE Jr. students administered a miniature quiz, to gauge what the 4th and 5th learned about industrial engineering. Following the quiz, the NSBE Jr. students fielded questions that the 4^{th} and 5^{th} graders had about the project and about industrial engineering in general. To effectively answer questions, the NSBE Jr. students had to reflect on what they knew about engineering and how to properly communicate that to 4th and 5th grade students.

The KIDS Club program was beneficial in many ways. The program gave the NSBE Jr. students an opportunity to take leadership initiative by forcing them to organize and facilitate the entire discovery course; it helped the students develop their ability to self-educate and teach by forcing the students to become familiar with industrial engineering history and practices, and the program also allowed the students to develop a sense of community responsibility by encouraging outreach to younger students.

NSBE Region 3 Fall Regional Conference

The Fall Regional Conference is a three day event that takes place every year and draws close to 800 participants from universities, high schools, and corporations across the southeastern region of this country. It is a meeting of the minds, where NSBE's three different membership demographic groups (Alumni, Collegiate and NSBE Jr.) get together to share their passion for science, technology, and engineering. At the conference, the TCHS NSBE Jr. Chapter participates in a Try-Math-A-Lon, where they compete against 7 other high school in a quiz bowl focused on math and NSBE history. The students placed in second and third place in 2007 and 2008, respectively. In addition to this, the TCHS NSBE Jr. Chapter is the only PCI chapter that has sponsored and facilitated a workshop at the regional conference.

The 2007 FRC took place in Jackson, Mississippi in October 2007 and the TCHS engineering club students designed and presented a workshop to fellow high school students on time management. This workshop focused on building the skills needed to be a successful science or engineering student in college. Time management is a critical skill that is needed for high school and college students to be successful. The TCHS students reenacted scenarios that each workshop participant had experienced, and the participant had to explain how they would manage their time in that situation. There was also a presentation given to the students on effective time management skills and how to build those skills. As the students presented their scenario and how they would react to and handle the situation, they were judged on how effective they were in managing their time. After the participants were judged, there was a feedback session on how one could improve on their decision making process and in turn increase their effectiveness in time management.

At the 2008 FRC conference in Jacksonville, Florida the students facilitated a workshop titled "Effective Team Work", where they had teams of middle school students build rockets. The goal of the workshop was to stimulate the students' interest in engineering and to emphasize the importance of teamwork. Seven students from the TCHS NSBE Jr. Chapter facilitated the workshop to approximately 25 middle school students. The workshop included an interactive role playing scenario, a PowerPoint presentation, and the building and testing of the rockets. The middle school students were able to work in teams of five to build their rockets after drawing a sketch of their rocket building plan. After the rockets were built, the rockets were submitted into a flight test, to see which rocket flew the farthest distance. After the flight test, the students reflected on what could have been done to make the rockets fly a greater distance.

In presenting these workshops, the students enhanced their organization, communication, and technical skills. The students planned and prepared the workshop during their normal class schedule and afterschool at the NSBE

meeting. They presented a well organized workshop with specific tasks, goals, and desired outcome. By doing this, their organization skills were greatly improved. During the workshop the students enhanced their verbal and non-verbal communication techniques. Presenting a workshop orally, with the aide of a PowerPoint presentation, is a great experience for a high school student and will benefit them when they move on college.

NSBE Jr. STEM Day

The engineering club at TCHS along with their teacher/advisor decided that there was a great need to expose younger students to science and technology in their community. Many students are not choosing the engineering or science fields because they did not know enough about it, and they don't feel prepared to succeed. After brainstorming on how to attack this problem in their community, the students decided to start an annual TCHS NSBE Jr. STEM Day. This day would be geared towards informing elementary school students in the community about the opportunities in STEM fields.

To advertise the event, an announcement was sent out to the elementary schools in the Eastpoint, GA area. The club members began to plan for this event by decided what exactly they wanted to share with the younger students in order to grab their attention and focus it on the fun of science. The NSBE Jr. members facilitated five different classes that day that focused on engineering, biology, chemistry, physics and mathematics. The elementary students rotated from classroom to classroom to learn about the five subjects.

STEM Day took place on a Saturday, February 15, 2008, and there were approximately 50 elementary school students that participated in the day full of science and fun. The NSBE Jr. students needed to have a deeper understanding of the science and math concepts that they were teaching in order to properly communicate them to elementary school students. This allowed for our students to increase their breadth of knowledge and understanding of science, technology, engineering and math at the same time as when they were doing outreach to the community.

Tri-cities NSBE Jr. club is an very active organization, however one challenge is keeping the students engaged. Students are busy balancing school, NSBE, work, and other extracurricular activities. One solution is to have the students plan the activities so that they can take responsibility for the organization's activities. Planning and participating in the programs gives them experience that they can add to their resume to strengthen their college applications. Tri-Cities has also won several NSBE regional awards for Tri-Math and for their International Fair Display. This also helped to keep students engaged with the club. The programs and meetings are constantly being evaluated and student feedback is always considered to make sure that students are getting the most from the program.

SUMMARY

The TCHS NSBE Jr. chapter has been a rewarding experience for both the high school students and the Georgia Tech STEP Fellows. Tri-Cities High School has also benefitted from the increased exposure to universities and companies through their NSBE conference participation. The students have been successful in the regional competitions and in their conference workshop presentations. TCHS students are also continuing to fulfill the NSBE mission by actively participating in their community to inspire other students to pursue engineering. The students have a greater exposure to STEM career fields and they have had an opportunity for greater participation in conferences. STEP fellows will continue to participate with the TCHS NSBE Jr. Chapter to ensure that the students are prepared for future careers in engineering and science.

For the future, Tri-cities NSBE Jr. will continue to host outreach workshops for the community. To get more students involved other organizations, such as National Honor Society, will be invited to participate with the outreach programs. The students will also have the opportunity to work with other NSBE Jr chapters in Metro Atlanta to increase their influence outside of their community. Tri-cities NSBE Jr members, along with the STEP fellows, will continue to fulfill the NSBE mission and encourage more students to purse STEM careers.

REFERENCES

[1] Georgia Department of Education - Adequate Yearly Progress (AYP) 2007. [cited 2008 Nov. 16]; Available from: http://www.doe.k12.ga.us/ayp2007.aspx.

[2] Georgia Department of Education - Adequate Yearly Progress (AYP) 2008. [cited 2008 Nov. 16]; Available from: http://www.doe.k12.ga.us/ayp2008.aspx.

[3] Kids Interested in Discovering Science. [cited 2008 Nov. 20]; Available from http://www.ceismc.gatech.edu/kidsclub.

[4] NSBE| About Us >> The Mission. [cited: 2008 Nov. 1]; Available from: http://national.nsbe.org/AboutUs/TheMission/tabid/67/Default.aspx

[5] STEP Program. [cited 2008 Oct. 27]; Available from: http://www.cetl.gatech.edu/step.

[6] Student Teacher Ratio Tri-Cities High School – East Point, GA. [cited: 2008 Nov. 24]; Available from: http://www.greatschools.net/cgi-bin/ga/other/1034#toc.

[7] The Center for Education Integrating Science, Mathematics, and Computing. [cited 2008 Nov. 20]; Available from http://www.ceismc.gatech.edu/.

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Akibi Archer received his Bachelors degree cum laude in Mechanical Engineering from the University of Florida in 2007, with minors in Sales Engineering and Biomechanics. He is currently a graduate student in the George W Woodruff School of Mechanical Engineering at the Georgia Institute of Technology. His research focuses on determining the in-vivo mechanical properties of skeletal muscle by studying the propagation of naturally occurring vibrations. Akibi is currently a STEP Fellow working at Tri-Cities High School and has served numerous positions regionally and nationally in NSBE.

Samantha Andrews

Samantha Andrews is a Ph.D. student in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech, where she is studying transdermal drug delivery. Her thesis is focused on using skin abrasion for to increase the skin's permeability to drugs. She was a 2007-2008 STEP Fellow at Tri-cities High School and also served as an advisor and Try-Math-A-Lon coach for the TCHS NSBE Jr. Chapter. In 2005, she was named the NSBE Mike Shinn Distinguished Member of the Year and continues to participate in NSBE by working with TCHS NSBE Jr.

Karolyn Babalola

Karolyn Babalola is a Ph.D. student in the School of Electrical and Computer Engineering at Georgia Institute of Technology. She received her B.S. in computer engineering at the University of Maryland Baltimore County where she was a Meyerhoff scholar. She is currently doing research in brain computer interface in the Brainlab under the advisement of Dr. Melody Moore Jackson and Dr. Robert Butera. Karolyn is a Georgia Tech Presidents Fellow, a Texas Instruments Focus Fellow, an IBM Focus Fellow and a FACES Fellow. Karolyn is motivated by her desire to increase diversity in research, particularly by increasing the number of African Americans pursuing Ph.D.'s in science and engineering. She tutors undergraduate minorities in engineering and works to motivate high school students to study engineering in college.

Jacqueline Fairley

Jacqueline is an alumnus of the University of Missouri-Columbia where she attended as a George C. Brooks scholar and graduated with a B.S. in Electrical Engineering and a Minor in Mathematics. Upon completion of her bachelor's degree she obtained a graduate fellowship from the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM)and Motorola Inc., to pursue graduate education at the Georgia Institute of Technology. She is currently under the advisement of Dr. George Vachtsevanos and Dr. David Rye in pursuit of her Ph.D. in EE. Presently, her research focus involves the investigation of novel methods for quantitative sleep modeling and artifact removal for polysomnogram data. Her career goals include the attainment of an academic position at a research oriented institution and technical consulting.

Margaret Tarver
Margaret earned her Bachelor of Science in chemistry from Alabama A&M University and a Master's Science in Education from Georgia State University in 1996. She has been a teacher in the Fulton County school system for over 20 years. She has served as the Science Department Chair and senior class sponsor at Tri-Cities High School. Margaret is a member of Georgia Science Teacher Association, National Science Teacher Association and Georgia Association of Educators. In 1992 she was awarded Teacher of the Year and the Tandy Science/Math Teacher of the Year.