
AC 2011-1525: THE CREATION, DEVELOPMENT, AND IMPLEMENTATION OF THE CULTIVATING ADOLESCENTS IN SYSTEMS ENGINEERING HABITS (CASH) PROGRAM FOR OUTREACHING TO INNER-CITY BALTIMORE MIDDLE SCHOOL STUDENTS

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In 1987, Dr. Carl White joined Morgan State University's School of Engineering in Baltimore, Maryland, as an assistant professor. He is currently the Associate Dean for Research & Development and Graduate/Professional Programs, as well as a full professor in the Department of Electrical Engineering. Dr. White has over ten years of experience in the management of funded research, both technical and educational. Dr. White's most recent award was from NASA's University Research Center program to establish the Center of Excellence in Systems Engineering for Space Exploration Technologies. As the Associate Dean for Morgan State University's School of Engineering, Dr. White's primary tasks are to provide support for the research endeavors conducted by faculty and associate researchers within the School of Engineering, to oversee the quality of the graduate program offerings, and to manage recruitment and retention programs in order to establish and sustain a pipeline of quality engineering graduate students and research professionals.

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The Creation, Development, and Implementation of the Cultivating Adolescents in Systems Engineering Habits (CASH) Program for Outreaching to Inner-City Baltimore Middle School Students

Background

In an ever-changing global society, it has become increasingly difficult to remain competitive on the international scene. The United States (U.S.) has traditionally been one of the world leaders in terms of technological innovation and scientific advancements. In order for the U.S. to maintain its global status, it is essential that it preserves the pipeline that provides the science, technology, engineering, and mathematics (STEM) professionals. However, that pipeline is currently insufficient and shrinking. Additionally, as the country continues to increase its technology requirements and needs, the demand for qualified and quality STEM professionals will continue to grow. If this pipeline shortage is not adequately addressed, it will pose a significant threat to America's position in the world.

Furthermore, the U.S. pipeline needs to increase its diversity. The U.S. is a country full of diverse people with distinct ethnicities, backgrounds, and beliefs. However, this diversity is not represented among the STEM professionals in the country. In fact, underrepresented minorities represent only a small fraction of the individuals currently in STEM majors and careers in America. African-Americans and Hispanic Americans represent only 1 in 10 of the engineering occupations in the country². The benefits gained from a more diverse pipeline include unique perspectives and viewpoints, as well as a larger pool of ideas and concepts.

Moreover, outreaching to historically underrepresented groups can prove beneficial while the U.S. attempts to address the shortage in its STEM pipeline. According to the National Science Foundation (NSF), African-Americans account for about 15 percent of the population between ages 20 and 24, but only about 8 percent of science and engineering degrees are earned by them¹. Data from the 2000 Census shows that African-Americans represent over 60% of the population of Baltimore City, Maryland. The population in Baltimore serves as a great opportunity to implement strategies, initiatives, and programs that can be duplicated and expanded to serve similar populations across the country to address the national pipeline STEM shortage. In response to these challenges, the Cultivating Adolescents in Systems Engineering Habits (CASH) summer program was created.

Introduction

In 2009, the Innovative STEM Foundation (ISF) created the Cultivating Adolescents in System Engineering Habits (CASH) program. CASH is a summer program designed for middle school students (Rising 7th and 8th graders) that allow the participants to gain an understanding of critical thinking principles, team working skills, basic research fundamentals, and a general understanding of system engineering standards. CASH is devised to be an innovative, educational, and exciting program for middle school students. Its purpose is to introduce and excite middle school students about STEM, through the practice of system integration, system engineering habits, and critical thinking. CASH aims to stimulate and sustain interest in STEM subjects and careers at early ages for the program participants.

ISF has teamed with its co-sponsor, the Center of Excellence in System Engineering for Space Exploration Technologies (CESET) within the School of Engineering at Morgan State University to offer the CASH program to inner-city Baltimore, Maryland middle school students. CESET is a NASA-funded University Research Center (URC), under the NASA Dryden Minority University Research and Education Division (MURED) managed by the Office of Equal Opportunity Programs (OEOP). CESET provides the undergraduate students who serve as research advisors during the CASH program. The undergraduates assisting with the program are also impacted, as they acquire management skills while helping facilitate the program. The undergraduate students also gain community involvement experience when dealing with the CASH students who come from assorted backgrounds. Also, through this collaboration between CESET and ISF, system engineering instructional models for CASH have been created and are in development for the program.

The CASH students spend five weeks over the summer at Morgan State where they are instructed in a student-centered learning environment and are exposed to critical thinking principles, system engineering basics, and team-working skills. During the program, the CASH students conduct NASA-related research, complete a project, and present their findings in a research exposition at the conclusion of the summer program.

For the 2010 program, NASA's Jet Propulsion Laboratory (NASA-JPL) in Pasadena, California worked with ISF over the spring and provided the CASH program with both a Solar-based and a Telecom-based project for its CASH students. These two projects allowed the CASH students to work in research areas relevant to NASA.

Program Description

Selection of Participants

For the first two years of the CASH program, students have been provided to the program through a partnership with the Bluford Drew Jemison (BDJ) STEM Academy located in Baltimore, Maryland. BDJ is an all-male STEM academy in the Inner-City of Baltimore that is pre-dominantly African-American, and their middle school students have participated in the Pilot Phase of the CASH program. Two different cohorts of students have been provided to the summer program exclusively from BDJ STEM Academy since 2009.

In the future, CASH will be available to all middle school students, but the target groups will be primarily historically underrepresented groups, specifically racial minorities and women. The students provided by BDJ were used to determine the effect that the program would have on students in general, as well as, students with similar backgrounds. CASH is aimed toward students who otherwise wouldn't be exposed to, or interested in, STEM fields and disciplines. The number of participants in the program is based on available funding for the program.

Program Layout

In CASH, each day is broken into two periods, Instruction and Lab. During the instructional portion of the day, the CASH students are educated on the fundamentals of system engineering,

basic critical thinking principles, as well as given math reinforcement. The instructional half of the day is delivered in a traditional classroom-setting. CASH students are shown the connection between their lives and each of the course lessons. There are pre-assessments and post-assessments given during this portion in order to determine the effectiveness of the material being taught. Undergraduate engineering students are used primarily as teachers for the CASH students in these courses.

Brief Overview of Courses:

- System Engineering: Students are introduced to engineering, and all the different concentrations within the field, specifically system engineering. They are exposed to the innovations, technology, and products that have been developed by engineers. Students are also given an overview of the fundamentals and techniques involved with System Engineering, and how they can be applied to their CASH projects, as well as their everyday lives. Students are instructed on the benefits of a systematic approach to problems. During the summer of 2010, CASH students took a field trip to the NASA Goddard Space Flight Center. This trip allowed the students to see practicing engineers at work, as well as the technology they use and produce.
- Critical Thinking: CASH students are given instruction on basic critical thinking principles, and how using these principles can be helpful in problem-solving situations in life. During the course, the students are broken into groups and given different scenarios where they are able to practice these critical thinking principles. The purpose of this course is to show the CASH students that with a strong foundation of critical thinking skills, an individual will be able to make smarter decisions, implement time-saving practices, and apply a different perspective to problem solving. The CASH students are encouraged to use these lessons when working on their CASH projects.
- Math: Students are given daily math lessons, specifically Algebra-based. This is to primarily reinforce what they learned during the previous school year and to help them retain the knowledge as they prepare for the upcoming school year. Furthermore, students are also advised on how math is used in countless situations outside of the classroom, specifically in their CASH projects.

The second half of the day is Lab. This is primarily a hands-on, out of the classroom learning environment for the students. It is during the Lab component that the students are given the opportunity to apply the lessons and the system engineering techniques they were taught during the Instruction component. They work in groups, developing their team-working skills, as they complete the CASH projects. CASH students work with undergraduate engineering students who assist and advise them on their projects. The undergraduate students provide the CASH students with the basic fundamentals required for the research the CASH students will conduct throughout the program.

During the 2010 Summer, the CASH students worked on the projects developed by NASA-JPL. At the start of the program, a video conference was conducted with the engineers at NASA-JPL using Adobe Connect technology provided by the School of Engineering at Morgan State University where students were given an introduction to the projects they would be working on

over the summer. At this video conference with the NASA engineers, the CASH students were given their project parameters. The CASH students were also introduced to the Juno mission that the engineers were working on, and their future planned trip to Jupiter. The CASH participants were able to interview and ask the engineers questions via the video conference. This feature of the program was particularly important because the students were given the feeling and impression that the work they were doing and knowledge they were gaining actually had real life applications.

CASH Program Weekly Schedule

Week One:

Instruction:

1. 1st Course: Fundamentals in System Engineering (**Pre-Assessment**)
2. 2nd Course: Critical Thinking (**Pre-Assessment**)
3. 3rd Course: Math (**Pre-Assessment**)

Lab:

1. CASH students will conduct background research on NASA and its missions.
2. CASH students will receive project specifications and description.

Weeks Two-Four:

Instruction:

1. 1st Course: Fundamentals in System Engineering
2. 2nd Course: Critical Thinking
3. 3rd Course: Math

Lab:

1. CASH students will work in teams with advisement from the undergraduate students to complete the assigned NASA-project.

Week Five:

Instruction:

1. Final Assessment for System Engineering Fundamentals
2. Final Assessment for Critical Thinking
3. Final Assessment for Math

Lab:

1. Final System Integration of project from teams.
2. Final presentation to NASA.
3. Final presentation to parents and family.

Conclusion

Every year, the students are given pre- and post surveys to determine how effective the CASH program was in changing their perceptions about the STEM field, specifically engineering. The data has been recorded and will be analyzed in the future to determine the effectiveness of the program components and its

impact on potentially adding these students to the pipeline. Students are also given pre- and post assessments to ascertain how much knowledge they gained as a result of the classroom instruction and its application in the CASH program projects. There was also continued interaction with the program participants throughout the academic year as undergraduate students provided tutoring. Also, the CASH students participated in the Innovative STEM Conference (ISC) during the spring.

Future additions to the program include continued interaction and participation in NASA-JPL's Juno mission. There will also be a comprehensive strategy for continued interaction with program participants during the school year. Additionally, once the pilot phase of the program is complete, CASH will increase the number of participants as well as open the program to the general public with an emphasis on targeting underrepresented minorities.

Bibliographic Information

1. Chute, E. (2009, February 10). Lack of diversity part of equation in stem fields. Pittsburgh Post-Gazette, <http://www.post-gazette.com/pg/09041/947952-298.stm>
2. Freeman, A., Persaud, A., Kharem, D., Rothwell, W., & Yoder, E. (2010). Money, math and engineering graduation: more high school funding could mean more underrepresented engineers. Proceedings of the American society for engineering education (pp. 1-3). <http://soa.asee.org/paper/conference/paper-view.cfm?id=24952>.