THE STEM INSTITUTE

SUMMER 2011 ANNUAL REPORT

December 2011

Grove School of Engineering/ STEM Institute
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the City College of New York

Welcome to the Grove School of Engineering at The City College

We benefit from both an outstanding heritage and high record of achievement. Founded in 1847, City College is America's first public institution of higher learning. It is the flagship campus of the City University of New York, which has an enrollment of nearly 200,000 degree-seeking students and over 150,000 continuing education students.

As a snapshot of history shows, City College is a consistent producer of long-distance runners on the American educational landscape. Between 1920 and 1970, for example, more of City's graduates earned Ph.D.'s than graduates of any other university in the U.S. Even when it had no graduate programs of its own — and no research facilities — nine of City's graduates went on to earn the esteemed Nobel Prize. This is an unsurpassed record for a public institution.

The College's Grove School of Engineering is the technological crown jewel of CUNY, the one and only engineering school in the system. Through its five academic departments, the Grove School offers undergraduates and graduates a broad range of traditional and newly emerging multidisciplinary degree programs. The faculty are known for their outstanding teaching/learning prowess, and professors are involved in more cutting-edge research enterprise right now than at any other time in City's history.

The heritage of faculty excellence has given the Grove School of Engineering its best product: outstanding and sought-after graduates. They demonstrate technical expertise as well as real-world skills appropriate for today's global workforce. And since our demanding social and academic environment reflects the multi-faceted world in which we live, our students are primed for the culturally diverse and technologically challenging world of work that lies ahead. The School provides a unique platform for students eager to help define the very nature of successful society.

Of course, as we embark on the technological millennium, the School is also poised to seize the opportunities to influence the new global engineering. You are invited to navigate through these pages, to learn how we may do this. Please, acquaint yourself with the exciting and energizing learning environment of which we are so proud.

Joseph Barba

Dean of the Grove School of Engineering

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History and Mission of the Program

The Science, Technology, Engineering and Mathematics (STEM) Institute was founded in 1992 on the campus of The City College of New York (CCNY) of the City University of New York (CUNY), with a grant from NASA to CCNY's Grove School of Engineering. The program's mission is to encourage talented high school students from traditionally underrepresented backgrounds (African, Hispanic and Native Americans, women and students from disadvantaged groups) to pursue careers in engineering, computer science, science, mathematics, and technology. This six-week academic enrichment program provides students with an intensive curriculum in mathematics, physics, chemistry, critical writing and reading, engineering design/robotics, and MATLAB programming. A selected number of students are also given the opportunity to conduct research with faculty of the Grove School of Engineering in areas of civil, mechanical, and electrical engineering, as well as the sciences.

To strengthen the goals and outcomes of the STEM Institute in New York and nationally, in 1995, the program entered into a strategic partnership with a national non-profit educational services organization, CAHSEE (Center for the Advancement of Hispanics in Science and Engineering Education). Largely supported by NASA, CAHSEE is also dedicated to creating the nation's future technical and scientific workforce by preparing Latinos and other underrepresented minorities to be an integral part of that leadership. Since then, the STEM Institute has continued to developed additional strategic relationships to expand its mission through foundation such as the Dorr Foundation, CUNY, and the New York City Department of Education (DoE), which has allowed the STEM Institute to offer high school credit to high school students who complete the program, improving their academic success in high school. The STEM Institute has also other internal and external partnerships.

Student Population

The population of students served by the STEM Summer Institute includes students entering grades ten, eleven, and twelve who are largely from public high schools throughout the New York City metropolitan area. The STEM Institute seeks students who; (1) have an interest in STEM fields, (2) show potential for success in STEM majors, (3) achieved a minimum high school average of 90, and (4) are committed to successfully completing the program. Students can apply to the program on their own or they can be nominated by their schools administrators and counselors, community agencies, or other organizations to enroll in the STEM Institute.

Students Served

There is no cost to participate in the STEM Institute and it is open to all New York City public high school students in grades nine through eleven. However, preference is given to previous STEM Institute participants. Participants are selected for the program through a competitive application process. The student applicant pool for this year (2011) was comprised of 280 applicants from 66 different high schools of which 47 (73%) were from New York City public high schools, 9 (14%) were from high schools outside New York City, and 8 (13%) were from private high schools. Based on their academic records, 194 of the 280 applicants (69 %) were invited to take the STEM Institute placement exam in college-level advanced algebra and pre-calculus. From those 194 applicants, 167 (86 %) students were accepted. This is an increase of 43 students from 19 more high schools than the program served in 2010 (see Appendix # for list of participating high schools).
All those accepted into the program decided to enroll in the program.

Over the years the diversity of the student body has grown, reflecting the STEM Institute's commitment to assisting students from underrepresented groups (Latino, African-American, and Native American, and women) and disadvantaged backgrounds. Special efforts are made to recruit students attending schools in underserved areas such as Washington Heights, Harlem and districts in the Bronx. This past summer, our student demographics were 45% Hispanic and African-American students enrollment and a 51% female student enrollment, 13% white-Non Hispanic, and 42% Asian-Pacific Islander.

Need for the Program

"Key to New York State's future as a global leader is tapping the underutilized talent pool that exists in the State's diverse population. New York State represents the third largest economy in country, with a dual status of having both a large proportion of wealthy citizens, as well as a large proportion of its citizens who are poor and economically disadvantaged." This dichotomous status is documented by differences in educational attainment between New York State's two largest populations, White and Hispanic, are among the largest of any state. Only 18% of Hispanics have attained college degrees, compared to 45% of Whites. Approximately 65% of New York City high school students graduate within four years. Among less needy New York State districts, the graduation rate is generally 70% or above. Low graduation rates are pervasive among the five largest urban school districts, of which New York City is a leader among these districts. While New York's overall population will remain relatively flat, significant growth is projected among demographic groups with low rates of graduation from high school (New York State Commission on Higher Education: A Preliminary Report of Findings and Recommendations, 2007).

The STEM Institute's mission is to encourage more underrepresented minorities and women to pursue STEM careers upon graduating high school. Out of the approximately 7,000 graduates annually from the New York public schools, a large majority of these students may not be exposed to, or prepared for college level study in the STEM fields. These students are too often from low income backgrounds attending underserved and crowded schools that are not likely to receive the extra lessons, tutoring, SAT preparation and encouragement that students from more advantaged backgrounds are likely to receive. Neither family members, nor teachers identify talented youth early enough and financial, social and mentoring support groups are often nonexistent, resulting in promising students losing interest or dropping out of high school altogether. While many minority and disadvantaged students are at risk of not even completing high school, STEM promoters are challenged with making STEM a priority for these youth to encourage them to attend college and facilitate their graduation in STEM and other majors.

It is incumbent upon this institution to maintain and increase New York's status as one of the top eight states in the country for producing minority engineers, and City College's status as one of the top 47 institutions in the country for this type of production. To address this issue one of the recommendations cited in the NYS Commission on Higher Education Report, (Focus on Math and Science, with Effective Intervention Models and Practices for Struggling Students, p.26), City College must play a leadership role within Education Partnership Zones (EPZ) to help restructure the mathematics curriculum, improve math preparation, and increase high school opportunity and enrichment programs.

The STEM Institute on City College's campus can serve as a model for others initiatives in New York State and across the country, that seek to help reduce the gap that currently exists in STEM workforce preparation and graduation underrepresented minorities.

Approach to Learning

The belief that all our accepted students have the potential to succeed in the STEM Institute is continuously communicated at the orientation and throughout the duration of the six-week program. Based on an assessment of the students' personal statement, teacher recommendations, and their academic records, appropriate measures are taken to ensure that each student can receive an optimal learning experience. Students are divided into eight intensive courses, based on the STEM Institute Placement Exam in math, their academic record, interest, and capabilities. They are placed in rigorous academic courses such as General Physics, Physics with Calculus Application, General Chemistry, Environmental Chemistry, mathematics (Calculus I with Analytic Geometry, Pre-Calculus and Trigonometry and Advanced Algebra), Computer Methods (MATLAB), Introduction to Engineering Design, and Critical Reading and Writing.

All STEM Institute courses are taught by City College faculty from the English, Math and Science Departments, as well as graduate students in engineering. Each STEM Institute course focuses on providing students with hands-on experience. Students are also required to apply principles learned in the classroom to real-world problems through a variety of projects, such as the Arduino Autonomous Robot, Remote Racing Car, Behavior of Light/Optics, Rube Goldberg Machine, STEM Magazines, and research poster presentations.

Course Information

Morning Courses ***(Mon-Fri, 9 AM - 12 PM)***

Course	Instructor	No. of Students
Advanced College Algebra	Prof. Nat Silver	21
Pre-Calculus	Prof. Doris Pichardo	32
Calculus	Prof. Dario Cardenas	12
Physics	Mr. Depaak Kapoor	20
Chemistry	Ms. Samema Sarowar	24
Engineering 101 (Introduction to Engineering Design)	Mr. Sebastian Pendola	17
Engineering 103 (Introduction to Computer Methods – MATLAB)	Mr. Xiaochen	21
Critical Reading and Writing	Prof. Jacklyn Janeksela	19
Total Morning Enrollment		**167**

Afternoon Courses (Mon-Fri, 1-4PM)

Course	Instructor	No. of Students
Advanced College Algebra	Prof. Nat Silver	25
Pre-Calculus	Prof. Doris Pichardo	27
Calculus	Prof. Dario Cardenas	26
Physics	Mr. Deepak Kapoor	33
Chemistry	Ms. Samema Sarowar	31
Research	Various Faculty/GSOE & Science Divison	21
Total Afternoon Enrollment		**163**

With the exception of four students who participated in previous STEM Institute courses, every student in the program enrolled in two courses for a total of six hours of daily instruction. Based on the results of their placement exams, students were placed in a combination of courses best suited for their skill level and academic progress. Upon successful completion of the STEM Institute, students received high school credit for each course. In order to accommodate a greater number of students this past summer, the STEM Institute offered two additional sessions of its most popular courses including Advanced College Algebra, Pre-calculus, Calculus I, Physics and Chemistry (see Appendices 2 and 3).

Science and Engineering Research

In addition to these class projects, the STEM Institute offered advanced students the opportunity to participate in engineering or science research projects alongside City College faculty members and graduate students. This past summer, 21 students participated in the research component of the program. Below is a brief list of the research projects students conducted:

- Ezra Rodriguez, Andre Tam, and Jamielyn Abad surveyed IT and Software Development at the City University of New York (CUNY) National Oceanic and Atmospheric Administration (NOAA)/Cooperative Remote Sensing Science and Technology (CREST) Center.

- Lucky Romero and Jenny Zhang analyzed Algorithms with data collected from the Long Island Sound Coastal Observatory to evaluate Satellite Ocean Color Sensor Chlorophyll.

- Jovani Sanchez worked on the evaluation of Multi-Sources Cloud-Top Height to estimate the concentration of clouds.

- Paul Alberton worked on determining the optimum approach for the development of arial remote sensing and processing model in arctic tundra.

- Maria Alfaro conducted research on improving biodiversity prediction through novel uses of remote sensing.

- Chayma Boussayoud studied the integration of multiple remote sensing and observations to asses regional air quality.

- Benson Qiu conducted an analysis of the effects of AOT and aerosols on precipitation.

- Nicole Caicedo explored DMSP SSM/T-2 measurements to understand atmospheric water vapor distribution.

- Xiaolu Wen worked on the analysis of the Curve Number Methodology.

Project Descriptions

Arduino Autonomous Robot: This project was one of two projects conducted by the Introduction to Engineering course. The project consisted of designing, programming and building an autonomous robot capable of navigating through a maze using the common robotic techniques of obstacle avoidance and line following.

Students were tasked with designing a mobile robot over a four wheel mobile platform where they could construct the circuits that interconnect and operate the sensors, actuators and programming board of the robot. Students also had to design the software that controlled the robot and allowed the robot to autonomously navigate through the maze successfully. The entire design process included fundamental tasks for any level of robotics research, such as:

1. Designing, assembling and soldering electronic circuits using basic principles of electronics and logical gates learned on class.
2. Designing and programming software using basic principles of robotics and the process of implementing algorithms that solve problems manifested in the real world.
3. Construction of mechanical vehicles using basic principles of robotics design integrating programmable circuits with sensors and actuators.

Remote Control Racing Car: This project was the second project for the Introduction to Engineering course. This project used a hands-on approach for teaching students how to design, program and manufacture a remote control (RC) racing car capable of autonomous navigation. Students were tasked with thoroughly researching and analyzing materials to ensure proper selection and use for their design, writing the program for the RC-car prototype and manufacturing the RC-car with a variety of components. Those components included:

1. Vehicle base
2. Ackerman steering assemble
3. Wheels and axle
4. Joystick controller

This project allowed students to gain a greater understanding of the role of electronics and their capabilities, as well as insight into more complex devices such as cell phones. Students also developed the ‘Designer’ or ‘Engineer’ mindset when analyzing technological devices as opposed to the ‘User’ mindset. All material taught can be applied to future design or engineering courses.

Behavior of Light/Optics: Students in the Advanced Physics Course designed two optics demonstrations to be presented during the closing ceremony of the program. The objective of the demonstrations was to teach students about the phenomena of light and how it behaves when it transfers between different mediums. Students studied reflection and refraction behaviors of light and researched how these optics principles are applied in modern day technology.

> **Reflection Demonstration:** For this demonstration students used a laser beam to reflect light among eight mirrors. The laser beam reflected off all eight mirrors and was reflected back to its original position. To successfully complete this demonstration, students had to understand the Law of Reflection and calculate angles of incidence and reflection for each mirror.

Refraction Demonstration: For this demonstration students once again used a laser beam to direct light into a stream of pouring water. Upon entering the water stream the light bended, this phenomena is known as refraction. The angle at which the laser beam entered the water was gradually changed until total internal refraction occurred. To present both demonstrations students had to understand how light refracts in mediums of different densities and had to know refraction occurs only when the angle of incidence is greater than the critical angle. At the end of the demonstration students discussed modern applications of refraction in fiber optic technology.

Rube Goldberg Machine: Students in the General Physics Course were asked to design and manufacture a Rube Goldberg machine. The objective of the apparatus is to perform a relatively simple task in a complex manner. This project is ideal for this course, in that it gives students the opportunity to apply difficult physics theories learned in lecture to the design of a series of simple devices that will be connected together to create a much larger complex machine. Through this project students gain a greater understanding of physic principles. For this project students also had the opportunity to work in a machine shop with a mechanical engineer and learn different techniques for constructing their Rube Goldberg machine.

This year's Rube Goldberg machine consisted of four different components and was designed to elevate a flag from ground level to a specified height. For each of the components students were required to apply theories of classical mechanics, conservation of energy, Newton's Laws and kinematics to successfully design the Rube Goldberg machine.

The four components of the Rube Goldberg machine included the following:

1. Roller coaster
2. Bridge
3. Pulley system
4. Transitional objects

The component of the rollercoaster initiated the Rube Goldberg machine. Through this first device students applied theories or velocity, linear and angular acceleration, potential energy, projectile motion, and kinematics. The second component was the bridge, through which students learned about kinetic, static and friction forces. The third major component of the Rube Goldberg machine was the pulley system. It was through the use of a rope, mass, and a two-pulley system that students planned to raise the flag. Students had to calculate the required force on one of the pulleys to be able to raise the flag attached to the second pulley. Through the integration of the rope in the pulley system students also learned about tension.

The Transitional objects of the Rube Goldberg connected the other three components and created the overall Rube Goldberg machine. The Transitional objects used designs based mainly with conservation of energy, conservation of momentum, collisions, and tension force concepts.

STEM Magazines: Students enrolled in the Critical Reading and Writing courses are asked to publish a magazine with several of their personal works. Works in this magazine are done primarily in the poetry and prose genres. Written works include poems, short stories, scripts, and narratives. Students even create original artwork for the magazine.

Prior to publication their work is constructively reviewed several times by the instructor and fellow classmates. Feedback is offered and with the improvements made the writing truly reflects the writing skills of our students. Through the magazine students get the opportunity to display some

of their best writing and artwork. The magazines are exhibited during the closing ceremony of the STEM Institute.

Research Poster presentations: Students who conduct research over the summer must present their findings to City College professors and to parents at the end of the program. For their presentation they are asked to present a poster that identifies the problem they are researching, the experimental set-up and procedure and the findings they observed during the course of the summer. Through the presentation students get the opportunity to improve their presentation skills and present the knowledge they gained through the research conducted.

Other Support Services

In addition to the above schedule of courses, the STEM Institute 2011 offered the following services:

- **Parental Involvement:** A parent and student orientation session was held before the program to discuss the roles and responsibilities of parents and students. There were also subsequent interactions with parents regarding the progress of their children.

- **Career Information/ Development Sessions:** As a part of these sessions, representatives from major corporations and CCNY Professors from Bio-Medical Engineering, the Sophie Davis School of Biomedical Education, NOAA CREST, Electrical Engineering, Chemical Engineering, and Science made presentations to students about the different career choices that are available in engineering and science-related disciplines.

- **College Informational Sessions:** Offered students information about City College's application process, financial aid, CUNY Honors programs, scholarships and research opportunities at City College.

- **Tutoring:** The program offered daily tutoring sessions from 8 AM to 9 AM and from 4 PM to 5 PM. These daily sessions are run by CCNY graduate students and focus on specific course material.

Program Infrastructure

Leadership and Management

The STEM Institute is directed by Dr. Joseph Barba, Dean of the Grove School of Engineering. His Assistant Director is Mr. Otto Marte, a City College electrical engineering graduate. Dr. Barba is responsible for leading the planning and implementation process for all program components, and is especially involved in the selection and hiring of all STEM Institute staff and budget management. The Assistant Director is responsible for the day-to-day operation of the STEM Institute and overall staff supervision. The staff of the STEM Institute is composed of 18 members; five City College Professors, four City College adjuncts, one high school teacher from the New York City Department of Education, six engineering and science undergraduate Teaching Assistants, and two administrative assistants. The Assistant Director supervises the Professors and adjuncts and they in turn supervise the Teaching Assistants.

Planning Process

The planning process for each year begins at the end of the current year's program through review and assessment of staff performance, budget expenditures, the curriculum and program components, space utilization needs related to student enrollment, students' academic progress, and student-staff-parent survey results. This data is used to plan for the next year's program and serves as a mechanism to ensure ongoing communications and involvement with participants and their families throughout the upcoming year.

The Director oversees the planning and implementation of program components that involve securing funding and space, discussions with the administration on program needs, staff hiring, as well as maintaining contact with internal and external partners. During the course of the STEM Institute he meets with the Assistant Director on a weekly basis to assess the budget, teaching and learning problems, and staffing concerns to ensure optimal outcomes. The Assistant Director then holds weekly meetings with the STEM Institute staff to assess challenges and opportunities related to the curriculum, student progress and personal/academic needs, communications and other areas. In addition, on-going monitoring of student attendance and homework assignments is implemented. Any student not performing to their full potential is asked to attend individual meetings with the Assistant Director to discuss his/her progress.

The student recruitment process for the STEM Institute begins in February of each year. Recruitment is done through the help of the STEM Institute's many partners. Faculty and staff on campus promote the program and information sessions are held at college-wide engineering and science events, current students aware of the program also promote it through their networks. The majority of recruiting is done through high school counselors who support the program. During the application process follow-ups are conducted with students who expressed interest in participating in the STEM Institute. The application deadline is at the end of March. A rigorous review of applicants begins in April, with invitations to take the Math Placement Exam at the end of April. Acceptance letters for those who successfully complete the exam are mailed in May.

Strategic Partnerships

STEM Institute partnerships include internal and external constituents that provide financial support, collaborative efforts, in-kind services and other support for the program. As was previously noted, the STEM Institute's relationship with CAHSEE, a recognized national entity, has helped to bring local and national attention to issues related to the lack of minority students in the STEM fields and the need for programs that aim to solve this problem. The STEM Institute also has other partnerships with numerous public high schools in New York City, two of which are A. Philip Randolph Campus High School and the High School for Math Science and Engineering. Both are located on City College's campus. IN partnering with public high schools, we work with Principals, Assistant Principals of Math and Science, teachers and guidance counselors, all of which provide a strong network of support in STEM education. When partnering with private institutions, such as the American Museum of Natural History (AMNH), representatives participate in our advisory board, were they help develop our STEM curriculum.

By administrating the STEM Institute through City College the program benefits from the numerous already established state and national partnerships the college has with initiatives and organizations that aim to address similar problems. City College partners include the City College Fund, the Dorr Foundation and the New York State Settlement College Readiness Program (SCRP). The SCRP is an educational organization located in the Greater Harlem area which provides access to academic resources available at City College for ninth grade minority students. The SCRP, like the STEM Institute also makes it a point to teach parents and families how to become proactively involved in their child(ren)'s education.

In addition the college has research centers on campus, such as NOAA-CREST and the Biomedical Engineering Program, which have partnered with the STEM Institute to broaden the opportunity available to STEM Institute participants. Faculty members who are part of this partnership provide information on engineering disciplines, research careers, and help to plan and implement the research component of the STEM Institute during the summer.

Program Evaluation

An extremely demanding program, the STEM Institute requires that students perform at their highest level. Faculty members continually monitor student progress through homework assignments, course projects, and exams. At the end of the program, students complete an exit evaluation, providing insight into their experience (See Appendix #).

Program Results

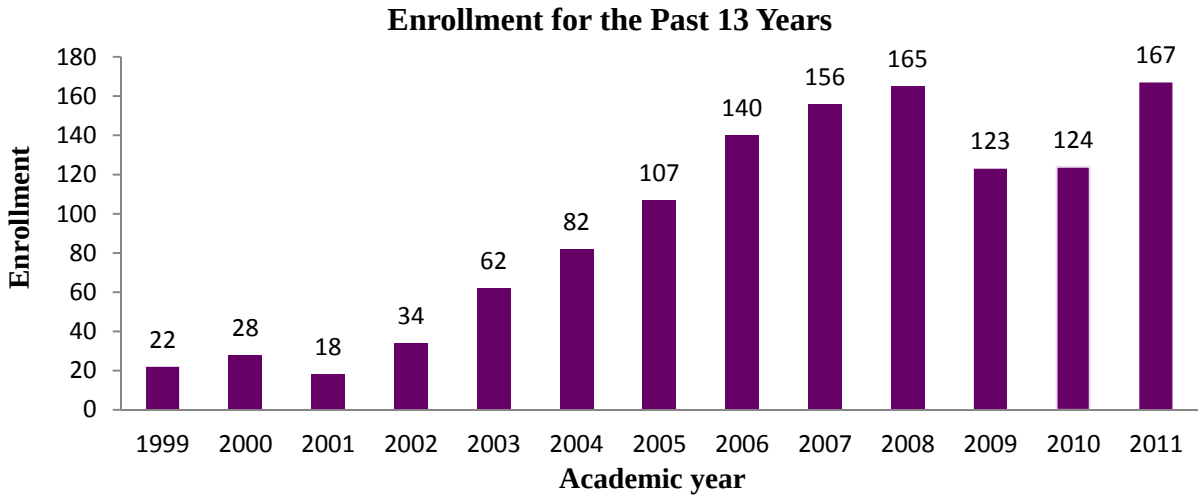
Courses Pass Rate

Despite the challenging nature of the program, this past summer, more than 90 percent of the participants achieved passing scores. Nine students (Eight received D and one received F), however, did not achieve success in their coursework, despite the additional support from teaching staff, and tutoring sessions.

Courses	Enrollment	Pass Rate
Mathematics		
Advanced College Algebra	44	95%
Pre-Calculus	56	98%
Calculus I	38	87%
Sciences		
General Chemistry	53	98%
General Physics with Pre-Cal Application	33	91%
Critical Reading and Writing	21	100%
Engineering Courses		
Computer Methods (MATLAB)	21	81%
Introduction to Engineering Design	17	100%

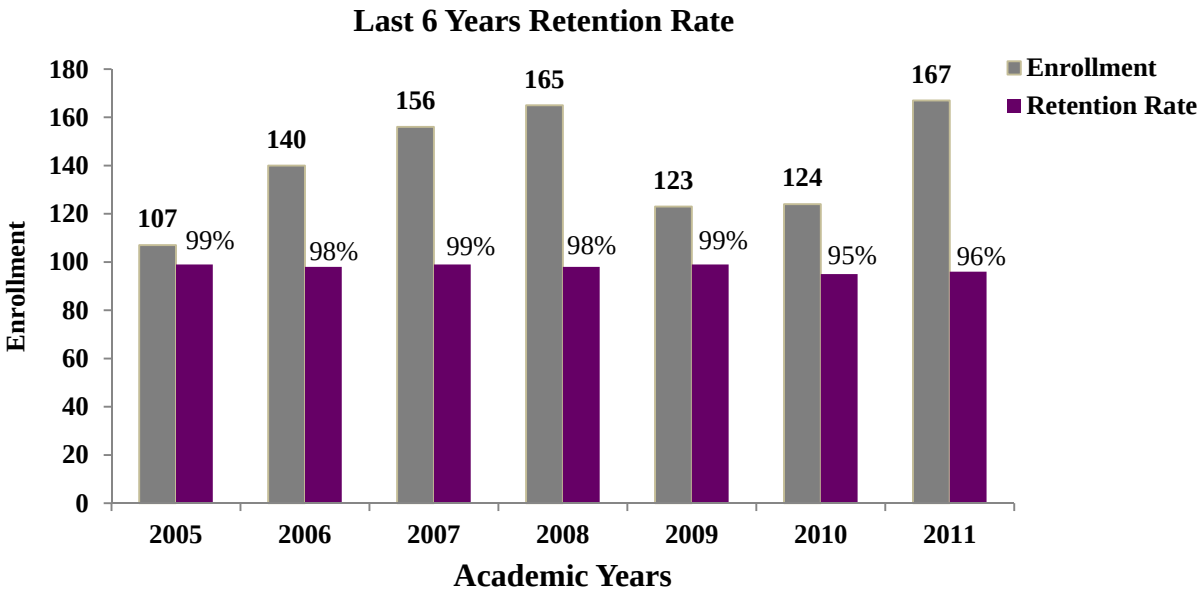
Enrollment

The STEM Institute's enrollment had grown exponentially from summer 1999 (22 students) to summer 2008 (165 students), however the Institute's enrollment decreased between summer 2009 and 2010 due to its loss in funding. Thanks to the partnership of the Dorr Foundation and the American Museum of Natural History (AMNH), the STEM Institute was able to accept 43 additional students this past summer. The total enrollment was 167 students, 86 (51%) were female students and 81 (49%) were male students. The graph below represents the last 13 years of STEM Institute enrollment.



Student Retention Rate

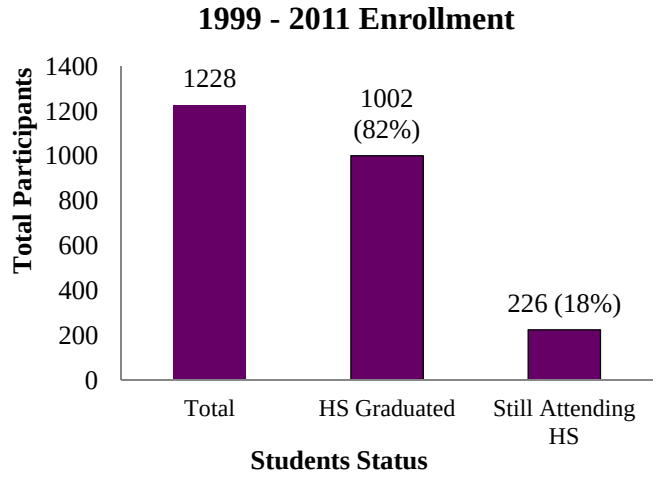
For many high schools, especially those located in urban areas, achieving good retention rates is a challenge. As the economy continues to experience difficulty, some of our STEM Institute participants had to drop out from the program and look for summer job employment to help supplement family's earnings. Despite the financial hardship our students face, our retention rate continues to remain above 95%. For summer 2011, the STEM Institute lost seven students due to financial hardship; however the overall retention rate was 96%. The graph below illustrates the retention rate for the last seven years.

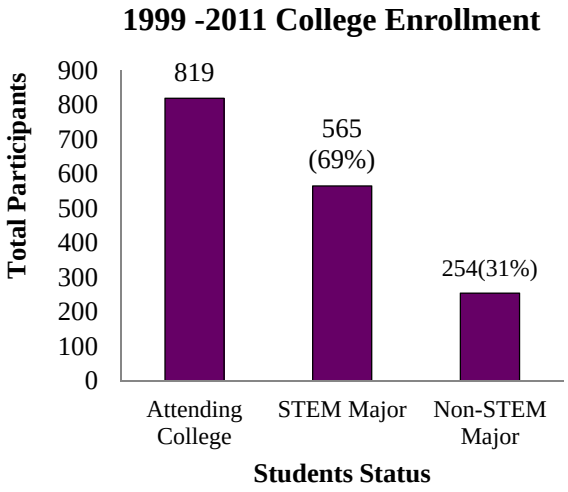


STEM Institute Graduates

The STEM Institute has a long record of proven success, helping minority students gain the knowledge, skills and motivation to successfully pursue STEM in college. Students are better prepared and more likely to go on to college and major in a STEM field. Since summer 1999 to summer 2011 the Institute has enrolled a total of 1,228 high school students. More than 97 % of the past STEM Institute participants have graduated high school and more than 95 % have gone on to college.

From available statistics, we also know that approximately 69% of these students major in science, technology, engineering and mathematics in college and 31% major in pre-med, the liberal arts or social sciences. The two graphs below show the last 13 years program enrollment and college enrollment status, as well as the total number of STEM major.





Of the 1002 students who graduated high school, 819 (82%) are attending college, we lost contacted with 177 (18%), and 6 high school graduated did not attend college. We are continuing to locate the 177 students we lost contact with through email, Facebook and family members.

Success Stories - Meet Our Students

Willie Caraballo
The STEM Institute 1999
The City College of New York – B.E. in Electrical Engineering 2004
Stony Brook Graduate School – M. Eng. In Electrical Engineering

Willie Caraballo participated in The STEM Institute for the first time in the summer of 1999. When asked about how the STEM Institute influenced him he claims "One of the main factors that helped me realizes my interest in engineering and science was the STEM Institute. It's because of this program that I got to know what engineering was about. Not only did I gain insight as to what engineering was all about, it also gave me the problem solving skills along with the motivation to do better for myself."

Upon graduating from high school he enrolled at The City College of New York and to pursue an education as an Electrical Engineer. He also quickly became involved in doing research thanks to Mr. Marte who mentored him while he pursued his undergraduate study at GSOE.

Mr. Caraballo's first research experience took place in summer of 2002 at Stony Brook University under the guidance of Professor Thomas Robertazzi. The research focused on determining whether a simple circulatory structure of probability flux, for a two class Markovian priority queuing system, existed. This kind of queuing system was of the non-product form solution type. Solutions to this type of queuing network are often tedious if not impossible to find. By means of generating a simulation program, using C++, he was able to prove Professor Robertazzi's hypothesis on how the circulatory structure of probability flux, for a non-product form network Markov chain, may be decomposed into aggregation of simpler circulations. On March of 2003, a publication of the results was accepted in the *Proceedings of the Conference on Information Sciences and Systems* journal.

The following year (summer of 2003) he worked as an intern at JHU/APL in support of a NASA discovery mission called MESSENGER (**ME**rcury **S**urface, **S**pace **EN**vironment, **GE**ochemistry, and **R**anging). The mission's purpose was to send a satellite out to space to investigate key scientific questions regarding Mercury's characteristic and environment using flyby data during a yearlong orbit. The spacecraft was launched on August 3rd, 2004. During that internship at JHU/APL, Mr. Caraballo worked under the Integration and Testing (I&T) division of the space department at APL. He worked extensively in the development and refinement of procedures and tools used during the Messenger spacecraft's integration and test phase of the development. With the use of software called EPOCH, I put forth a great effort in developing EDL (EPOCH Displayed Language) pages. The EDL pages allowed certain telemetry points from the satellite to be viewed. Numerous EDL pages were made, each focused on different subsystems of the satellite, such as the Main Processor (MP), the Fault Processor (FP), the Solar Array Drive (SAD), the Star Tracker (ST), and the Inertial Measurement Unit (IMU). Mr. Caraballo also worked on creating STOL procedures, which allowed certain commands to be sent to the satellite directly. Apart from that, he was assigned to assist various scientists and engineers in multiple mini projects. These projects ranged from designing a weight balance bracket for the adapter on the spacecraft, using PRO/E and AutoCAD, to writing a "Safety & Fault Protection Requirements Specification" manual.

The following semester he got the opportunity to engage myself in research at the "Institute for Ultra fast Spectroscopy and Laser" (IUSL) at CCNY. The IUSL is a world-renowned multidisciplinary research laboratory devoted to promoting research and education in photonic and laser technologies for scientific, engineering, medical, and industrial applications. During his employment at that institute, he worked closely with Dr Wubao Wang on creating a novice optical device that detected frost formation on different surfaces using various polarization techniques of light. Mr. Caraballo was in charge of developing and setting up numerous experimental procedures that helped analyze the absorption and backscatter characteristic of light on frost and ice under different conditions. The research goal was to someday implement this optical device in aircraft vehicles to monitor and detect frost formation on the wings at certain altitudes, thus insuring safety.

Mr. Caraballo gained valuable research experience through these opportunities and remained in strong standing in his academics. He received his Bachelors in Engineering from City College in 2006 and his Master in Engineering in 2008 from Stony Brook. Both degrees were in Electrical Engineering. He currently works for GAL Manufacturing Inc. as a Software & Test Engineer.

Afua Afo-Sante
The STEM Institute 2003
The City College of New York
B.E. in Mechanical Engineering 2011
Masters Program in Energy and Sustainability

Afua Safo-Asante is a mechanical engineering graduate of The City College of New York and proud STEM Alumnus. In her sophomore year of high school, she participated in the STEM Institute to take college level courses in Advanced Algebra, and Physics, and returned the next year to take full advantage of the courses offered and completed Calculus and Physics II.

It was her experience with the STEM Institute that convinced her to attend The City College of New York upon graduating from High School. She was accepted into the Honors Program at City College and was determined to participate in research during her undergraduate years. She claims the STEM Institute introduced her to the importance of student research and the research opportunities available at City College. She began conducting research in her sophomore year. Her research consisted of studying and testing vibrations in model systems with one, two and continuous degree of freedom under the guidance of Prof. Benjamin Liaw. Through this opportunity she familiarized herself with the research process. She learned to identify and develop her topic, find background information, learn from texts and other media (periodicals, Internet), experiment, evaluate results and how to properly cite work. She believes the experience was valuable and can be directly applied to her work, and several industries including the automotive, air plane and construction industries, which use similar methods of testing for mechanical failures.

During her senior year Ms. Safo-Asante interned for the CCNY Solar Decathlon 2011. An integral part of this internship requires students to research, design, build and operate a solar powered house. She was a part of the mechanical engineering group responsible for designing sustainable heating systems for the house. Ms. Safo-Asante plans to spend the next couple of years learning, interning, researching and specializing in the field. After obtaining her degree in Mechanical Engineering, she enrolled in the Masters Degree in Energy and Sustainability and PhD at City College.

Charles Sosa
The STEM Institute 2004
The City College of New York
B.E. in Mechanical Engineering 2011
Minor: Mathematics

Charles Stephen Sosa graduated from The Grove School of Engineering at The City College of New York in the fall of 2011 with a degree in Mechanical Engineering, a minor in Mathematics, a concentration in Nuclear Engineering. Mr. Sosa has achieved significant academic success in his studies, as well as in his research with Distinguished Professor of Electrical Engineering at City College and former NASA-GSFC/GISS scientist, Dr. William B. Rossow, over the past four academic years. Despite tremendous physical adversity with a debilitating nervous system disorder and rheumatological conditions, Charles has maintained strong academic performance and has been recognized on the Dean's List.

During his high school education, Mr. Sosa participated in the STEM Institute at City College, where math and physics professors sympathetic to his physical conditions, saw his potential, and enabled him to realize his capabilities in mathematics and physics. The STEM Institute was a major turning point for him as it made the possibility for him to pursue undergraduate studies in engineering, a reality. The STEM Institute offered a rigorous and challenging college-level experience that prepared him for the difficulties of the math and physics courses at City College. Following his completion of the STEM Institute, opportunities started to emerge for him in the form of NASA internships.

Mr. Sosa also pursued a three-year research project involving the Thermal Protection System of the Space Shuttle, where he received guidance and mentorship from Dr. Yiannis Andreopoulos, a faculty professor of the Mechanical Engineering Department at City College. His interest in scientific research was furthered when he participated for five summers under the NASA New York City Research Initiative (NYCRI) internship program, directed by Dr. Frank Scalzo, to work with Drs. Leonard M. Druyan and Matthew Fulakeza at The NASA Goddard Institute for Space Studies. There he engaged in research involving remote sensing and regional climate modeling of African Wave Disturbances. His contributions to the research played an important role in a 2006 *Cloud Dynamics* journal publication entitled, "Mesoscale analyses of West African summer climate: focus on wave disturbances," where he was gracefully recognized in the acknowledgements. Charles's research in the area of Remote Sensing and climate studies continues with Dr. Rossow, where he serves as a research assistant and IDL/MATLAB programmer under the NOAA CREST scholarship program.

Mr. Sosa is an example of someone who demonstrates that it is possible to succeed through adversity with determination. He is a role model for all incoming student at the STEM Institute and the City College of New York.

Daniel Ho
The STEM Institute 2006
John Hopkins University, 2011
B.S. in Materials Engineering

Oshane McCrea
The STEM Institute 2008
Vanderbilt University, 2012
Earth and Environmental Sciences
Minor: Economics

Both STEM Institute alumni interned at the MIRTHE (Mid-Infrared Technologies for Health and the Environment), a National Science Foundation Engineering Research Center at Princeton University. Their research focused on characterizing semiconductor nanostructures and materials at the Molecular Bean Epitaxy Laboratory of the City College of New York. Mr. Ho and Mr. McCrea were responsible for applying a technique of Contactless Electro-reflectance to their research and analyzing results.

Plans to Sustain the Program

In order to increase the number of STEM Institute participants, additional funding will be required. Partners such as federal research centers, outside organizations, and departments who collaborate with the STEM Institute to increase their own recruitment efforts will be asked for funding and other support. Proposals and grants have also been submitted to several foundations and companies for sponsorship.

Additional funding will not only allow a greater number of participants to enroll in the STEM Institute, but it will also pay for the additional instructional staff needed to accommodate students, including a full-time Program Coordinator and Program Evaluator to ensure that longitudinal data collection and reporting becomes a priority to document outcomes. This will also allow the STEM Institute to better market the program to a broader range of constituents. Additional funding is also needed to include a more comprehensive program for the entirety of the academic year. Such a program will provide expanded academic and personal support to students through ongoing workshops and sessions with parents and families to sustain interest, communication, feedback, and support.

Sponsors

The STEM Institute extends its sincere appreciation to its sponsors. The STEM Institute could not continue to impact the lives of students interested in pursuing an education and career in the STEM fields without their tremendous support.

the City College of New York

Office of the Provost

the City College of New York

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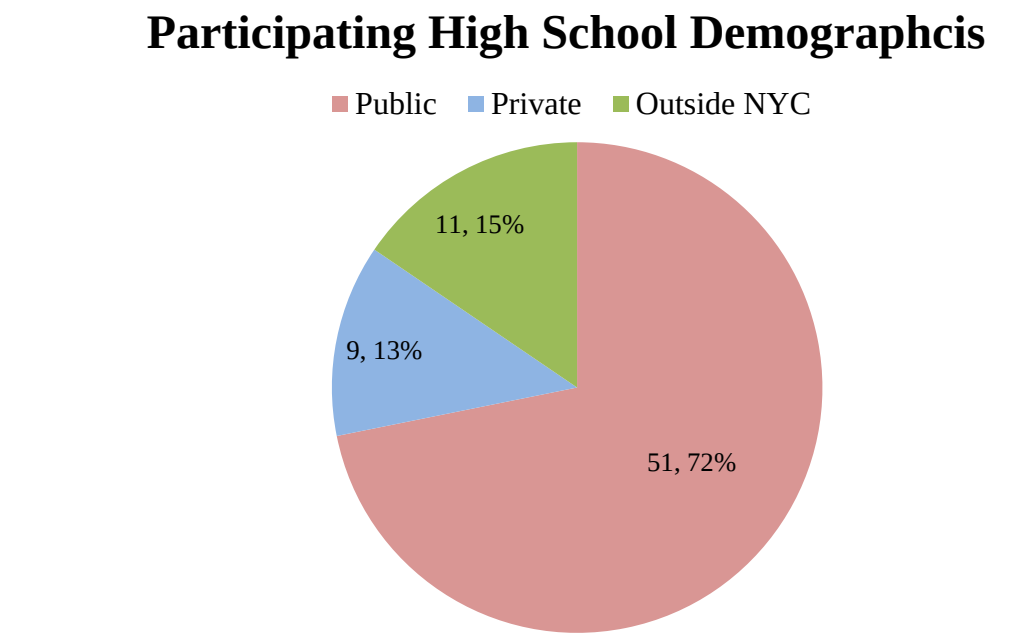
The Dorr Foundation

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

Appendix 1: Student Population

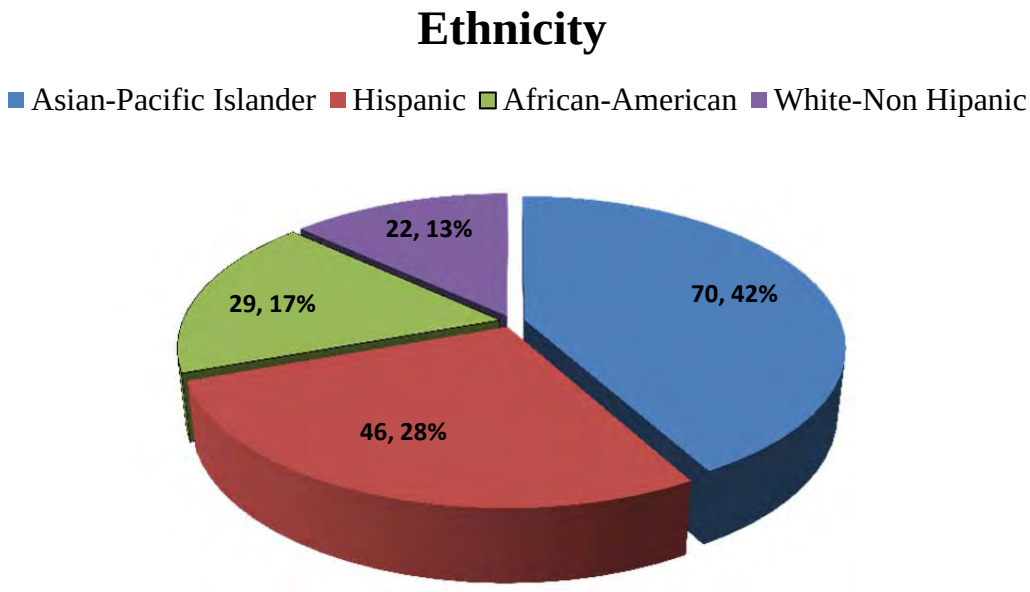
High School Information

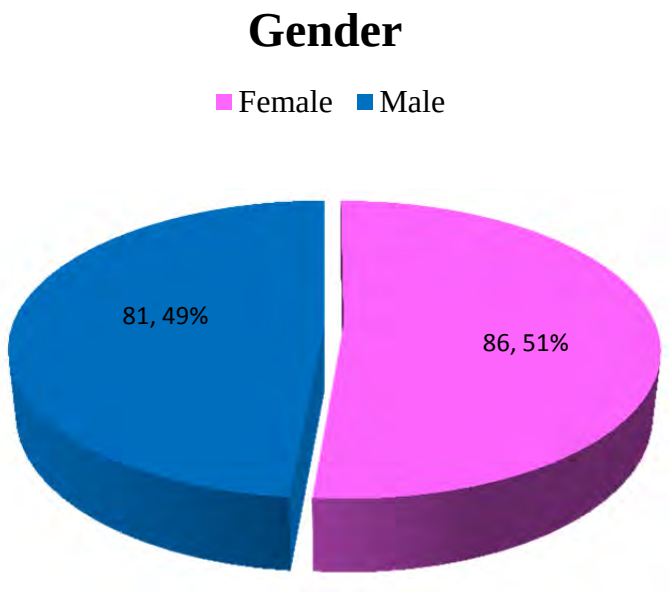
Students from a total of 71 different high schools participated in the 2011 STEM Institute. Of those schools 51 (72%) were New York City Public High Schools (all five boroughs), 11 (15%) were high schools from outside the New York City area, and 9 (13%) were private or Catholic high schools. (See Appendix B-1 for list of participating high schools)



2011 Institute Participants Ethnicity & Gender

The pies below represent the breakdown of ethnicities and gender.




Gender
Female
Male
81, 49%
86, 51%

Appendix 2: Course Descriptions

1. Calculus I (MATH20100)

Calculus I is an introductory Calculus course, which covers differentiation and integration of functions of one variable, with applications.

Topics: Concepts of Function, Limits, and Continuity, Differentiation Rules, Application to Graphing, Rates, Approximations, Definite and Indefinite Integration, Fundamental Theorem of Calculus, Applications of Integration to Geometry and Science, Elementary Functions, Techniques of Integration, Approximation of Definite Integrals, Improper Integrals, and L'Hôspital's Rule.

Pre-Requisites: Pre-Calculus or be placed through the STEM Placement exam.

2. Pre-Calculus (MATH19500)

Pre-Calculus is the continuation of College Algebra and Trigonometry course.

Topics: Vectors and their properties , intervals, inequalities, operation of functions, inverse functions, graphing of polynomial and rational functions, binomial theorem, exponential and logarithmic functions, decomposition of functions, trigonometric functions, angles, trigonometry identities, graph of trigonometry functions (Sine, Cosine, Tangent and their inverse), simplifying trigonometry functions, double-angles, half angle, and product sum formulas.
Pre-Requisites: College Algebra and Trigonometry or be placed through the Math Placement exam.

3. College Algebra and Trigonometry (MATH19000)

College Algebra and Trigonometry is an introductory course in algebra which focuses on the fundamental concepts of Algebra and Trigonometry.

Topics: Vectors and their geometric representation, decomposition of vectors, definition of angles between vectors, introduction to polynomials, functions and graphs, rational expressions and their applications, rational functions and exponents, system of non-linear and linear equations, absolute value functions, inequalities, rectangular coordinate system, determinants and Cramer's rule, complex numbers, quadratic functions, and introduction to trigonometric functions.
Pre-Requisites: Math A Regent (90% or better).

4. General Chemistry (CHEM10300)

General Chemistry is a first-year course which introduces students to the basic principles of chemistry.

Topics: The periodic table and its properties, atomic and molecular electronic structure, atomic models, chemical bonding, moles and Stoichiometry, physical behavior of matter, and acids and bases. This course also introduces the chemistry of organic molecules, kinetics and equilibrium, oxidation, and nuclear chemistry.
Pre-Requisites: Advanced Algebra (90% or better).

5. General Physics (PHYS 20300/20700)

General Physics is a first-year college-level physics course which introduces students to classical mechanics and kinematics. Emphasis is on the basic principles and general laws.

Topics: Vectors, motion in a plane, forces and equilibrium, basis of Newton's 1st and 2nd laws, particle dynamics, velocity, uniform motion, universal gravitation, collisions and conservation laws, work and potential energy, vibrations, conservative forces, inertial forces and non-inertial frames, central force motion, rigid bodies and rotational dynamics.
Pre-Requisites: Has completed or be enrolled in either Pre-Calculus or Calculus I.

6. Introduction to Computer Methods/MATLAB (ENGR10300)

MATLAB is an integrated technical computing environment that combines numeric computation, advanced graphics and visualization, and a high-level programming language (MATLAB is more than a fancy calculator; it is an extremely useful and versatile tool. Even if you only know a little about MATLAB, you can use it to solve several problems).

Topics: Standard MATLAB windows, arrays, functions & files, programming techniques, plotting, linear algebraic equations, probability and statistics, and other special topics in engineering such as remote sensors.

Pre-Requisites: Be enrolled or completed Calculus I, AB Calculus.

7. Introduction to Engineering Design (ENGR10100)

This course is designed to introduce students to the science of robotics, its scientific fundaments and real world application. This course covers the theory of robotics, integrating aspects of calculus and physics, and the design and actual implementation of an automated robot (both in hardware and software), and its construction.

After completing this six weeks course, students are expected to have completed a group project consisting on a self-navigating robot capable of finding the path out of a mace or traveling through a delimited circuit avoiding obstacles. All completed projects will compete on a final project demonstration and competition by the end of the course.

8. Environmental Chemistry

This course is divided into two parts. Students first will learn the basic concepts of general chemistry such as periodic table and its properties, atomic and molecular electronic structure, atomic models, chemical bonding, moles and Stoichiometry. The 2nd part students will learn the chemical processes taking place in our environment such as the relationship between atmospheric, soil, water, life and technology. Students will also learn about the transformation and degradation processes, classifications of hazardous substances and wastes, environmental toxicology, effects of and integration of the astrosphere of earth, industrial ecology. Other important topics are: Fundamentals of aquatic chemistry such as the properties of waters, water pollutions, the atmosphere and atmospheric chemistry and the geosphere and geochemistry. Students will be divided in group of four to present a poster presentation in one of the different topics cover in class.

Pre-Requisites: Has completed at least a semester of basic chemistry.

Appendix 3: Course Groups

Group	Courses	Recommended Grade Level
Group A	Advanced Algebra (Math 19000) Plus one of the following: 1. Chemistry 2. English	9 & 10
Group B	Pre- Calculus (Math 19500) Plus one of the following: 1. General Physics 2. English	10 & 11
Group C	Calculus I (Math 20100) Plus one of the following: 1. Engineering Design (Robotics) 2. Computer Methods - Matlab	10 & 11
Group D	1. Computer Methods – Matlab 2. Research (Science or Engineering)	10 & 11
Group E	Critical Reading & Writing (Engl11000) Plus one of the following: 1. Pre-Calculus 2. Advanced Algebra	9 – 11

Appendix 4: The STEM Institute 2011 Course Evaluation

Please answer the following questions to the best of your ability. The answers you provide will help us to improve the program for next year's STEM students.

Please check your answers.

1. The program as a whole was: ☐ Excellent ☐ Very good ☐ Good ☐ Poor ☐ Very poor

2. Please circle which math class you were in and how you would rate it.

   ☺ **Advanced Algebra** ☺ **Pre-Calculus** ☺ **Calculus**

   ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor ☐ Very poor

3. Please circle which elective class you were in and how you would rate it.

   ☺ **Physics** ☺ **Chemistry** ☺ **English** ☺ **MATLAB** ☺ **Robotics**

   ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor ☐ Very poor

4. The intellectual challenge presented in (circle courses below) was:

   Math Course: ☺ Advanced Algebra ☺ Pre-Calculus ☺ Calculus

   ☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

   Elective Course: ☺ Physics ☺ Chemistry ☺ English ☺ MATLAB ☺ Robotics

   ☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

5. The amount of effort you put into this course (circle courses below) was:

   Math Course: ☺ Advanced Algebra ☺ Pre-Calculus ☺ Calculus

   ☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

   Elective Course: ☺ Physics ☺ Chemistry ☺ English ☺ MATLAB ☺ Robotics

   ☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

6. The effort needed to succeed in this course (choose courses below) was:

   Math Course: ☺ Advanced Algebra ☺ Pre-Calculus ☺ Calculus

   ☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

   Elective Course: ☺ Physics ☺ Chemistry ☺ English ☺ MATLAB ☺ Robotics

   ☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

7. Your involvement in this course (doing assignments, attending class, working in groups) was:

   Math Course: ☺ Advanced Algebra ☺ Pre-Calculus ☺ Calculus

   ☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

Elective Course: ☺ Physics ☺ Chemistry ☺ English ☺ MATLAB ☺ Robotics

☐ Substantial ☐ Adequate ☐ Inadequate ☐ None

8. Which course did you find most difficult?

☐ **Advanced Algebra** ☐ **Pre-Calculus** ☐ **Calculus** ☐ **Math Lab (Engr103)**

☐ **Chemistry** ☐ **Physics** ☐ **English** ☐ **Robotics (Engr101)**

Why?_____

_____

9. On average, how many hours per week did you spent on this course?

☐ Under 5 hrs. ☐ 6-10 hrs. ☐ 11-15 hrs. ☐ More than 15 hrs.

Please answer the following questions <u>FOR YOUR MORNING (AM) COU</u>RSE to the best of your ability. Be sure to print clearly.

1. State and describe positive aspects of the course.

_____

_____

2. State and describe negative aspects of the course.

_____

_____

3. Did this course meet your expectations?

_____

_____

4. How can this course be improved?

_____

_____

Please answer the following questions <u>FOR YOUR AFTERNOON (PM) COURSE</u> to the best of your ability. Be sure to print clearly.

1. State and describe positive aspects of the course.

_____

_____

2. State and describe negative aspects of the course.

_____

_____

3. Did this course meet your expectations?

_____

_____

4. How can this course be improved?

_____

_____

Please answer the following questions about <u>THE STEM INSTITUTE</u> to the best of your ability. Be sure to print clearly.

1. Would you recommend The STEM Institute to other high school students? Why or why not?

_____

_____

2. In your opinion, what was the most enjoyable aspect of The STEM Institute? Why?

_____

_____

3. Considering your skills in the areas of math, physics, chemistry, robotics, programming and English, which skills were most improved during The STEM Institute?

_____

_____

4. How and in what ways has The STEM Institute changed or influenced you?

_____

_____

_____

5. During The STEM Institute, there were guest speakers from the City College Chemical Engineering Department, the Honors Program, the Sophie Davis School of Bio-Medical Education, and Admissions. Which, if any, did you find the most interesting and why?

_____

_____

_____

_____

_____

_____

Appendix 5: The STEM Institute 2011 Instructors & Teaching Assistants Evaluation

1. Please circle who your **MATH** instructor was and check how you would rate them?

   ☺ **Dr. Silver (Adv. Algebra)** ☺ **Prof. Pichardo (Pre-Calculus)** ☺ **Prof. Cardenas (Calculus)**

   ☐ Excellent ☐ Very good ☐ Good ☐ Satisfactory ☐ Fair/Poor

2. Please circle who your **ELECTIVE** instructor was and check how you would rate them?

   ☺ **Ms. Sarowar (General Chem.)** ☺ **Prof. Salame (Env. Chem.)** ☺ **Ms. Kapoor (Physics)**

   ☺ **Prof. Janeksela (English)** ☺ **Mr. Xiao Chen (MATLAB)**

   ☺ **Mr. Persaud/Mr. Pendola (Engineering 101)**

   ☐ Excellent ☐ Very good ☐ Good ☐ Satisfactory ☐ Poor

3. Which instructor did you like the most and why? _____

   _____

4. Please circle who your **math teaching assistant** was and check how you would rate them?

   ☺ Sazea (Adv. Algebra) ☺ Carmen (Adv. Algebra) ☺ Victor (Pre-Calc)

   ☺ Tenzin (Calulus) ☺ Yohan (Calculus)

   ☐ Excellent ☐ Very good ☐ Good ☐ Satisfactory ☐ Poor

5. Please circle who your elective course TA was and check how you would rate them?

   ☺ Ceena (Chemistry) ☺ Nathan (Env. Chem.) ☺ Yohan (Physics)

   ☺ Dean (MATLAB ☺ Md (Engr101)

   ☺ Moe (Physics) ☺ Bryce (Physics)

   ☐ Excellent ☐ Very good ☐ Good ☐ Satisfactory ☐ Poor

6. Which TA did you like most and why? _____

   _____

7. Would you recommend your TA's? Why or why not? _____

   _____

8. The organization of the courses was:

   Math Course: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

   Elective Course: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

9. The instructor's contribution to your ability to solve problems was:

Math Instructor: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

Elective Instructor: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

10. The instructor's interest in whether students learned was:

Math Instructor: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

Elective Instructor: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

11. The instructor made the course material interesting.

Math Instructor: ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

Elective Instructor: ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

12. The instructor used enough examples to make the material easy to understand.

Math Instructor: ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

Elective Instructor: ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

13. The instructor was knowledgeable on the topics covered.

Math Instructor: ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

Elective Instructor: ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

14. The text book used for the course was:

Math Course: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

Elective Course: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

15. The answers to questions from the course were:

Mathematics Course: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

Elective Course: ☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

16. What did you liked or dislike about your courses:_____

_____

_____

_____

Appendix 6: List of Participating High Schools

A. Phillip Randolph Campus High School
Aquinas High School
Aviation High School
Baruch College Campus High School
Bayside High School
Benjamin N. Cardozo High School
Bishop Kearney High School
Bronx High School of Science
Brooklyn College Academy
Brooklyn Technical High School
Central Park East High School
Chelsea Career & Technical Education High School
Christ the King
Cultural Academy for the Arts and Sciences
Dewitt Clinton High School
EBC High School for Public Service
E.B.T. High School
East Islip High School
Edward Murrow High School
Elmont Memorial High School
Excelsior Predatory High School
Fiorello H. LaGuardia High School
Flushing International High School
Forest Hills High School
Fort Hamilton High School
Francis Lewis High School
Frederick Douglass Academy
Greenwich High School
Gregorio Luperon High School for Math & Science
HAFTR High School
Harry S. Truman High School
High School for Math, Science & Engineering
High School for Telecommunication Arts and Technology
High School of Economics and Finance
Hunter College High School
Information Tech High School
International Leadership Charter High School
Iona Prepatory School
Jamaica High School
James Madison High School
John Jay High School
John Dewey High School
Liberty High School
Lincoln High School
Louis D. Brandeis High School
Manhattan Center for Science and Mathematics
Manhattan International High School
Manhattan Village Academy
Midwood High School
Millenniums High School
Monsignor Scanlan High School
NEST & M
New Explorations Into Science, Technology and Math
Notre Dame School
NYC Lab School for Collaborative Studies
NYC Museum School
Ossining High School
Riverdale/Kingsbridge Academy High School
Ronald E. McNair Academy
Salesian High School
St. Jean Baptiste High School
Stuyvesant High School
Talent Unlimited High School
The Brooklyn Latin School
The Hotchkiss School
Thomas A. Edison Career & Technical High School
Townsend Harris High School
University Heights High School
Valhalla High School
Ward Melville High School
Yonkers High School

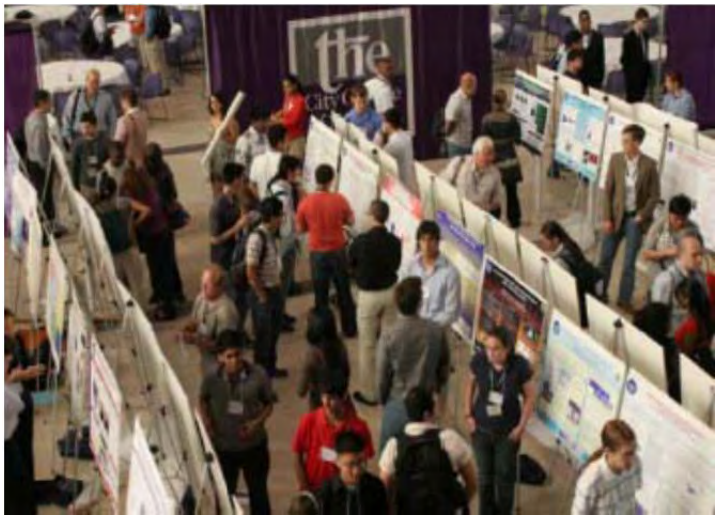
Appendix 7: Closing Ceremony 2011 Program

See attached PDF file.

Appendix 8: 2011 STEM Institute Photo Gallery

Summer 2011 Participants

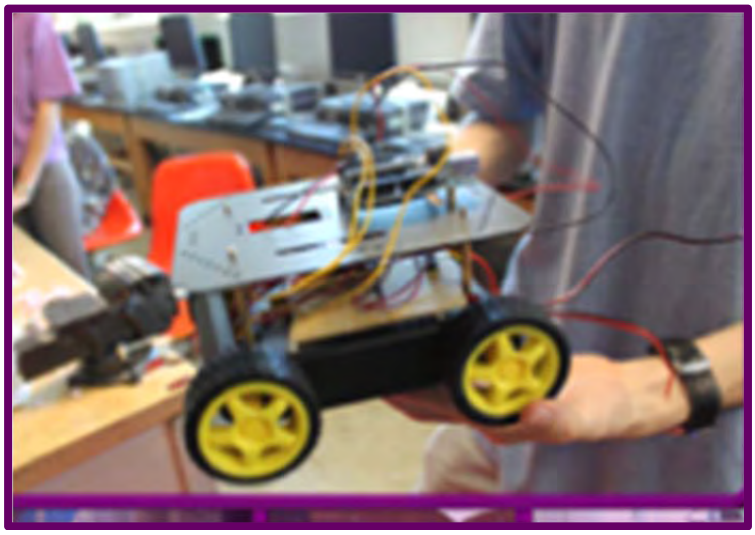
2011 STEM Institute Research Poster Presentation



Poster Presentation continued

General Chemistry

Introduction to Engineering Design – 10100

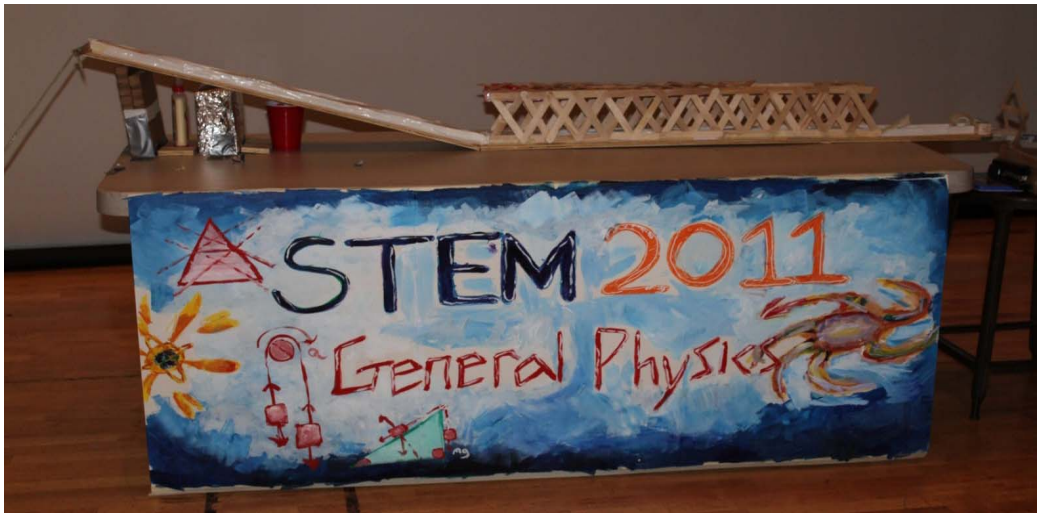


Engineering 10100 Continued

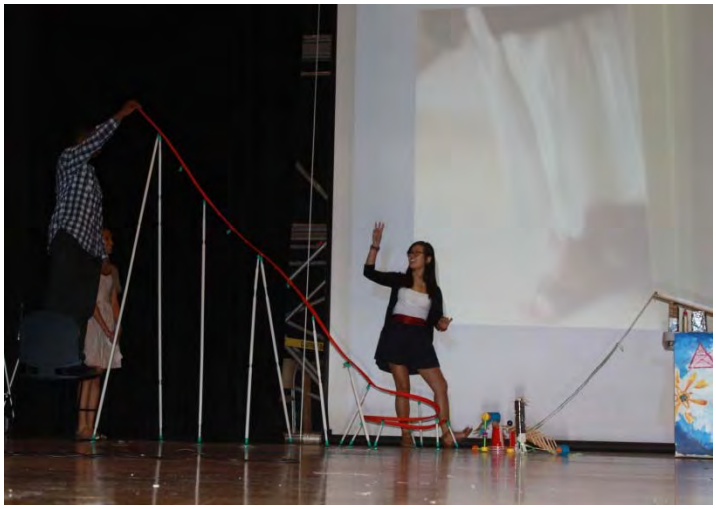
Engineering 10100 Continued

Engineering 10100 Continued

Engineering 10100 Continued



Rube Goldberg physics project



Reflection of light demonstration

Refraction of light demonstration

Special thank you to physics TA Tenzin Getso (middle)

Students showcasing their musical talents

Students performing a song

Top students of each course

After Some Much Fun!! – Time to EAT!!!!

Appendix 9: Math Final Exams

1. Advanced Algebra and Trigonometry
2. Pre-Calculus
3. Calculus I