



Central Brooklyn STEM Initiative

A Strategic Grantmaking Initiative of the
BROOKLYN COMMUNITY FOUNDATION

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OVERVIEW

On November 23, 2009, when President Obama introduced his new initiative, “To Educate and Innovate,” he said, “I believe that robotics can inspire young people to pursue science and engineering.” For over a decade, our team has advocated engaging students’ fascination with modern technologies (e.g., robotics, gaming, and sensing) as a hook to stimulate them to learn science, technology, engineering, and math (STEM). For example, in 2008, to gauge the effectiveness of using robotics to engage youngsters in STEM education, we piloted the Central Brooklyn Robotics Initiative (CBRI). This program has served Central Brooklyn public elementary and middle schools, bringing Poly-NYU’s STEM expertise to classrooms, pairing science and math teachers with Poly graduate students with significant subject matter knowledge. In addition, extensive and detailed professional development is delivered to teachers and Fellows, and Fellows are placed at schools to work with students and robotics teams.

The CBRI pilot was initially created through grants from the Independence Community Foundation (ICF) and JP Morgan Chase Foundation. In 2008, the CBRI team received a 5-year National Science Foundation grant for a synergistic project “Applying Mechatronics to Promote Science (AMPS).” Moreover, in 2009, CBRI received renewed support from ICF, Chase, Motorola, NY Space Grant, and AGEP. This proposal seeks funding to greatly expand the number of public schools served from the current 12 to 36 over the three-year term of the grant, enhance and extend the content of the program to other STEM disciplines, and provide leverage to seek new opportunities to deliver high-quality professional development to public school math and science teachers for the benefit of their students.

Schools served by CBRI have a high percentage of free lunch eligible students who come from minority groups vastly underrepresented in STEM fields. It is critical to engage the interest of these students in STEM fields since a large majority begin to lose interest in STEM studies in grades 5–9. The CBRI

program has addressed the need to 1) dispel negative stereotypes of engineering held by students; 2) present engineering as a creative enterprise, engaged in solving problems of societal interest, thus attracting students to consider careers in engineering through which they may benefit themselves, their families, and society; and 3) promote technical literacy for all students so that they can function effectively in, and benefit from, our increasingly technological society.

The main elements of this project are as follows. We conduct a 3-day summer workshop for the selected Poly-NYU Fellows participating in the program, with 2 follow-up training days during the academic year. This training enhances the pedagogy and communication skills of the Fellows. Fellows and CBRI teachers receive co-training in robotics and FIRST Lego League (FLL) at a 3-day summer workshop where they also explore the potential for integrating STEM-based activities in a regular classroom setting. After summer training, Fellows are deployed in schools where they use their expertise in mechatronics and robotics to enrich students' educational experience through robotics-based lessons. Moreover, Fellows and teachers mentor student teams participating in the FLL competition.

As mentors, Fellows use their background to empower students to implement fundamental robot design principles, e.g., structural/mechanism designs, sensor selection and placement, and programming strategies. To familiarize students with a real-world robotics competition, NYU-Poly hosts a practice contest. Under CBRI, students collaborate to develop strategies to complete robot missions and to prepare research presentations. This learning exercise reveals that what students learn surpasses mere mastery of building and programming robots. They also learn applied math and science, improve their computer skills, engage in research, work effectively in groups, and become effective presenters. Moreover, Fellows receive ample opportunities to improve their communication, team-building, and management skills, which prepare them for leadership roles in their careers and communities. Finally, summer training and collaborative activities with Fellows allow teachers to use

robotics as a vehicle to engage students through exciting hands-on activities.

This grant request proposes a significant expansion of the CBRI effort, both in the number of schools served and its programmatic content. Students, parents, teachers, administrators, Fellows, NYU-Poly Board, and sponsors have all indicated that the project has exceeded initial expectations and must be broadened to serve additional schools, students, teachers, Fellows, and STEM content.

STRATEGIES

To develop and conduct a highly engaging project and to ramp it up to 36 schools in 3 years, we will take following steps. First, we will partner with NYU-Poly faculty and admissions staff to invite participation of students from all engineering disciplines. Project investigators and teachers will interview and select Fellows who can communicate complex STEM concepts in an effective manner to non-technical audiences. Second, every spring project teachers, Foundation leaders, and the Department of Education (DoE) will identify up to 12 schools for inclusion in the program.

Principals, teachers, students, and parents from these schools will be introduced to the Central Brooklyn STEM Initiative (CBSI) project and STEM enrichment via an exhibition event at which CBSI teams compete in an FLL contest and Fellows present robotics-based lessons. Following the exhibition, invitees will be encouraged to complete a formal application to the CBSI program. Eight schools will be selected by a panel of investigators, teachers, and Fellows, in consultation with Foundation leaders.

During summers, Fellows will undergo training in mechatronics and robotics. They will use Lego technology to develop sample lessons to illustrate grade appropriate science and math concepts. Finally, following the summer pedagogy workshop and the technical workshop, Fellows and teachers will begin their partnership to mentor FLL teams and integrate robotics- and

STEM-based activities in classrooms.

This strategy will allow us to recruit and train qualified Fellows who can enrich the education of students most in need. Moreover, teachers' knowledge and repertoire of instructional skills in robotics and other STEM disciplines will be improved. The Fellow-teacher teams will engage students in exciting learning activities and expose them to technological applications, tools, and techniques that scientists and engineers use in their careers.

Interactions among teachers, students, and Fellows during the robot design process will allow them to acquire understanding of the place that science and engineering occupy in design. To design, build, and operate robots to complete designated tasks, students will learn to use sensors and actuators to enable their robot to measure physical phenomena and interact with the environment. Beyond providing mere knowledge of STEM, this project will prepare students for the workforce of the 21st century.

Our experiences with CBRI, National Science Foundation projects, and other work in K-12 education have taught us that: constant communication is critical for program effectiveness; learning applications and great teaching are imperative for student engagement and knowledge acquisition; teacher professional development is paramount; and principal's support is necessary for a school-based project's success. Moreover, having graduate students with STEM expertise working closely with students and teachers generates intergenerational learning, brings relevant technical knowledge to classrooms, and exposes students to career possibilities. This is especially true with careers in science and engineering for students who lack exposure to these fields and to STEM role models in their own communities. Finally, the partnership between a research university and public schools in Brooklyn offers a profound investment in the education of young people when they are impressionable and potentially at-risk.

The project also exposes Central Brooklyn students to a national program

where they compete against students from diverse communities and participate with them in informal learning experiences. Moreover, it addresses the need to ameliorate a national educational crisis: inadequate teacher preparation in STEM; poor achievement in these areas by Black, Hispanic, and female students; and weak career preparation for students of color and women which close them out of scientific careers at a very young age.

COMMUNITY ROLE

From inception, this project has reflected community input. Initially, schools were designated to participate in the project by Dr. Lester Young, a former schools superintendent who is active in the community. ICF and Chase Foundation provided important support for the project. Each year, one principal serves on the project management team to ensure that all principals support the project. Community members host an Annual Celebration and Exhibition where CBRI teams are honored for their commitment to participate in and learn from robotics competitions; and Fellows are recognized for transforming the lives of students. Fellows make frequent presentations about the project to stakeholders, such as the NYU-Poly Board, IBM Foundation, Xerox Foundation, and the College Board Forum.

All constituencies of the project will be invited to serve on the program's executive committee. Specifically, project managers and representatives of teachers, principals, parents, Department of Education, Fellows, evaluators, and funders will serve on the committee, which will periodically review the project's progress and offer programmatic recommendations.

COLLABORATION

To ensure this project's viability and sustainability, we will collaborate with external organizations and local, state, and federal government funded projects. This effort is synergistic with a GK-12 Fellows program for which NSF

has committed five years of support. NSF has also designated NYU-Poly as a Research Experience for Teachers Site, which offers a 6-week summer workshop to develop teachers' repertoire of instructional skills in mechatronics and robotics. We will seek increased support from Motorola under its *Innovation Generation-The Collaborative* program and have recently received a \$100,000 grant from The Black Male Donor Collaborative, which considers grants by invitation only. In addition, there are a number of funding and collaboration opportunities emerging at both the Federal and State level, including the US Department of Education's Race to the Top initiative, alternative teacher certification programs being discussed at the New York State Department of Education and several other education reform efforts aimed at improving STEM education.

For over a decade, NYU-Poly's Packard Center has cultivated a close relationship with US FIRST, an international not-for-profit organization, allowing NYU-Poly to serve as the lead university in bringing the FIRST Robotics Competitions to New York City (NYC). Our strong ties with FIRST will afford students the opportunity to participate in the FIRST Lego League (FLL) and the FIRST Tech Challenge (FTC) as culminating activities. Moreover, we frequently offer STEM enrichment programs to public school teachers with support from NYC Department of Education, which is an enthusiastic supporter of this project.

The summer workshop to prepare Fellows for classrooms and enhance their communication, leadership, and teamwork skills involves collaboration with New York University's Steinhardt School of Culture, Education and Human Development, which provides the instructor and materials. The Packard Center itself is a major collaborator providing valuable resources for project administration. NYU-Poly's Development Office also supports the project in many ways, with outreach to potential corporate and philanthropic foundations and preparing grant applications. Finally, NYU-Poly's President and Board of Trustees recognize the strategic value of this project to the

university and the Brooklyn community and continue to champion the program in numerous ways.

EVALUATION

Evaluation will determine project's impact on each participating group. For students, the project's impact on their interest in STEM studies and careers, as well as their academic motivation and achievement will be examined. For teachers, the project's impact on their teaching techniques, confidence, motivation, and STEM literacy will be investigated. For Fellows, the project's impact on their leadership and team building skills and their ability to explain technical material to non-technical audiences will be ascertained.

The extent to which the program serves schools with high needs students and introduces them to experiences that they rarely encounter will be assessed. Finally, the sustainability and the ability of the project to continue its expansion and be a model for STEM education will be examined.

The program will use an external evaluation team that will: design and administer targeted surveys to each group; perform observations at summer workshops, FLL contests, classrooms, and meetings; conduct focus groups to qualitatively evaluate the project's effectiveness; and collect and analyze demographic data.

A recent evaluation of the project indicates that it has been implemented with a high degree of quality and fidelity to its original design. Survey responses from 228 students reveal that large percentages of project students are from groups historically underrepresented in STEM. Students indicated that working with Fellows: increased their interest in STEM (77% of students); helped them learn more about STEM (82% of students); and helped them gain a better understanding of how STEM fields are used to solve real-world problems (73% of students). Moreover, 79% of students reported that Fellows were creative in helping students understand lessons and nearly 83% reported improvement

in their ability to listen and respond to other people's suggestions and concerns. Students were engaged academically, socially and emotionally in the project and students' families were supportive and enthusiastic.