

PLUGGING IN

PROFILES FROM NYC'S K-12 TECH AND STEAM SKILLS-BUILDING ECOSYSTEM



K-12 PROGRAM PROFILES

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Cornell Tech: Teachers in Residence

Teachers in Residence is a free professional development program offered by Cornell Tech that trains non-CS teachers in underserved elementary and middle schools in Manhattan, Queens, and the Bronx to integrate CS into their classrooms.

Who is served: K–8 non-CS teachers in schools where most students are Black and/or Latinx and eligible for free or reduced price lunch. Mostly grades 4–9, and fewer K–3 students

Number of participants: 150 teachers and 3,415 students served in 2018

Location: In school; multiple locations: PS/IS 217, Roosevelt Island, , Manhattan; Girls Prep Middle School, Lower East Side, Manhattan; Hunter’s Point Middle School, Long Island City, Queens; PS 86, Kingsbridge Heights, the Bronx.

Fall 2019 additions: The Young Women’s Leadership School, Manhattan, East Harlem, Creo College Prep Middle School, the Bronx, South Bronx, at least 1 additional school in Brooklyn.

Frequency/Duration: 1 to 3 days per week, entire school year (approx. 40 weeks)

Eligibility Criteria: The entire school, or an entire grade level or subject, must participate.

Curriculum: Computer Science Teachers Association (CSTA)- and NYS-standards-aligned curriculum focused on computer science and computational thinking; taught in the context of various non-CS subjects. Responsive to each school, with an emphasis on giving students agency with computing, and teaching them to use digital tools to build and problem-solve.

Partnerships: NYC FIRST, Tata Consultancy Services, Robin Hood, Siegel Endowment, CS for All, The Computer Science Teachers Association, NYC DOE/CS4All, CUNY, WiTNY (Women in Technology and Entrepreneurship in New York), Mouse

Cost: Free

Sources of funding: Private, support from Siegel Family Endowment and Pinkerton Foundation

What makes the program stand out? Teachers in Residence works closely and regularly with teachers throughout the school year, and that makes it unique among professional development programs. It also stands out for its requirement that the entire school, or an entire grade level or subject participate—an effort to overhaul a school’s culture and practice.

What do participants need to succeed? A teacher trainer is assigned to each school for a year, helping teachers prepare hands-on collaborative lessons, observing teachers and providing feedback. Therefore, participating teachers need to be able to devote time before and after class for planning lessons and troubleshooting/debriefing with teacher trainers. And they need to be dedicated to working with teacher trainers for a full year.

What does the organization need? “One of the most difficult things for us is there’s a very limited capacity of coaches,” said Levitt. “I think we’re just a little ahead of the curve. It’s a time when there isn’t so much expertise yet.” Because the program is a very high-touch model, it demands coaches “who not only have a very high level of knowledge of the content, but also really great pedagogy,” Levitt explained.

What overarching challenges face the CS education field? “I’ve been personally disappointed by the lack of response by schools of education who just do not seem to want to engage,” said Levitt. This may owe to the expense of creating curriculum, and the lack of faculty with both CS and pedagogy expertise. Schools of education may also be waiting to see whether CS education is just a trend, suggested Levitt. “I do think there’s a role for philanthropy to step up and help drive this, or public funding,” she said.

Curriculum presents another hurdle. “There’s a lack of high-quality curriculum, especially curriculum that has a scope and sequence from K to eight,” said Levitt. There are often curricula targeting only 1 grade or age level, for example, whereas “a good sequential, joyful, rigorous curriculum—that’s hard to find.”

Genspace Biorocket Research Internship

Biorocket Research Internship is a genetic engineering and biology lab program for high school students provided by nonprofit community biotech lab Genspace in Sunset Park.

Who is served: High school students ages 15 and up who are minority groups in STEM. 80 percent of participants are from Title I schools.

Number of participants: 4 teams of 3 students each (12 students total) served annually

Location: Out of school; Genspace Lab in Sunset Park, Brooklyn

Frequency/Duration: 2 days per week after school from February to May, and 4 days per week 10 a.m.–2:30 p.m. for 7 weeks in July and August

Eligibility Criteria: Must be 15 years of age by July 1; attend a NYC public or charter school located within 45 minutes of Genspace; have a teacher or mentor reference; complete an application (including video or short essay); and commit to participating from February to May and in July and August.; Minority and low-income students are encouraged to apply.

Curriculum: STEM (biology/genetic engineering)-focused curriculum emphasizes lab and technical skills, computational thinking and design thinking, experimental design, digital literacy as well as the ethics of biotech. It's naturally aligned with but more advanced than NYS science education standards.

Outcomes: Biorocket is part of the NYC Science Research Mentoring Consortium (SRMC) led by the American Museum of Natural History, which is tracking whether participants enroll in college and pursue STEM majors/research. Genspace also tracks students' science knowledge and lab confidence through qualitative and informal interviews. Several alumni have gone on to work in other SRMC programs.

Partnerships: Pinkerton Foundation, NYC SRMC

Cost: Free, and student interns earn \$2000 stipend for summer internship

Sources of funding: Private, Pinkerton Foundation

What makes the program stand out? The program begins with an afterschool component: 4 months focused on technical lab skills and soft skills. During the seven-week summer session that follows, students work in small groups to conceptualize, design, and prototype a biotech project, such as biosensors to detect metals in the water supply.

Lab programs such as Genspace which let students design their own experience rather than take direction are rare. Lab space alone is hard to come by in New York City's public schools, making Genspace uniquely valuable to the community it serves. Moreover, Biorocket replicates the project-driven learning approach of iGEM (International Genetically Engineered Machine), a competition that costs thousands of dollars, but Biorocket is free and pays students a \$2,000 stipend.

The city's LifeSci NYC initiative, announced in December 2016, will put \$500 million toward generating jobs in the life sciences over the next decade. But the industry faces the same equity and access dilemmas as other tech fields, according to Genspace Director of Education Beth Tuck. "If we're not very intentional and strategic about [diversity and inclusion] upfront and persistently, we're going to hit the same exact challenges." Biorocket represents an important step in the right direction, but it's very small and selective (they receive about 70 applications for 12–15 spots).

What do participants need to succeed? More funding so that they can be paid minimum wage, rather than the \$2,000 stipend

What does the organization need? More funding and staffing, which could allow the program to reach more students. Better connections to other after-school programs, libraries and summer camps that could use elements of the program.

Rockaway Waterfront Alliance Environmentor Internship

Environmentor is an environmental science research program for underrepresented high school students in the Rockaways provided by the nonprofit Rockaway Waterfront Alliance.

Who is served: 9th, 10th, and 11th graders from high schools in the Rockaway Peninsula or adjacent city neighborhoods.

Number of participants: 12 students served in 2018; 15 students served in 2019

Location: Out of school program located at Rockaway Waterfront Alliance RISE Center, Queens, Far Rockaway; Field research settings around the Rockaway Peninsula and Jamaica Bay; Labs of New York City colleges/universities such as Brooklyn College and Hunter College.

Frequency/Duration: 8-month program includes once-weekly after-school classes from February–June, and 3 days per week of field research/lab work for 7 weeks in summer.

Eligibility Criteria: Students must be in grades 9–11 and live or go to school on the Rockaway Peninsula (or adjacent city neighborhoods). Students who have participated in the RWA Shore Corps Program as a prerequisite are given priority.

Curriculum: Environmental science curriculum with significant focus on computational thinking, field data collection, and lab work, including data analysis. Sometimes incorporates coding/computer science, such as with ImageJ, a Java-based image-processing program, and GIS mapping. Core skills taught include data collection, data analysis in a lab setting, technical lab skills, and science research.

Outcomes: 95 percent of participants are going on to college or trade schools, and more than 80 percent are studying or working in STEM-related fields.

Partnerships: Pinkerton Foundation, School partners include: Scholars' Academy, Channel View School for Research, Far Rockaway Educational Complex/Far Rockaway High School

Cost: Free and students receive a stipend

Sources of funding: Private. Most funding comes from

the Pinkerton Foundation. Other funding sources include the Simons Foundation, Alfred P. Sloan Foundation, WT Grant Foundation and People's United Community Foundation.

What makes the program stand out? Environmentor is one of only a few out-of-school STEM programs in the Rockaways, and the only one with a lab component. The program begins with weekly after-school classes at RWA's RISE Center, where students learn about data collection and the Rockaways' natural environment. Students are then paired with professional scientists from local universities for seven-week summer internships centered on a local environmental issue. They spend 3 days per week gathering data from around the peninsula and analyzing data in a college/university lab. Students then present their findings to the community through presentations and informational posters.

What do participants need to succeed? "I think some kids get scared away by science research," said program coordinator Julie Schroeger. RWA has struggled with recruiting, so it has adjusted its marketing and outreach language to reflect the program's less-academic activities, like kayaking and surfing; and to emphasize that it's also about gaining a better overall understanding of the community.

Participants also need better pay; the program pays a small stipend, but only some of the participants are selected (through a lottery system) for the city's Summer Youth Employment Program (SYEP), which pays minimum wage. "They want jobs that are going to pay them minimum wage, so they'll take a job at Rite Aid or CVS instead of doing this program, which would look much better on a college application. It's just another barrier to diversity and inclusion in STEM," said Schroeger.

What does the organization need? More funding to pay students a higher wage and to hire more staff, as well as capital dollars to purchase lab equipment and computers. "We take [participants] out and do more observational things and water-quality monitoring, but we don't have the capacity to have a lab," said Schroeger.

Girls Who Code: Summer Immersion Program

Girls Who Code is a nonprofit organization that provides coding programs for female-identifying K–12 students nationwide. These students become part of a vast network of female-identifying coders who major or minor in computer science or related fields at 15 to 16 times the national average

Who is served: Rising 11th- and 12th-grade girls with little to no computer science experience. Students from underrepresented groups in STEM and those eligible for free and reduced price lunch are encouraged to apply.

Number of participants: 400 girls in the NYC area in 2018

Location: 22 sites in Manhattan and Brooklyn

Frequency/Duration: 5 sessions/35 hours a week, 7 weeks total

Eligibility Criteria: Female identifying, U.S. resident, rising junior or senior. Students are not eligible to apply if they: have already taken any AP/IB or other intermediate to advanced computer science course; reside and/or attend school outside the United States; have participated in the Summer Immersion Program in the past.

Curriculum: Participants learn different computer science principles each of the 7 weeks, with art, storytelling, robotics, and game- and web-development integrated into real-world projects. Programming languages include Scratch, Python, Arduino, C, HTML, CSS, JavaScript. The program also includes field trips to tech companies, guest speakers from the industry, and workshops that allow participants to meet female engineers and entrepreneurs.

Outcomes: Alumni who've declared majors are choosing to major in CS or related fields at a rate fifteen times the national average. Participants may connect with female engineers/entrepreneurs during the program as well as become part of an alumni network

Cost: Free; stipend available as-needed to offset transportation, living expenses, and lost wages. (Qualified recipients receive a sum of \$300–\$1400.)

What makes the program stand out? Few programs provide free coding instruction and professional skills-development during the summer, making this program a rare opportunity for the 400 annual participants served in New York City. But what sets this, and all of the organization's programs apart, is the in-house set of curriculum developers' focus on "building more than code; impact; and sisterhood," according to director of education Chrissy Zaccarelli.

Building more than code refers to building an underlying understanding of computational concepts, not just becoming experts in 1 language or being really good at debugging, "but understanding how to look at a problem; understand the puzzle pieces you have and the different ways they can fit together; moving towards a solution that also includes working with other people, wire-framing, talking to the constituents or stakeholders or audience that you want to serve with whatever it is you're building," said Zaccarelli.

"Impact" is about girls "building their very individual identities as computer scientists," through gaining an understanding of the diversity of women working in or with technology in numerous industries, whether an artist who's a technologist or a biologist who codes. "They can see that you can be a well-rounded person, and they don't have to give up their existing interests in order to pursue technology," said Zaccarelli. The "sisterhood" piece addresses that, for women in tech, "you need sponsors, you need mentors, you need cheerleaders, you need a support system." And "at that age where you're sort of figuring out who you are, if one of your friends is really into computer science, the likelihood that you'll persist is a lot stronger." In addition to a wide network of fellow alumni, Summer Immersion participants benefit from exposure to Girls Who Code's numerous corporate partners during field trips to tech companies and guest speaker events.

P-TECH / CUNY Early College Initiative

CUNY Early College Initiative's grade 9–14 model, known as P-TECH, combines high school and free college classes with professional work experience in tech, healthcare, and media.

Who is served: NYC students in grades 9–14

Number of participants: A total of 3,283 students are enrolled in P-TECH schools, with 287 entering grade 13 this fall, and an estimated 97 entering grade 14. In 2018/19 school year, 1176 students across P-TECH schools were enrolled in tech-related courses, broadly defined.

Location: In-school as well as out-of-school workplace exposure and paid internships. Schools include: Business Technology Early College High School (BTech), Queens Village; City Polytechnic HS of Engineering, Architecture and Technology (City Poly), Downtown Brooklyn; Energy Tech High School (Energy Tech), Long Island City; Health, Education, and Research Occupations High School (HERO), Mott Haven; Inwood Early College for Health and Information Technologies (Inwood), Inwood; Manhattan Early College School for Advertising (MECA), Lower Manhattan; Pathways in Technology Early College High School (PTECH), Crown Heights

Frequency/Duration: Frequency depends on which courses students take. College-level courses can begin in grade 10 and continue through two years of college, or students can graduate after grade 12.

Eligibility Criteria: Early College is an unscreened public program aimed at students who wouldn't typically have access to tech-industry jobs. There are no academic criteria for admission.

Curriculum: Workplace learning curriculum informed by industry standards. Career goals, mentoring, guest speakers, workplace visits, and internships are woven into the program. Minimum requirements for entry-level industry jobs, as provided by industry partners, are mapped to the curriculum and serve as academic benchmarks. College-level coursework is CUNY-equivalent. Problem-solving, teamwork, and communication skills are a focus at each school.

Outcomes: Students get an AS or AAS and a high

school diploma if they continue through grade 14. About 20–25 percent of graduating seniors go on to grades 13/14 for a complete bachelor's degree (often but not necessarily in STEM-related field). CUNY is just beginning to compile data on whether students are going into tech jobs, majoring in STEM, and/or graduating from four-year schools.

School/AAS & AS Degree Options:

BTech: AAS Internet & Information Technology, AAS Computer Information Systems;
City Poly: AAS Construction Management, AAS Civil Engineering, AAS Architectural Technology;
Energy Tech: AAS Energy Technician, AS Electrical Engineering, AS Mechanical Engineering, AS Civil Engineering;
HERO: AAS Nursing, AAS Community Health;
Inwood: AAS Cybersecurity, AS Biology;
MECA: AS Multimedia Programming & Design, AS Animation & Motion Graphics, AS Video Arts Technology, AS Digital Marketing;
PTECH: AAS Computer Information Systems, AAS Electromechanical Engineering Technology

Partnerships:

BTech: Queensborough Community College, SAP;
City Poly: CH2M Hill (an engineering company), BTEA (Building Trades Employers' Assoc.), MTA, RAND Architecture, City Tech;
Energy Tech: National Grid, Con Ed, LaGuardia Community College;
HERO: Montefiore Hospital, Hostos Community College;
Inwood: Bronx Community College, NY Presbyterian;
MECA: Borough of Manhattan Community College, Museum of Arts and Design, Paley Center for Media, 4A, 4A's MAIP (Multicultural Advertising Intern Program), Hearts & Science, J. Walter Thompson;
PTECH: IBM, City Tech

Cost: Free; students get free college credits

Sources of funding: Public (a DOE/CUNY partnership).

What makes the program stand out? In 2011, IBM teamed up with NYCDOE and CUNY to create the first P-TECH school. Building on DOE's history of career and technical education and CUNY's early college high schools in New York City, the partners devised a model linking classroom learning from high school and college with industry-based skills training that lead directly to jobs. Students at any of the 7 P-TECH schools can accumulate up to 60 free college credits starting in grade 10, as well as gain industry exposure through paid internships, apprenticeships, job shadowing, and mentoring. They can opt to leave with a high school diploma or an AS or AAS degree; some students then transfer into the CUNY system to complete a four-year degree.

Given persistent barriers to diversity and inclusion in the tech industry, P-TECH serves as a powerful model for bringing students directly into companies like IBM, National Grid and SAP—as well as into the CUNY system. And even if students don't continue through grade 14, they leave with a leg up in terms of college proficiency and readiness for college courses.

What do participants need to succeed? Students across all P-TECH schools have to make college proficiency before they can take college-level courses, and CUNY is still figuring out how to create a perennially marketable degree program that's also accessible to a diverse study body with special needs students and English language learners, according to Claire Riccardi, associate director of the CUNY Early College Initiative. More data around how to support incoming freshmen early on, as well as funding to allow for the right kind of staffing support could make a big difference, said Riccardi.

What does the organization need? More funding and data to help determine necessary staffing and extra supports (and subsequent staff training) that would help ensure all incoming freshmen able to access/succeed in the degrees being offered.

Professional development? DOE teachers get professional development through CS4All

Code Nation

Code Nation is a nonprofit organization that brings coding courses and work-based learning programs to students who attend under-resourced high schools.

Who is served: High school students in under resourced high schools in Brooklyn, Queens and Manhattan. 76 percent of participants identify as Black or Latinx, 44 percent identify as female or other, and 78 percent qualify for free or reduced price lunch.

Number of participants: 1,020 students served in New York City from 2018 to 2019.

Location: After-school at schools in Brooklyn, Queens, and Manhattan as well as at tech company offices.

Frequency/Duration: Up to 3 years total, Fellowship Courses: 31 lessons from October–June; Intro to Web Development Courses: 66 lessons from September–June

Eligibility Criteria: Schools where at least 75 percent of the student population qualifies for free or reduced price lunch.

Curriculum: 3 courses aimed at giving students exposure, experience, and agency with coding and coding concepts. The year-1 Intro to Web Development course (grades 9-10) focuses on coding exposure through HTML, CSS, and JavaScript. Year-2 Fellowship course (grade 11) focuses on project-based JavaScript concepts including APIs and professional skill development. Year-3 Fellowship course (optional, grade 12) offers more advanced APIs such as Firebase, as well as an intro to front-end frameworks and the fundamentals of ReactJS. Curriculum is updated annually with industry input. The two-day intensive summer Developer's Lab program helps students keep up with tech skills between courses.

Outcomes: 74 percent of reported alumni who completed 2 or more years of Code Nation programs are currently majoring or employed in STEM. 63 percent are studying or working in computer science.

By the end of the program, students have developed their LinkedIn and Github profiles and resume, along with a professional portfolio. Students will have also

attended the annual Code Nation Hackathons. Students gain workplace experience through their fellowships at tech companies and field trips.

Partnerships: American Express, Etsy, Flatiron Health, Google, Major League Baseball Advanced Media, Oscar Health, Salesforce, Schrödinger, Teachers Pay Teachers, Uber, IEX, Seatgeek, Disney Streaming Services, MoneyLion

Cost: Free

Sources of funding: Private

What makes the program stand out? Code Nation emphasizes professional skills in the first year, particularly brainstorming, wireframing and public speaking. Technical skills are taught by industry experts, so students begin to develop real relationships with people in the industry and cultivate lasting networks. There's also an emphasis on independent problem solving and being able to communicate computational thinking, through whiteboarding activities and HackerRank challenges, for example.

Given the tech industry's struggle to hire and retain employees from nontraditional backgrounds, Code Nation's effort to create a tech pipeline of Black and Latinx students from under-resourced high schools is promising.

What do participants need to succeed? Participants attending schools in the outer boroughs are missing out on Code Nation programs because of a lack of tech-industry volunteers willing/able to go beyond Manhattan and certain parts of Brooklyn, according to Oppong.

What does the organization need? More volunteers from the tech industry (industry volunteers teach all programs); more volunteers in the outer boroughs.

Does it provide professional development? Yes

The Knowledge House: Exploring Technology

Exploring Technology is a customizable exploratory tech and computational thinking course for low-income, minority K–12 students in the Bronx led by tech-education nonprofit The Knowledge House.

Who is served: High school students in the Bronx

college credits.

Number of participants: Roughly 200

Location:

Home base: 363 Rider Ave, 3rd Fl, Bronx, NY

Community organizations: Eugenio María de Hostos Community College, Nelson Management Group Ltd, Workforce 1

Schools: Bronx Aerospace, KIPP Academy, Wings Academy, Bronx Compass, Urban Assembly, Astor Collegiate, Bronx Latin, University Heights, BASE, Bronx International, AIM II New Visions, Ellis Prep, Bronx High School for the Visual Arts, Fordham STEP, YPIE

Frequency/Duration: The 80-hour modular curriculum is customizable. The summer SYEP-partnered program extends to 120 hours.

Eligibility Criteria: Students go through a standard application process but because Knowledge House works directly with teachers and school administrators, they often pre-select students.

Curriculum: Exploring Technology introduces tech skills including robotics, design and software. It also puts an emphasis on computational thinking and social emotional learning. The 80-hour modular curriculum also exposes students to pathways into tech careers, college programs and Knowledge House adult programs.

Outcomes: The organization runs 3 programs (2 for adults and 1 for K–12 students) that can be completed sequentially; alums can then take more advanced courses at the Knowledge House or through partner bootcamps. “The purpose is that they learn different pathways to pursue tech careers, [including] non-tech jobs, tech jobs, and tech jobs at non-tech companies,” said co-founder and CEO Jerelyn Rodriguez.

The Knowledge House is also working to strengthen the bridge from its high school programs into adult programs and local colleges.; It spent a year aligning its Intro to Tech course to Hostos Community College’s curriculum so that a student can matriculate with advanced placement and 6

Partnerships: Mouse, DreamYard, Here to Here (helps KH connect w/certain schools in the Bronx), local CUNY schools (Hostos CC, that have pre-college partnerships w/high schools), Lafayette Boynton, NYC Workforce 1

Cost: Free for students

Sources of funding: Mixed

What makes the program stand out? Being small and neighborhood-oriented allows the Knowledge House to respond quickly and creatively to the needs of students, schools and CBOs as well as the tech industry itself. For example, when adult graduates came back to Rodriguez saying they didn’t want to learn code but still wanted to work in tech, the Knowledge House found referral partners focused on design, cybersecurity or project management. They also began exposing K–12 students to a wider variety of skills and career options beyond coding.

The Knowledge House also stands out for its approach to staffing. The organization often hires program alumni rather than bringing in tech industry volunteers. “One of our value adds is all of our teachers are of color, because most of them are our alums,” said Rodriguez. “We know that if we do a volunteer model, we’ll have a diversity problem.” (Staff of the Knowledge House lead K–8 sessions, while high school sessions are co-taught by DOE teachers and program alums.

What does the organization need? While the Knowledge House has the goal of being in every Bronx high school, it has struggled to expand now that schools get free professional development through CS4All and “they’re not prioritizing their dollars for STEM programs” the way they used to, Rodriguez said. The Knowledge House has a pay-per-student model that “today a lot of schools can’t afford.”

Does the organization provide professional development? Yes. The Knowledge House has partnered with Mouse to provide professional development in computer science education to public school teachers.

Schools That Can: Maker Fellows Program

Maker Fellows is a professional development program offered by STEM-learning nonprofit Schools That Can that equips K-8 teachers in low-income communities to create and lead STEM maker spaces in their schools.

Who is served: K-8 teachers in schools in low-income communities

Location: Multiple school locations in the Bronx, Manhattan, Queens, and Brooklyn. See Appendix for full list.

Frequency/Duration: 90 minutes per week from September to June; teachers get 3–4 off-site trainings per year.

Eligibility Criteria: The organization’s focus is on reaching K–8 schools where at least 60 percent of students are eligible for free and reduced price lunch, and that serve historically marginalized students. For Maker Fellows, schools must be committed to continuous improvement through collaboration with Schools That Can (STC) throughout the school year.

The organization also partners with “well-resourced independent schools,” including charters and faith-based schools, some of which are eager to share their “highly resourced maker spaces” with lower-income schools.

Curriculum: Professional development program equips teachers to lead project-based maker education curriculum focused on CS and STEM, problem-solving, critical thinking, collaboration and persistence. Partly aligned to NGSS, common core, K–12 CS Framework.

Outcomes: Teachers running STC maker programs (in Chicago, Pittsburgh, Newark, St. Louis, NYC) demonstrated a 27 percent increase in ability to incorporate CS and computational thinking into classes. 85 percent of students in STC maker programs can picture themselves in a job using computers.

Partnerships: Da Vinci Schools; Next Generation Learning Challenges; Robert F. Kennedy Human Rights; Student Success Network; Dream See Do; 180 Skills; Maker State; The Research Alliance for NYC Schools; Horatio Alger Association

Cost: Free

Sources of funding: Private

What makes the program stand out? While it also partners with middle schools, STC is among the few organizations focused on professional development for K–5 teachers, and that emphasizes computational thinking skills for elementary school students. Younger students “naturally want to be tactile and creative,” and have little opportunity for that during the school day, according to Roger Horton, manager of STC maker programs in New York City. Maker education is also a natural vehicle for teaching students problem-solving, critical thinking, collaboration and persistence, according to research by Schools That Can.

What do participants need to succeed? To overcome negative stereotypes around girls in STEM: Research by STC has found that such perceptions may take root as early as third grade.

Less complications around paying for programs and more basic resources. “There’s a lot of bureaucracy that principals have to go through . . . Most school leaders get that the earlier you start [with STEM and maker programs], the better,” said Horton, but they face challenges around “having the right staff and hardware in place.”

What does the organization need? Funding. STC wants to expand its Career Skills program for high school students, a career pathway program that aligns to CTE standards and includes help navigating curriculum options, mentorship/internships, and college credit opportunities.

How can the city make the most of the tech skills-building and industry assets it already has? “I think New York should keep thinking about how to coordinate efforts across the city, remove duplication [in programs] and cover those areas [where there] are gaps,” such as the far reaches of Queens (Flushing, South Richmond Hill, for example), said Horton. Additionally, he’d like to see the city helping connect schools/programs in those more remote neighborhoods with major tech employers, such as airports and the maritime industry.

BEAM (Bridge to Enter Advanced Mathematics)

BEAM is a nonprofit organization that offers free programs for underserved middle and high school students that explore high-level mathematical concepts and ways of thinking, rather than school-based math.

Who is served: Students in grades 6–12 in the Bronx, Upper Manhattan and Chinatown, Brooklyn, and Queens who are underrepresented in STEM (90 percent black or Latinx, half female, 70 percent first generation to go to college; family income is \$30,000 or less).

Number of participants: 200 rising 6th graders in Discovery summer program; 80 students are accepted to Pathway in NYC per year; 400+ alumni in grades 8–12.

Location: Pathway summer program is held at college campuses (this year at Bard College and Union College). Subsequent school-year programming is at BEAM offices in Manhattan's Financial District.

Frequency/Duration: Discovery (Summer program for rising 7th graders): 5 weeks, 5 days per week, 7 hours per day. Pathway (five-year summer program for rising 8th- through 12th-graders): 3 weeks, 5 days per week, 7 hours per day. During 8th grade: Algebra I course, private tutoring & enrichment courses. High school: classes every Saturday, drop-in hours.

Eligibility Criteria: Highly competitive admissions process, but with no consideration of test scores. Students must be ready for advanced math (most students who are admitted to Pathway have completed Discovery program the year before). Priority given to those who come from lower-income families or wouldn't otherwise have access to similar programs.

In addition to Discovery/Pathway programs, BEAM partners with 35 public schools in Brooklyn, the Bronx, Manhattan and Queens where the majority of the student population is eligible for free and reduced price lunch and Black or Latinx.

Curriculum: BEAM doesn't reinforce school-based math, except for the Algebra 1 course preparing 8th graders for the Regents. Rather, "the key is thinking," said Lynn Cartwright-Punnett, BEAM senior director of programs, including critical reasoning and abstract thinking, as well as how to see patterns, determine whether something can be proven, and organize mathematically.

Discovery/6th-grade summer program: 4 classes in Logic, Math Fundamentals, Math Team Strategies, and Applied Math. Faculty have "free reign" for applied math courses and some focus on coding. Career day visits/guest speakers, and tours of STEM-related workplaces included.

Pathway: 7th-grade courses change each year and can include number theory, incidence geometry, logic, astrophysics, computer programming. Some students learn Arduino, Python, Java, Alice (not block-based coding/Scratch); 8th grade: focus on Algebra 1; High school: SAT/ACT prep.

Outcomes: Help applying to high schools in 8th grade; Support during 9th and 10th grade through the BEAM Next Saturday program, assistance with applying to future summer programs; free SAT/ACT prep courses; advising to assist with getting college scholarships; dedicated support for college students majoring in STEM fields.

Partnerships: Partners include 34-36 partner middle/high schools in Manhattan, Brooklyn, Queens and The Bronx, as well as Bard College and Union College. See appendix for full list.

Cost: Free

Sources of funding: Private. Major supporters are Jack Kent Cooke Foundation, Simons Foundation.



What makes the program stand out? BEAM is one of the few programs in New York City taking direct aim at the disparity in higher-level mathematics between Black and Latinx students and their white and Asian peers, as part of its mission to diversify STEM fields.

Math is recognized as a critical pathway into STEM subjects. Beyond sparking students' interest in math before high school (especially in New York City, where only 40 percent of public high schools offer calculus) BEAM propels students into additional extracurricular opportunities in STEM, such as math contests and other summer programs which will help students stand out on in college admissions. Most students are unaware of the wide range of professions that a higher degree in math can lead to. BEAM exposes students to different pathways to success, like working at the NSA, becoming a professor or consulting at Google.

What do participants need to succeed? Students have requested a trigonometry refresher class prior to AP subject tests, which BEAM provided, along with opportunities to learn computer programming. Another need has been social and emotional support for students from nontraditional backgrounds (often Black and Latinx students) who are accepted into top high schools that don't reflect the demographics they were used to in middle school. BEAM began offering social worker-led young men's and women's groups, where students can talk about whatever is on their minds.

Although students are digital natives, according to Cartwright-Punnett, they need guidance with professional/workplace skills like how to archive email, for example, and advice on "what it's like to be a woman in 21st-century America."

NYC FIRST STEM Centers and Robotics Programs

The nonprofit mentoring organization FIRST operates 2 New York City STEM Centers that provide free robotics education programs for underserved high school students.

Who is served: Robotics programs: all K–12; STEM Centers: students attending under-resourced high schools

Number of participants: Approximately 7,000, including 150 in credit-bearing courses

Location: STEM Center at Cornell Tech: Energy Tech HS, The Young Women’s Leadership School of Astoria, High School for Environmental Studies, Legacy High School. STEM Center at NYPL’s Washington Heights Branch: Gregorio Luperón HS, Washington Heights Expeditionary Learning School (WHEELS), City College Academy of the Arts, University Heights HS. Out of school robotics programs: locations around NYC.

Frequency/Duration: Credit-bearing courses: 3 hours per week throughout the school year

Eligibility Criteria: None

Curriculum: Structured around the FIRST Tech Challenge robotics competition, and tied to what students are learning in school. Core skills taught include coding, 2D and 3D design and fabrication, circuitry, collaboration, project management, and computational thinking. Languages taught include Java and Python for Raspberry Pi, and C for Arduino.

Outcomes: Students earn high school credits at STEM Centers. A pre/post-program survey measures baseline skill level and social-emotional learning progression.

Partnerships: NYC DOE, Cornell Tech, NYPL, BPL, QPL

Cost: Free for STEM Centers

Sources of funding: Private (foundation, corporate and individual support)

What makes the program stand out? FIRST is known for its annual Robotics Competition, where teams of high school students guided by professional engineers create industrial-size robots that compete against each

other. College scholarships are offered. Students can also join teams as early as kindergarten to learn how to code with LEGO Education WeDo 2.0; older elementary- and middle-school student teams use LEGO Education MINDSTORMS EV3 to design and build robots.

While the robotics programs create excitement around technology, teams must find financial support or apply for grants to cover registration fees. NYC FIRST STEM Centers stand out for introducing similar content to underserved high school students at no cost, and with guidance from trained educators who emphasize computational thinking.

It’s also one of the rare programs that goes beyond having students memorize different coding languages. “We put a lot of emphasis on understanding the logic of how these [coding] languages work, and why they should use them and how to combine them,” said instructor and program manager Francesca Rodriguez. In the fall, students are introduced to programming with Java, Python for Raspberry Pi and C for Arduino, as well as physical computing (including 2D and 3D design and fabrication, and circuitry). In the spring, students apply what they’ve learned by designing and building a technological solution to a problem in their community.

What does the organization need? Funding and more awareness in the community that the STEM Center is a resource for everyone living in the neighborhood. Students from Crown Heights and the Bronx have also come in to use the equipment, and this is the sort of resource-sharing that the STEM Center wants more people to know about.

STEM From Dance

STEM From Dance is a Brooklyn-based nonprofit that uses dance to teach STEM concepts to middle and high school girls of color from low-income backgrounds.

Who is served: Middle- and high-school Black and Latinx girls ages 12–18 from schools in low-income communities in Brooklyn

Number of participants: 216

Location: In school during the school year: the Highbridge Green School, Uncommon Collegiate Charter High School, New Heights Middle School, Children’s Aid P.S. 219, Opus Dance Theater. Summer camp at Bishop Loughlin Memorial High School.

Frequency/Duration: Varies according to school needs, from one 2-hour session per week up to 5 hour-long sessions per week; for the semester or full school year; 3-week daily summer camp.

Eligibility Criteria: Camp requirements: New York City girls ages 12-18; must arrange their own transportation to and from camp, and attend the full 3 weeks, Monday–Friday, 9 a.m. to 3 p.m.. No previous coding or dance experience necessary

Curriculum: Curriculum combines choreography principles with software and electrical engineering principles as students create a dance routine that combines the 2 realms. Participants use computational thinking to create a dance piece that incorporates technology. This can include wearable tech, such as costume accessories that light up and have sensors that are input to a circuit, for example. Participants might also design projections to add intrigue to a dance performance. While learning block-based coding, circuitry, and how to create dance in a way that is responsive to tech, girls also learn to be part of a team. Programs culminate with a performance.

Outcomes: 40 percent of participants increased their confidence; 50 percent had a more positive attitude towards STEM; 80 percent increased their STEM proficiency. Students are guided toward other STEM programs and internships with partner organizations such as dance companies (including Brooklyn Ballet).

Partnerships: Schools: the Highbridge Green School,

Uncommon Collegiate Charter High School, New Heights Middle School, Children’s Aid P.S. 219, Opus Dance Theater. Nonprofits: Code Nation. Companies: dance companies such as Brooklyn Ballet.

Cost: Free for students in school programs; camp is \$425 (total for 3 weeks, including lunch) with scholarships available.

Sources of funding: Mixed: funded through Department of Cultural Affairs and subcontracted through the Department of Youth & Community Development (DYCD). Also receives funding from foundations and individual giving.

What makes the program stand out? Students of nontraditional backgrounds rarely see themselves reflected in STEM fields, and subsequently don’t imagine themselves pursuing STEM careers. STEM From Dance takes a unique approach to correcting this misperception: introducing girls of color to coding and circuitry through a nontraditional lens that resonates with them. Moreover, the programs teach girls to be leaders and computational thinkers by allowing them the freedom to create and perform their own tech-enhanced choreography.

What do participants need to succeed? A shift in perception around tech and STEM and where they might fit into that world. For most participants, this program is their first experience with computer programming/circuitry; once they’re introduced to the curriculum they tend to respond well.

What does the organization need? Identifying partner schools is a challenge and having greater staff capacity could help. Finding staff that fit the role, are well-qualified, and that students can relate to.

Sunset Spark

Sunset Spark is a nonprofit that provides free creative technology programs in Sunset Park K–8 schools with majority immigrant populations.

Who is served: K–8 (mostly elementary) schools where student population is at least 85 percent from immigrant families; also students with disabilities and ELL students in Sunset Park, Brooklyn.

Number of participants: ~2,000 students in-school 2018–19

Location: In-school programs at P.S. 24, 971, 516, 169, and 131. After-school program at M.S. 136 and M.S. 821. Drop-in programs at the Sunset Spark office at Industry City

Frequency/Duration: Classes during the school day based on school needs for 10–14 weeks throughout the school year; clubs and drop-in hours.

Eligibility Criteria: K–8 public schools and community-based organizations in Sunset Park are eligible.

Curriculum: Schools decide what they need: robotics (3rd–5th grade), game development, coding, or computer engineering. Curriculum is written by the 2 founders. It's project-based and student-driven, and they work with dual language and self-contained classrooms, and do Integrated Co-Teaching (ICT). Skills taught include computer science, computational thinking, coding (Python, Lua, Scratch, Hopscotch), and robotics.

Outcomes: While programs only became fully operational in 2013, several alumni have been accepted into specialized high schools, for example.

Partnerships: DOE (Sunset Spark works with the DOE's CS4All effort; they wrote the K–2 CS4all curriculum). Nonprofits/companies: Sunset Park Library, Atlas:DIY, Muslim Community Center, Industry City.

Cost: Free to participants

Sources of funding: Most funding comes from schools that pay for services. Also paid by the DOE for writing curricula.

What makes the program stand out? Sunset Spark stands out for building a neighborhood culture around creative technology. The organization provides teacher training and works across entire grade levels in partner schools, including dual language and special needs classrooms. Students can also join after-school clubs and attend drop-in hours at Sunset Spark's offices. Parent workshops in tech and child development are also available. Being immersed in the neighborhood makes it easy for instructors to get to know students' families and stay involved with them over multiple years, said founder Gaelen Hadlett. Parents can more easily accompany their children to drop-in hours or after-school programs, and siblings and cousins often join programs together.

They're also one of the few programs to prioritize working with immigrant students, including Spanish-, Chinese-, and Arabic-speaking immigrant students. "Kids in the class get really excited, especially if they just moved to the country and this is something they can do that doesn't involve them having to figure out English," he said. "We try and make it as accommodating as possible for the kids. When I'm teaching coding, if I find out there's a kid in the class who doesn't speak English, I'll pair them with someone who speaks their native language," and make sure the iPad and apps they're using are set to their native language, so they can follow along with the lesson.

What do participants need to succeed? Most are English language learners and many are special needs students; all need particular types of support when it comes to learning computer science.

What does the organization need? The schools they work with are budget-constrained, so Sunset Spark will charge schools what they can afford. Hadlett sees schools' lack of funding for these types of programs as one of his organization's biggest challenges.

City Parks Foundation: Green Girls

CityParks Learn is the STEM-education arm of the City Parks Foundation that includes environmental science programs for underserved K–12 students throughout New York City.

Who is served: Middle school girls ages 10–13 from low-income backgrounds

Number of participants: 40

Location: Summer: IS 204 Oliver Holmes, Long Island City. After-school during the school year: IS 204 Oliver Holmes; MS 577 Conselyea Preparatory School, Williamsburg; K 366 The Science and Medicine Middle School, Canarsie; Fannie Lou Hamer Middle School, Crotona Park East.

Frequency/Duration: Summer: 4 days per week, 6 hours per day for 5 weeks total. After school: September–June: once per week for 2.5 hours

Eligibility Criteria: The application takes into account interest in the environment, but there are no test scores/grades involved in process. City Parks aims to reach low-income minority students.

Curriculum: STEM program focused on teaching environmental science through hands-on projects that can include data science. For example, participants have built their own temperature sensors to collect temperature data inside and outside parks and used computers to do data analysis.

The program centers on visits to urban forests of NYC parks and waterways in all 5 boroughs, where participants conduct fauna surveys, including an annual dragonfly survey. They also learn about science careers and go birdwatching and canoeing, as well work closely with the Parks Department Stewards program to learn about and remove invasive plants.

Outcomes: Paid high school interns are trained to lead the 5 K–8 programs, while receiving career and college prep. Green Girls participants can apply for these internships.

Partnerships: NYC Parks (Stewardship program)

Cost: Free

Sources of funding: Mixed (foundations and City Council)

What makes the program stand out? There are numerous environmental science education programs available around the city, but very few if any free summer camps focused on urban ecology across the 5 boroughs. The program is aimed at reaching girls from under-resourced neighborhoods, which are facing environmental degradation themselves, according to director of education Chrissy Word. Green Girls is also an example of how difficult it can be, even for long-running (founded in 2002) and popular programs (100+ student waitlist) to integrate technology into curriculum. Green Girls has done so with varying success, largely due to a lack of funding which impacts staff retention.

What does the organization need? Retaining educators with technical knowledge has been challenging, thwarting efforts to integrate more advanced technologies. Attempts to incorporate Remote Operated Underwater Vehicles (ROVs) into Green Girls have “not flourished,” said Word, and Learning Gardens (another Parks Foundation program) hasn’t kept pace with developments in urban agriculture. More consistent industry partnerships could help fill in the technical gaps, while also helping high school interns access jobs, said Word. The Foundation’s Coastal Classroom program, for example, could be feeding students into maritime trades with the Port Authority. “There should be a real pipeline right into those tech jobs,” she said.

Lack of space is a challenge, too. The Foundation is housed by the Parks department in 4 different locations around the city; “This is kind of where they’ve been able to put us,” said Word. “Even if I got a bump in funding and was able to grow the programs, space for staff would be an issue.”

BioBus: Mobile Lab

BioBus is a nonprofit organization that provides underserved students around New York City with free hands-on biology lessons inside a mobile lab.

Who is served: Minority, female and low-income pre-K–12 and college students throughout New York City

Number of participants: 60,000 among all programs

Location: On the BioBus parked on school grounds during the school day (over 100 NYC schools visited)

Frequency/Duration: 45-minute sessions (the BioBus can remain parked at a school for 1 or more days in order to serve as many students as the school would like; cost goes up for additional day(s); the Bus can see a maximum of 6 classes per/day of 30 students max, or about 180 students in a single school visit).

Eligibility Criteria: No requirements to qualify.

Curriculum: Aboard the BioBus, scientist-teachers lead science lessons that follow New York State grade-level learning objectives and teach general skills of science inquiry and process, such as knowing how to make and understand an observation and how to develop and test a hypothesis. Lessons are tied to what students are learning in class as much as possible.

Outcomes: The organization has measured significant changes in students' attitudes toward science after spending only 45 minutes on the bus. Students in a 12-week after-school program displayed a similarly significant shift toward identifying as scientists.

Students may have the opportunity to continue programming at summer camp as well as Pursue (paid internships for high school and college students) and Explore (8- to 12-week programs at schools and community centers incorporating more research practice), all held at BioBase Harlem at Columbia's Zuckerman Institute or the BioBase Lower East Side location.

The paid internships allow students to develop a science research project while mentoring younger BioBus students. Interns also benefit from the organization's network of scientists, who often guide interns toward research opportunities and college programs.

Partnerships: Columbia's Zuckerman Institute, Variety Boys and Girls Club of Queens, Lower Eastside Girls Club (LESGC), Lower East Side Ecology Center, NYU Materials Research Science and Engineering Centers (MRSEC), Billion Oyster Project, BrainNY, Greater NYC Chapter of the Society for Neuroscience Dana Foundation's Brain Awareness Week, Columbia SEBS (Science and Engineers for a Better Society), Earth Day NYC, Girls Prep, Harlem Week, HypotheKIDS, Imagine Science Films, Lowline Lab, Maker Faire, Math For America, New York Hall of Science (NYSCI), New York City School District 1, NYC Department of Education Citizen Science Program, NYC Department of Youth and Community Development, RockEdu (Rockefeller University Science Outreach), World Science Festival

Cost: Free

Sources of funding: Mixed (City Council, DYCD, NYS Assembly and numerous private donors)

What makes the program stand out? Science labs are something of a luxury in New York City public schools, and BioBus is helping fill in the gaps. "We can go to schools [in low-income communities and/or that don't have labs] and provide them with an \$85,000 microscope and change that landscape in a really radical way," said founder Ben Dubin-Thaler.

What do participants need to succeed? "One thing [the city] could do is live up to their own rule: students are supposed to have labs in school. It's a state requirement and the city does agree in principle, but we need to make the investment to make sure [that it's actually happening]," said Dubin-Thaler.

What does the organization need? Direct funding and/or more funding for schools.

CAMBA After School

CAMBA is a nonprofit organization that provides STEM learning activities for underserved elementary and middle school students in Brooklyn.

Who is served: K–8 students from low-income communities in Brooklyn. Majority are living in poverty; more than half are immigrants or refugees.

Number of participants: 1,988 (not including Beacon/Cornerstone center participants)

Location: 2 Middle Schools: SONYC at Huddel, SONYC at Whitman M.S. 72. 9 Elementary Schools: CAMBA All-Stars at P.S. 114, CAMBA Creative Kids at P.S. 139, CAMBA Elite at P.S. 3, CAMBA Kids Connection at P.S. 249, CAMBA Kids Shine at P.S. 361, CAMBA Kids Unite at P.S. 170, CAMBA Kids Unlimited at P.S. 92, CAMBA Kids World at P.S. 269, STARS Drug Prevention at P.S. 249. 1 homeless shelter: SONYC at Flagstone Family Center. 4 Beacon community centers and 4 Cornerstones

Frequency/Duration: After-school every weekday for 3 hours per day, including holidays. Summer program for 7 weeks, 10 hours per day.

Eligibility Criteria: None, other than being enrolled at the school where the program is being offered.

Curriculum: CAMBA provides STEM activities as part of its after-school and summer educational programs for elementary and middle school students in Brooklyn. Across school sites, CAMBA delivers STEM education in 4 ways: through purchased curriculum, such as After-School Science PLUS, an inquiry-based curriculum that uses hands-on activities to teach physical science; subcontracts with STEM-focused organizations such as Digital Girl, Beam Center and KoKo; a partnership with Expanded Schools Pathways: Computer Science, which trains CUNY students to teach CS to upper-elementary and middle school students; and inquiry-based field trips year-round to the New York Hall of Science and American Museum of Natural History, for example.

CAMBA takes a similar approach at Beacon and Cornerstone Community Centers, including through partnering with NYU's Tandon School of Engineering to bring a lab-based program called Creativity in Engineering, Science and Technology (CrEST) to Beacon sites during K–5 summer camps.

Outcomes: Students participating in Beacon/Cornerstone programs have been hired to lead those programs.

Partnerships: Colleges/universities including NYU, CUNY; DYCD, which leads COMPASS and SONYC; nonprofit STEM orgs such as Beam Center, Digital Girl, City Science, KoKo, ExpandedEd (subject to change annually).

Cost: Free

Sources of funding: Mixed

What makes the program stand out? CAMBA reaches some of the Brooklyn neighborhoods most in need of STEM/technology-skills training. The organization's after-school programs also serve more students than small nonprofits are usually capable of reaching. CAMBA's reach alone is noteworthy, as are its year-round offerings and efforts to partner with nonprofit providers of STEM programming such as Beam Center and City Science. While computational thinking is not necessarily an overriding focus of CAMBA's STEM programming, senior vice president of education & youth development Christie Hodgkins strives for programs to foster critical thinking around STEM subjects.

What do participants need to succeed? More consistent programming and instructor expertise in STEM across K–5 and 6–8 after-school programs.

What does the organization need? Daily after-school programs are funded in part through the DYCD's COMPASS and SONYC program models. While SONYC programs, aimed at middle school students, are "funded at a level to hire specialists in STEM as well as subcontractors, COMPASS Elementary programs are not," said Hodgkins. CAMBA tries to fund subcontracts for COMPASS programs through accruals in other areas, but that's an unpredictable, year-to-year method. "It concerns me because [programming is] not consistent across our elementary school sites," Hodgkins said. The model "has to be funded at a higher level to support this level of quality" expected by DYCD.

ELiTE Education (Emerging Leaders in Technology and Engineering)

ELiTE is a Harlem-based nonprofit that helps local middle and high schools improve the quality of their computer science and engineering education.

Who is served: Middle and high school students in Harlem, East Harlem, and Washington Heights. Among participants, 96 percent are Black or Latinx; 70 percent or more are eligible for free and reduced price lunch.

Number of participants: 348

Location: 4 middle and high schools in East Harlem/District 4: Manhattan Center for Science and Math HS (M435); The Lexington Academy MS (M072); Isaac Newton MS (M825); Renaissance School of the Arts MS (M377)

Boys and Girls Club of Harlem
Google CodeNext, Harlem

Frequency/Duration: Twice-weekly co-teaching in middle and high schools. One hour per week of instructional coaching for CS, technology, and engineering teachers throughout the school year. 4 hours per month of leadership coaching and management support for middle and high schools

Eligibility Criteria: Currently only working with schools in Districts 4, 5, and 6.

Curriculum: ELiTE delivers services to middle and high schools through 4 pathways. First, it increases CS/technology/engineering teacher capacity by providing curricula as well as instructional coaching, and by bringing in student teaching fellows with CS/technical expertise to co-teach twice a week. Secondly, ELiTE helps school leaders increase their benchmarks for student performance, enabling the “more rigorous profile in the maths and sciences” required of college STEM majors, according to ELiTE founder Chelsey Roebuck.

A school’s college and guidance counselors also receive support in preparing students for STEM-focused degrees and careers, such as through ELiTE-led summer bridge programs before students enter high school, as well as weekly after-school programming throughout the school year. In 6th grade, the curriculum focuses on basic computational thinking skills, often with math remediation (in most of the schools ELiTE works with,

students are 1 to 3 grade levels behind in math and ELA). 7th and 8th grade brings an introduction to physical computing (using electronics and circuits, but also computers to program those electronics and circuits).

K–5 students are reached through ELiTE’s Lego Robotics partnership as well as through out of school time programming in partnership with the Boys and Girls Club of Harlem, whose K–5 program staff received STEM-focused professional development from ELiTE staff.

Outcomes: Roebuck estimates approximately 20–30 students per year from ELiTE programs go into rigorous CS or engineering college/university programs at schools including Hunter College and City College. ELiTE tries to be “intentional about connecting [students] to pathways where they can apply [CS skills] in industry,” said Roebuck. That includes everything from “connecting them to research labs or opportunities where they can use computer science as their way into a biomedical-engineering, chemistry or mechanical engineering lab.” ELiTE also tries to connect students to industry-focused opportunities or internships, from summer programs like All Star Code and Girls Who Code (which has internship programs at companies like Goldman Sachs), to supporting students through their own technical internships (a graduating senior who attended ELiTE programs is a technology intern at Bloomberg for the third straight summer).

The organization is also tracking several engagement metrics (number of students served, hours served in various types of programs) and impact metrics (grit, confidence, interest in science/engineering) through daily attendance records and pre- and post-program surveys.

Partnerships: District 5: UA Academy for Future Leaders MS (M286), Frederick Douglass Academy MS/HS (M499), UA Academy for Social Action HS (M367); District 4: Manhattan Center for Science and Math HS (M435), The Lexington Academy MS (M072), Isaac Newton MS (M825), Renaissance School of the Arts MS

Community Program Partners: Boys and Girls Club of Harlem, Google CodeNext, NYC FIRST Robotics, Facebook TechStart

Cost: Free

Sources of funding: Mixed; City funding (DYCD), individual schools, corporation/foundation grants, earned revenue for curriculum development, program development, and training sessions.

What makes the program stand out? ELiTE is unique in its comprehensive approach to school partnerships. The organization guides school leaders and guidance counselors, and offers professional development in computer science and engineering education for teachers, while also providing after-school computer science classes at schools, a variety of CS programs at the Boys & Girls Club of Harlem, and internship/college/career guidance. Together, these efforts help create a clearer pathway into the tech industry for students from non-traditional backgrounds. “Imposter syndrome is real,” said Roebuck. Underrepresented students “really do need to be able to see, experience, and appreciate that they fit in and belong in these environments, and that they can be successful in these environments. And the only way to do it is through hands-on practical experience.”

What do participants need to succeed? Programming that goes beyond a one-off CS class, and a clear pathway into those other programs. Guidance around internships, industry opportunities and college. Also extra support in math and ELA.

What does the organization need?

Also, a clearer route to collaborating with the DOE, and more incentive among different DOE buckets (such as the Algebra team, CS team, STEM team) to work together: “We can have 1 initiative and have it funded by 3 or 4 different [DOE] teams or offices. There doesn’t really seem to be a clear, streamlined way or process to make that happen currently in the DOE, at least through their channels.”

Roebuck also said that demand is always greater than their capacity to staff or fundraise since they try to keep schools’ contribution to a program’s cost to less than 35%.

Beam Center

Beam Center is a nonprofit that provides creative engineering workshops in underserved public schools throughout the city, as well as hosts high school apprentices at its Red Hook production space.

Who is served: K–12 schools in Brooklyn, the Bronx, Manhattan and Queens that serve predominantly low-income students of color and new immigrants. Majority of partner schools are Title I, and half are in the International Network for Public Schools.

Number of participants: School partnerships: 6,000 (4,500 during school year and 1,500 over summer (this includes STEM Summer in The City, CareerCLUE and SYEP Younger Youth). Apprenticeships: 50 Beam Project Leaders, 70 Summer Youth Employment Older Youth job placements.

Location: School locations in the Bronx, Manhattan, Queens, and Brooklyn. See Appendix for full list.

Frequency/Duration: Projects can last from 4 weeks to a full semester; 2–3 days per week; 90 or 180 minutes per week.

Eligibility Criteria: None.

Curriculum: Beam Center brings artists and engineers into public schools to help students create hands-on projects integrating design and technology.

School partnerships can extend school-wide or involve only 1 teacher or a team of instructors across different grade levels. Each partnership begins with at least 2 days of professional development, which includes skills-building around different tech disciplines (making, digital fabrication, physical computing, programming, soft circuits), as well as collaborative planning of the project. Beam Center works with teachers to design a project that incorporates learning goals for a particular unit, or that extends beyond the classroom curriculum.

Computational thinking is emphasized, and projects often incorporate computer science and physical computing, along with crafts like woodworking and metalworking. Brooklyn International High School students, for example, used Python and Arduino to create a digital poetry machine that posts tweets based on magnetic laser-cut words. Fourth graders at Brooklyn School of Inquiry used stop-motion animation and a laser-cutter to reenact the Battle

of Brooklyn. “We’re turning a classroom into a production environment,” said Matt Robinson, Beam Center’s director of school programs.

Outcomes: In addition to school programs, Beam Center offers in-house programs at its Red Hook headquarters, including an annual apprenticeship program for high school students, and workshops for 2nd through 12th graders.

Apprenticeships take a similar approach to school partnerships. They center on projects that incorporate technical skills from a variety of disciplines, from wood and metal work to web and 3D design, fabrication and multimedia production. At the same time, apprentices learn how to design and lead activities and create a club-like atmosphere during youth workshops. Apprentices “come out of that program prepared to work in [Beam’s] summer camps or after-school programs,” said Robinson. Some of those jobs are funded through SYEP.

Partnerships: DOE

Cost: Free

Sources of funding: Mixed

What makes the program stand out? Beam Center has a goal of developing lasting collaborations with schools. Members of the organization’s staff of artists and engineers are often there for each classroom session, helping students and teachers prototype and roll out full projects.

Additionally, by incorporating multiple STEM and creative disciplines into a production-centered approach, Beam Center has been able to reach populations for whom “conventional schooling has become ineffective, and perhaps overly compliance-bound and not responsive to the real world as they experience it,” said Cohen.

What does the organization need? More capacity: they can’t always take on a school partnership at the moment when a school gets funding for it.

American Museum of Natural History – BridgeUp: STEM

BridgeUp is a STEM program for high school girls that is housed at the American Museum of Natural History involving coursework in coding and a paid internship in scientific research.

Who is served: A diverse group of high school girls, primarily from NYC public high schools lacking access to coding classes and out-of-school learning opportunities.

Number of participants: 40–45

Location: American Museum of Natural History

Frequency/Duration: 120 hours of coursework that can be taken after school during the school year, or during a five-week summer program; nine-month paid internship; annual Hackathons; monthly field trips and workshops around academic and professional opportunities in CS, such as visits to tech companies; optional standalone two-hour workshops.

Eligibility Criteria: They look for students who wouldn't have these types of opportunities in their schools or communities, and who have minimal experience with coding, but have a strong interest in studying science and computer science. Applicants do not necessarily need to live in New York and can begin in grade 9 or 10. 8th grade NYS ELA and math exams/transcript/report card are part of the application, but there are no explicit requirements. Economic status is also considered, with a focus on accepting low-income students.

Curriculum: The first component is 120 hours of coursework centered on coding with Python. Coding is introduced through different scientific disciplines, including the earth sciences, astrophysics and molecular biology. Curriculum relates back to museum exhibitions.

After successful completion, girls can apply for the program's second component, a nine-month paid internship in computational research within one of the museum's scientific divisions. This offers a chance for girls to apply what they've learned about coding in a real-world lab setting and under the guidance of their near-peer mentors (post-baccalaureate women who've majored in CS and science). Throughout the program there are also annual Hackathons with professional developers, and monthly visits to tech companies and science-related academic settings in New York City. Participants can also take standalone two-hour workshops in web development, machine learning, app development and other CS and STEM topics, presented at AMNH by women working in the tech industry.

Outcomes: BridgeUp began only 5 years ago as a pilot program of the museum but has proven effective. As the years progress, participants in BridgeUp tend to become more confident and their interest in science often increases, according to observation-based evaluations and parent surveys. "The change is absolutely amazing. Not only are they learning computational science and programming, but [also] developing their skills through group work, completing a project from start to finish and learning presentation skills," said Yvonne De La Pena, director of BridgeUp: STEM.

Partnerships: None

Cost: Free

Sources of funding: Private

What makes the program stand out? Few programs progress over the course of years, and BridgeUp also has the distinct advantage of being housed in a world-class museum where scientific research is continually underway. Participants are embedded in a professional science setting, and work alongside current STEM majors, bringing them face-to-face with possible career and academic paths to pursue after the program ends.

Coding and computer science, as well as dealing with large data sets and creating data visualizations, have become "essential to research" in the sciences, said Cohen. And in turn, "The girls have become a critical asset to a lot of our scientists." While there's a data science framework around the internship, the participants also have a chance to explore a field they're interested in; typically there are several projects to choose from, and they work in teams of 6 to perform research, analyze data and write code to answer a guiding question.

What does the organization need? Due in part to the success of Bridge Up, AMNH wants to embed CS skills training across its K–12 programs. The museum also sees an opportunity to partner with other institutions to share the BridgeUp framework.

Genesys Works

Genesys Works provides low-income high school students in the Bronx with a 14-month program that combines professional and technical training with paid IT internships and college and career coaching.

Who is served: Rising high school seniors in the Bronx from low-income backgrounds

Number of participants: 30

Location: Out of school: summer program at Pace University. 7 partner Bronx high schools: Alfred E. Smith Career and Technical Education High School, Bronx High School for Law & Community Service (TR), Bronx Leadership Academy II, KAPPA - Knowledge & Power Preparatory Academy International High School (TR), New Visions High School for the Humanities (JFK), New Visions High School for Advanced Mathematics and Science (JFK), West Bronx Academy of the Future (TR)

(TR) = Theodore Roosevelt Campus

(JFK) = John F. Kennedy Campus

Frequency/Duration: 14 months total, starting with 8-week half-day summer training, followed by 20-hour-per-week internships of up to 12 months. Students also receive 60 hours of counseling on college and career pathways, including finding a college match, filling out applications and financial aid forms and applying for scholarships.

Eligibility Criteria: Schools are not charged a fee but must designate a “school champion” who will work a few hours per week as an internal point person for Genesys Works, helping ensure that student interns are still keeping up academically. Genesys Works targets “the quiet middle,” or high-potential students in the 75-85 range academically for whom “school hasn’t turned on the light bulb,” but who are interested in working for a Fortune 1000 company, according to Mike Gross, executive director of Genesys Works New York City. This year, 30 out of 111 applicants were chosen.

Curriculum: The 14-month program begins with 8 weeks of paid, part-time training in the summer before senior year of high school. Participants learn technical skills, with a focus on IT hardware and software, including MS Office/Word/Excel, and

professional skills such as public speaking, writing professional emails and the basics of working and socializing in a corporate setting. In the fall, students begin an internship of up to 12 months, often within the IT department of a Genesys Works corporate partner, including tech and non-tech companies such as Warner Media and Salesforce.

As internships progress, students also receive 60 hours of college and career counseling, including finding a college match, filling out applications and financial aid forms, and applying for scholarships. Alumni also get ongoing support as they navigate post-secondary institutions. “We use this experience as a way for them to begin to transform what they think is possible for themselves, see themselves working in a corporate environment and understand what’s it going to take to get there,” Gross said.

Outcomes: This is the organization’s first year in New York, but it has a strong record of success in other urban centers. Among Genesys Works’ approximately 4,500 alumni, more than 3 quarters of whom are first-generation college students who qualify for free or reduced price lunch, 100 percent graduated high school, 95 percent have enrolled in college and they’re 3.5 times likelier than their peer group to earn a degree. Among employed alumni, at a median age of 24, 46 percent earn the same or more than at least 1 parent and 23 percent earn more than both parents combined.

Partnerships: Companies where interns will be placed this year include: BlankRome, Fried Frank, Kirkland & Ellis, Lazard, Mizuho Americas, Per Scholas, Ropes & Gray, Salesforce, SEO, SMBC (Sumitomo Mitsui Banking Corp), WarnerMedia, Weil, Gotshal.

Cost: Free

Sources of funding: Private

What makes the program stand out? While there are many internship programs in New York, “not a lot



are for high school students, other than SYEP,” said Gross, as well as Here to Here, which connects Bronx high school students with paid internships and on-the-job training through the Bronx Private Industry Council and CareerWise New York. Among the available options for high schoolers, Genesys Works stands out for providing intensive professional and technical training, as well as extensive support throughout the program and into post-secondary life.

What do participants need to succeed? It’s an intensive program, with a 1,000-hour internship, including 20 hours per week during senior year of high school; participants need to be able to keep up with school work and not lose sight of graduation. “That intensity unleashes student potential, and also allows for really strong mentoring relationships to be built with folks in the workplace, whether a supervisor or someone else,” said Gross.

Genesys Works also helps students stay on track by placing advisors in partner schools, as well as “helping them continue to work at the company

where they interned, find other employment in the summer, and nudging them to make sure they’re aware of various deadlines,” said Gross. There are also gatherings during holiday breaks so students can continue supporting one another.

Participants also need to be paid minimum-wage during the summer training

What does the organization need? Genesys Works has had to compete with SYEP for students, so for the first time it will be paying students for summer training. Gross would like to see a shift to allow for programs like Genesys Works, which provide career-oriented curriculum and work-based experience, to qualify for SYEP. “We don’t want [students] to have to make that choice,” he said.

DIVAS for Social Justice: STEAM for Social Change + STEAM Camp

DIVAS (Digital Interactive Visual Arts Sciences) for Social Justice offers free social change-focused STEAM programs for underserved K–12 students in Brooklyn and Southeast Queens.

Who is served: Underserved K–12 students in Brooklyn and Southeast Queens

Number of participants: 250

Location: After-school: P.S 156, Laurelton (K–5), The Linden SDA School, Laurelton (Private; PreK–8), The Trey Whitfield School, East New York (Private; PreK–8). Camp: Brooklyn Public Library, Macon Branch

Frequency/Duration: After-school programs: 5 sessions/total of 15–20 hours per week, September–June. Camp: 3–6-weeks, 9 hours per day

Eligibility Criteria: None

Curriculum: After-school and camp program curricula typically center on a yearly community social justice issue, such as gentrification or food access. Students apply the skills they’ve learned in the fall (or at the start of camp) through a social output project at the end of the program.

Summer campers have learned how gentrification is shaping Bed-Stuy through various STEM-based activities, such as 3D-printing brownstones, and using Google SketchUp 3D software to learn about engineering and design. In other programs, students have worked with a community organizer to create an interactive food justice map of Bed-Stuy, which required interviewing urban growers and mapping areas where healthy food is growing around the neighborhood.

Skills taught include digital media, robotics, animation.

Outcomes: Students can join the organization’s other programs: 2 programs focused on media and digital photography, and a newly launched virtual reality mentorship program for high school students at DIVA’s new social justice makerspace, Forward, in Bed-Stuy. Forward offers the community use of tools such as computers, sewing machines, VR/AR equipment, 3D printers, videography/photography tools.

Partnerships: NYU, Julia Robinson Math Festival

Cost: Free

Sources of funding: Mixed (DYCD funding for after-school programs; Department of Cultural Affairs)

What makes the program stand out? Few programs integrate community-level social justice issues, which DIVAS centers around. “We want our work to be community solution-based and for [participants] to actually see themselves as being the future leaders of their communities,” said founder Clarisa James. Founded in 2011, the organization initially set out to “change the narrative of who was dispensing stories,” by training young girls in digital media and IT skills, according to founder James. DIVAS later expanded to include boys and incorporate robotics, 3D printing and other tech skills, because they saw a real need in the neighborhoods where they work, including Bed-Stuy, East New York and Eastern Queens.

Forward, the organization’s new social justice maker space in Bed-Stuy, is the culmination of DIVA’s efforts since 2007 to raise awareness around tech skills and how they can be applied to solve problems facing underserved communities.

What does the organization need? James insists on hiring instructors from within the community, and finding highly qualified candidates has been difficult due to funding constraints. She does the majority of employee training, but ExpandedED has recently provided DIVAS instructors with professional development as well. Instructors are particularly important given that one of James’ greatest challenges has been “creating an environment where [students] think it’s OK to make mistakes,” she said. The programs are often students’ first exposure to tech skills, and many are intimidated at first. James also wants there to be less red tape around obtaining equipment/the complicated reimbursement process that comes with some forms of city funding.

HYPOTHEkids: HK Maker Lab

HK Maker Lab is a six-week summer intensive in engineering, design, and entrepreneurship at Columbia University for rising juniors and seniors from underrepresented backgrounds in STEM.

Who is served: Rising juniors and seniors from low-income families and underrepresented backgrounds in STEM.

Number of participants: 23

Location: Columbia University

Frequency/Duration: 30 hours per week, 6 weeks in total

Eligibility Criteria: Applicants must attend a NYC high school during this academic school year (due to the rigor and demands of the program, preference is given to rising juniors and seniors) and demonstrate economic or educational disadvantage. Academic history/attendance record, essays, and letters of recommendation taken into consideration.

Curriculum: Foundations of engineering design curriculum modeled on the senior design class taken by students in the Columbia University School of Engineering and Applied Science. Course is matched to students' abilities, meets Next Generation Science Standards (NGSS) and is taught by a Columbia Engineering program professor.

Students learn the engineering design process, with a focus on biomedical engineering. The process of identifying a problem, doing a needs analysis of potential customers, brainstorming solutions, and building a prototype teaches computational thinking and “instills in them that you will fail if you’re trying to do something meaningful,” said Christine Kovich, executive director of HYPOTHEkids and co-founder of Harlem Biospace. “It’s just a different way of working than they’re used to.”

Outcomes: Program is tracking students as they begin, and are now completing STEM majors. Teams of students develop a business plan and pitch to biomedical community executives, for the chance to have their design projects incubated at Harlem Biospace.

Partnerships: Harlem Biospace, Columbia University, NIH, Weill Cornell Medicine, West Harlem Development Corp., ConEd, Pinkerton Foundation, NYC Science Research Mentoring Consortium

Cost: Free

Sources of funding: Private

What makes the program stand out? New York City has the largest concentration of academic medical centers in the country. This presents an opportunity to create a diverse pipeline of future biotech industry leaders, and HK Maker Space is among the few programs helping this particular cause.

Working in teams, students identify a health problem and build a biomedical-device solution, such as an automated eyedrop system for glaucoma sufferers. Each team develops a business plan and a pitch, which they present to biomedical community executives, with the chance of their project being selected for incubation at Harlem Biospace, a state-of-the-art biotech incubator. “We’re showing students that they can take their STEM skills and apply [them] to solve real-world problems,” said Kovich.

What do participants need to succeed? Schools could be doing more to prepare students for post-secondary programs and careers in the life sciences. Feedback from instructors and mentors of Hypothekids programs suggests that “students don’t get a good foundation in biology in high school,” said Kovich.

The lack of labs and research programs in schools serving low-income students represents another hurdle, and even life sciences-focused schools “have had their research programs falter because they can’t find mentors,” said Kovich. To help fill that instructional gap, HYPOTHEkids invites public school teachers to “co-learn” alongside students in summer programs, with the goal of having them bring engineering back into their classrooms.

What does the organization need? HYPOTHEkids’ capacity is limited by funding and space constraints. It has use of Columbia lab spaces, but Harlem Biospace facilities are typically in use by companies based there. Kovich has also seen huge demand for the limited number of scholarships for elementary school programs (including summer camp).’

TEALS

TEALS (Technology Education and Literacy in Schools) is a Microsoft Philanthropies program that provides high schools with CS education taught by tech-industry volunteers.

Who is served: High school teachers of any subject (and students, to a lesser extent.) TEALS works with both high-performing and high-need schools, public/charter/independent schools

Number of participants: Approximately 40 classrooms served in 2018–19

Location: In school; multiple sites in the Bronx, Manhattan, Brooklyn, Queens.

Frequency/Duration: Varies from one-semester/full-year courses to lab sessions and customized programs to boost AP scores.

Eligibility Criteria: TEALS will work with teachers with at least 2 years of classroom teaching experience. Partner schools are selected largely based on an in-person interview with a TEALS Regional Manager.

Curriculum: The organization provides classroom support for the following curricula in NYC in 2018–19: Intro to CS course that TEALS designed, AP CS A course, AP CS Principles course (versions from both code.org and UC Berkeley). The one-semester Intro course introduces computational thinking through the Snap! visual programming language; an extended version transitions to Python in the second semester. AP Computer Science A is equivalent to a first-semester, college-level course for CS majors, introducing Java as well as fundamental computer science topics such as problem solving.

Outcomes: TEALS does teacher pre/post surveys, an anonymous student pre/post survey, tracks the number of students in each TEALS class, and aggregates AP Score data. The student survey includes awareness and attitudes towards computer science as a discipline and career; their assessment of the TEALS support for their class; and future plans for continuing with computer science. The teacher surveys are focused on teacher comfort with the CS content as well as their experience in the TEALS program.

Partnerships: Microsoft Philanthropies, DOE (TEALS has been serving NYC DOE schools since the 2013-2014

school year, and formally partnered with the CS4All program since the 2018-19 school year), Schools

Cost: free

Sources of funding: Mixed

What makes the program stand out? The organization's reliance on industry volunteers and its tiered levels of support for teachers are unique. The co-teaching model in particular can bring non-CS teachers up to speed in a way that one-off professional development programs may not. "Rather than coming to a workshop for a week, the actual learning is getting to work hand-in-hand with these content experts day in and day out in your own classroom," said Nathaniel Granor, Lead Program Manager, TEALS East Region at the time of this reporting. Additionally, through a new partnership with the DOE, teachers who will be implementing TEALS's intro course in the fall will be required to take a three-day, synchronized online professional development workshop this summer.

What do participants need to succeed? CS4All provides funds to pay teachers for the additional time they spend doing TEALS (such as attending professional development) as well as some expenses related to onboarding volunteers into the schools. Teachers need the "commitment and willingness" to implement the model," said Granor. While many science and math teachers sign on, business, social studies, and art instructors have also participated.

What does the organization need? While TEALS aims to reflect the diversity of New York City in the schools it partners with, that doesn't necessarily include the lowest-performing schools, which probably "don't have the capacity to take on our partnership," said Granor. The time it takes to apply for the program, for example, and having teachers who can commit to it are potential roadblocks to participation. Achieving gender parity among participating students has also proved elusive.

New York Hall of Science, Science Career Ladder/Explainers

The Science Career Ladder Explainers program trains New York City high school and college students to guide visitors through exhibits as well as lead hands-on activities at the New York Hall of Science.

Who is served: For students ages 14–25 (in high school or college). 85 percent of participants are from backgrounds typically underrepresented in STEM, and 60 percent are female.

Number of participants: 165 in 2018

Location: New York Hall of Science (NYSCI)

Frequency/Duration: 2-day orientation. High school students: minimum 5 hours per weekend, with additional shifts during school breaks and summer. College students: minimum of 10 hours on weekdays and up to 20 hours per week. Explainers spend an average of 2.25 years in the program. 1 hour per week of peer-to-peer training

Eligibility Criteria: Currently enrolled in high school or college in New York City; Interest in exploring and learning STEM; Interest in interacting with the public and developing communication skills

Curriculum: Explainers are trained to work in the museum, including explaining exhibits and engaging visitors and younger students, as well as leading hands-on activities. “Their main purpose is to bring the science to life and make it relatable,” said Priya Mohabir, director of the Alan J. Friedman Center for the Development of Young Scientists at NYSCI. There’s a lot of breaking down complex ideas; “Rather than talking about the refractive index of various mediums and how that changes over time, you might talk about how light bends through a certain object through different times of the day,” said Mohabir.

Students don’t necessarily learn how to code (though there have been coding workshops for some cohorts), but rather, “It’s really thinking about technology, not just as a career pathway, but technology as a skillset that you need for any aspect of a STEM career.” For example, NYSCI has hosted engineering career nights for Explainers with discussions around “the role that technology and coding skills play in how [engineers] are designing new software or workflows.”

Skills: communication skills, scientific process, teaching and communicating science.

Outcomes: Many students go on to major in STEM fields in college; in the program’s 33-year existence, 95 percent of participants have gone on to college, with 70 percent majoring in STEM.

Mohabir also emphasizes that 89% of alumni are using the communication and presentation skills and scientific literacy skills that they gained through the program in their academic lives and in their careers. Explainer Trainees can move up to become senior Explainers as well.

Partnerships: CUNY’s Accelerated Study in Associate Programs (ASAP), Internationals Network for Public Schools, Young Adult Borough Centers, Kingsborough Community College, Hostos Community College.

Cost: Free; participants are paid minimum wage

Sources of funding: Private

What makes the program stand out? While many Science Career Ladder participants go on to pursue STEM in college and beyond, the program’s emphasis is on “how STEM literacy makes you a more active citizen” and a more capable decision-maker in multiple sectors, said Mohabir. The rounded approach reflects efforts across NYSCI to prioritize active engagement with families in surrounding neighborhoods, which are made up largely of recent immigrants. The museum offers free STEM workshops for local parents, for example, and hosted a conference on STEM as an opportunity pathway for first-generation families. This is the environment in which Explainers are immersed.

The program also supports a vast alumni network, and Explainers participate in various professional development and career exploration opportunities, from events with STEM internship providers and nonprofit providers of STEM programs (like Girls Who Code and All Star Code) to field trips to tech companies to events where university leaders describe the different



CREDIT: Photo by Andrew Kelly/NY Hall of Science

STEM majors they offer. Participants also engage in weekly peer-to-peer training with Senior Explainers in science content, and communication and presentation skills. “We’re trying to become a support system for a community of people who might have some hurdles to face as they move forward in their academic and career lives. Building this as a community has been really helpful [for participants] just to fall back on,” Mohabir said.

What does the organization need? NYSCI is not looking to expand the size of the 100-person program because it wants to maintain “the one-on-one attention and the sense of community,” said Mohabir. She would like to extend career exploration workshops to a broader range of students but funding is a challenge, in part because Explainer doesn’t qualify for inclusion in SYEP (because students stay for years, not weeks), “although this work is directly contributing to the development of students that live in the city,” she said. Mohabir would like to see more city funding, specifically from DYCD, directed toward non-city agencies, particularly cultural organizations that are focused on youth.

How is computational thinking integrated into the program? New York Hall of Science has also become a leader in developing K–12 and professional development programs that integrate computational thinking, including through a partnership with Robin Hood. An app called The Pack, for example, created by NYSCI and Design I/O with input from middle and high school teachers, combines environmental systems and computational thinking concepts. Designed for classroom or home use, the digital game prompts students to test and revise algorithms by, for instance, having them combine game functions (such as holding and digging for food sources) in a computational sequence (an algorithm). Explainers help lead NYSCI programs for younger students that involve computational thinking, such as in the Maker Space, “so they have an opportunity to learn a new content area, but also be role models or near peer mentors for those students in the program,” said Mohabir.

New York on Tech: TechFlex Leaders/360 Squad

New York on Tech is a nonprofit that provides free computer science and technology classes as well as mentorship and internship opportunities for low-income high school students of color.

Who is served: Students in grades 10—12 from schools throughout the city where at least 50 percent of the population is eligible for free and reduced price lunch. Majority of participants are Black and Latinx.

Location: In and out of school; multiple companies, community organizations and schools in all 5 boroughs

Frequency/Duration: Tech 360 Squad: fall and spring sessions each run for 10 weeks, once or twice per week in person plus 2 hours in additional homework/coursework; Tech Flex Leaders: September–June, every Saturday for 5 hours.

Eligibility Criteria: Tech 360 Squad: 10th or 11th grader in a NYC high school who is interested in careers in web design/computer science/technology, and able to demonstrate dedication, passion and leadership. Tech Flex Leaders: 10th or 11th grader in a NYC high school at the time of application who is interested in careers in computer science/technology, available for workshops after school or on weekends once per week during school year, eligible for free or reduced price lunch, and able to demonstrate dedication, passion and leadership

Curriculum: Tech Flex Leaders: CSTA- and Common Core-aligned curriculum created by New York on Tech. Students learn front- and back-end web development skills and create portfolios of technology projects. Tech 360 Squad: fundamentals of web design and development; available tracks include web development, web design and mobile development; cyber security, data and product-focused tracks will be rolling out next year. Core skills: Front-end and back-end web development skills (coding, database administration, accessibility, and security compliance). Coding languages taught include HTML, Javascript, Python, Ruby, and ReactJS.

Outcomes: Students leave the program with a portfolio of technology projects they've created and have the opportunity to apply for internships with the companies they've been embedded in. Tech 360 Squad alumni have priority eligibility into Tech Flex Leaders program.

Partnerships: General Assembly, Teach for America, Girl Scouts, Google, Morgan Stanley, Vodafone, Facebook, Consensusys

Cost: Free

Sources of funding: Private

What makes the program stand out? “We really see ourselves as like a General Assembly, but a nonprofit model,” said co-founder Jessica Santana. Participants in both Tech Flex Leaders and 360 Squad are embedded in tech companies around the city, and as a result they come away well positioned for internships and careers.

Tech 360 Squad cohorts meet once or twice weekly at partner companies for a course in the fundamentals of web design and development taught by a tech-industry professional. Participants have priority admission to Tech Flex Leaders, a CS-focused nine-month program in which students take classes at tech companies and are also mentored by company employees, with the opportunity to apply for internships.

New York on Tech also runs similar programs in high schools across the 5 boroughs, but mainly in the Bronx and Manhattan. “Schools choose which track of the curriculum they want us to teach to their students,” said Santana. The organization does the same for community-based organizations, like the Girl Scouts, that want to incorporate computer science into their programming.

What do participants need to succeed? Active mentorship within tech companies, and help overcoming overcome imposter syndrome.

What does the organization need? “Every year, we have to turn students away, and not because they don't meet our criteria. We just don't have the capacity,” said Santana. “If we had the funding we could reach as many students as we want.”

New York Academy of Sciences: Scientist-in-Residence

The Scientist-in-Residence Fellowship Program pairs scientists with science teachers in underserved K–12 schools to develop and implement long-term research projects in the classroom.

Who is served: K–12 teachers and students in underserved schools (with a focus on middle school) in Brooklyn, Manhattan, and Queens

Number of participants: Roughly 335 students

Location: 7 in-school locations in Brooklyn, Manhattan, and Queens: MS442 Carroll Gardens School for Innovation, PS142 Amalia Castro, Institute for Collaborative Education, High School for Health Professions and Human Service, Teachers College Community School, The Queens School of Inquiry, Expeditionary Learning School for Community Leaders

Frequency/Duration: 10 sessions (at least every 2 weeks per semester) of 45 to 60 minutes. A scientist might support 2–4 classes at each school.

Curriculum: Research project developed by teacher and scientist and aligned with NGSS curriculum standards. Middle school teachers typically propose life sciences research, while elementary school teachers take a STEAM approach; last year, a third-grade class used clay to represent different layers of skin during a biology research project, for example.

Outcomes: Students can go on to other NYAS programs, such as Junior Academy. NYAS is working on creating a teaching credential for scientists who complete the program. Pre- and post-program surveys measure teachers' comfort level with implementing STEM projects after the program; whether teachers see any improvement in students' skill and knowledge. For scientists, NYAS measures interest in becoming a science educator and skills in pedagogy, communication, and collaboration.

Partnerships: DOE, schools listed above

Cost: Free

Sources of funding: Mixed; The program was created in partnership with DOE, but moving forward NYAS will be "running the program more independently" according to program manager Rowena Kuo.

What makes the program stand out? The program targets underserved schools identified by DYCD and aims to give students an opportunity to conduct long-term, authentic scientific research, as well as expose teachers to computer science techniques while preparing them to carry out independent research projects. Teachers propose a research project and NYAS then seeks out scientists with backgrounds in that particular field, often graduate or undergraduate students interested in teaching.

Additionally, NYAS encourages teachers and scientists-in-residence to develop their projects around improving students' communication, collaboration, and critical thinking skills. Digital literacy is another major component, said Kuo, as students gain experience with "how to critically evaluate the resources that they find online." In doing so, students get the rare opportunity to learn directly from scientists, who share the vetting methods they use when conducting their own research.

What do participants need to succeed? Teachers need help preparing students for the 8th-grade NYS science test. For that reason, NYAS plans to shift the focus of Scientist-in-Residence towards middle schools this coming year. Because of the lack of science instruction at the elementary level, Scientist-in-Residence can help provide the "catching up" that many middle school students need, according to Kuo. And whereas in previous years the DOE recruited teachers while NYAS recruited scientists, NYAS will be doing both for the coming school year in an effort to better align teacher needs with scientists' expertise.

What does the organization need? There are always more teachers wanting to be part of the program than there are scientists available to lead classes. NYAS needs more scientists to be part of this program, as well as resources to help with aligning curriculum to scientists' expertise. More buy-in from schools, including more support for teachers who want to or are participating in Scientist-in-Residence, is another need.

Global Kids: Digital Learning & Leadership

Digital Learning & Leadership (DLL) is an after-school program that exposes underserved K–12 students throughout New York City to real-life applications of STEM learning.

Who is served: Underserved K–12 students throughout New York City

Number of participants: Roughly 2000

Location: In school/after school: Bronx Studio School for Writers and Artists, Bronxdale High School, Careers in Sports High School, Curtis High School, High School for Global Citizenship, High School for Medical Professions, High School for Public Service, High School of Art and Design, International High School at Union Square, John Adams High School, Manhattan East School for Arts & Academics, Renaissance Charter School, P.S./I.S.109, P.S. 96, School for Human Rights, Transit Tech Career and Technical Education High School, The 30th Avenue School (Q300), Washington Heights Expeditionary Learning School (WHEELS), William Cullen Bryant High School

Frequency/Duration: 1 to 2 sessions per week throughout the school year

Curriculum: The culturally inclusive curriculum draws on the CS4All Blueprint, and centers on building 21st-century skills, particularly leadership. Students may work on game or graphic design, audio or video production, 3D technologies, or virtual reality, always with a connection to a global issue and often with local relevance. Because Global Kids staff are embedded in schools, they can adjust the DLL curriculum to meet each school's unique needs, whether that means introducing new skills or supplementing ongoing coursework.

Outcomes: Students leave with both hard and soft skills. "We're not exclusively talking about tech skills. We're talking about how you use and produce digital media; how you engage in public speaking and participate in policy advocacy using those skills as well," said Elizabeth Bishop, director of curriculum & outcomes evaluation and supervisor of DLL.

Because of GK's involvement with The Hive, a consortium of STEM program providers in New York City, it can guide students toward other nonprofit

providers of STEM programs and internships.

Partnerships: DOE, The Hive

Cost: Free

Sources of funding: Mixed

What makes the program stand out? The organization's focus on cultivating global citizenship results in unique project-based work that allows participants to learn tech skills while addressing problems or questions in their own communities. Through a partnership with LinkNYC, for example, students used graphic design software to create murals about STEM innovators who were women of color from New York City, which were projected on LinkNYC screens for Women's History Month. Through an upcoming partnership with ICCROM, an international cultural heritage preservation organization, students at William Cullen Bryant High School in Long Island City will use Tinkercad (3D design software) to research destroyed UNESCO World Heritage Sites and then identify sites around New York City that they feel are worthy of similar preservation and care.

What do participants need to succeed? Bridges to maintain their engagement in digital skills and STEM during the transitions between middle and high school, high school and post-secondary, and into careers.

What does the organization need? DLL could be more effective if all schools had consistent access to high-speed Internet. Other challenges include figuring out how best to introduce soft skills to very young students, and how to broker opportunities for young people when they're changing schools or transitioning to middle or high school. The organization also needs more investment from the city and consistent funding, as well as better connections within the STEM ecosystem.

Consortium for Research & Robotics (CRR)

The Consortium for Research & Robotics provides free STEM education for K–12 students incorporating industrial robotics and other digital manufacturing technologies.

Who is served: Black and Latinx students from underserved communities. While the focus is grades 7–12, 4th and 5th graders have also participated in recent programs.

Number of participants: 200; 10–30 per cohort

Location: Out of school: CRR, Brooklyn Navy Yard; Red Hook Initiative, Red Hook. In school: PS 686 Brooklyn School of Inquiry, Bronx School of Inquiry, Dock Street School, Children of Promise, Brooklyn Democracy Academy, and Susan S. McKinney Secondary School of the Arts.

Frequency/Duration: Varies from weekly to monthly. From 3 days per week for 3 weeks in the summer program to 10 one-hour sessions over the course of a semester.

Eligibility Criteria: For state-funded STEP program, eligible students receive free and reduced price lunch, or come from historically underserved communities. For privately funded STEM program, they work directly with schools, which select the participants.

Curriculum: Project-based curriculum focused on using analog and digital tools to create something with scalable, real-world applications. Skills taught: CAD, laser-cutting, 3D printing, robotics, and soft skills including presentation, critical thinking, and how to communicate decision-making.

The largest program consists of 5 modules beginning with a visit to the Consortium and followed by in-school sessions led by a researcher. Students first learn how to approach problem solving before brainstorming ideas for projects with real-world implications; previous groups have created rip-rap to prevent flooding along the Gowanus Canal. Students take an analog approach first, such as graphing, and then learn and transition into using digital tools that allow for scalability, such as 3D CAD software and laser-cutting. During the final session, held at the Consortium, projects are automated; students “can see how the math is a code that the robot can read, and then make big. It’s an amplification of

their agency,” said founder Mark Parsons.

Outcomes: Students return to school with a sign about their project, created using Consortium technologies, to present to their peers and faculty.

Partnerships: Pratt, New Lab. Schools: PS 686 Brooklyn School of Inquiry, Bronx School of Inquiry, Dock Street School, Children of Promise. Schools, in partnership with New Lab: Brooklyn Democracy Academy, Red Hook Initiative - Digital Stewards, Brooklyn Democracy Academy, Susan S. McKinney Secondary School of the Arts

Cost: Free

Sources of funding: Mixed (some private and public schools and community groups pay for the STEM programs, while other funding comes from NYS Science Technology Entry Program (STEP), for Title I schools)

What makes the program stand out? Across all programs, students learn CAD and a variety of digital manufacturing technologies, as well as “soft skills around the technology.” That combination of hard and soft skills, and the impressive technologies available at the Consortium, make its programs stand out. It’s rare for students to not only see but participate in a functioning industrial space that uses cutting-edge technology. Moreover, students interact with researchers and are exposed to a mix of tech professionals, artists and academics, ultimately giving them a sense of belonging, according to Parsons. “They are proud of their work and feel like this space is a place where they belong and are contributing.”

What do participants need to succeed? A feeling of belonging in a tech-focused, professional space.

What does the organization need? Funding in general, as well as for a full-time STEM program coordinator.

CodeScty

CodeScty has developed curriculum that uses original hip hop music and videos to teach foundational computer science to diverse communities.

Who is served: Diverse communities; mainly middle and high school students, some elementary

Location: They've piloted with schools and organizations including Google Code Next, Atlanta Public Schools, PS33 in NYC, DreamYard, All Star Code, New Rochelle High School, Monroe College, Pier55

Frequency/Duration: The lessons are customizable for different age groups and durations of time.

Eligibility Criteria: The organization is focused on working with communities of color and students from underrepresented backgrounds in STEM.

Curriculum: Music-based curriculum uses original hip hop songs and videos to teach foundational computer science. The company has carried out successful pilot projects in New York City public schools using this approach, always with an emphasis on pre-coding concepts and culturally relevant real-world applications. Skills taught: computational thinking, innovator mindset, standards in the CS4All Blueprint

Partnerships: NYU Steinhardt, SXSW, Google Code Next, Pier55, DreamYard, #YesWeCode, All Star Code, NEW INC, Startup Leadership Program, 4.0 Schools, Idea New Rochelle

Cost: Free for students.

Sources of funding: Private

What makes the program stand out? Code Scty's approach of teaching tech skills and computational thinking through a culturally relevant lens is powerful. But what also sets the organization apart is its emphasis on empowering students to be creators of technology, largely through giving students a theoretical foundation that will set them up to succeed in coding.

The curriculum helps students "to understand complexity and engage in solutions that they can develop in their community," said co-founder Armando Somoza, who comes from a nonprofit arts background

and has taught web development and coding. "We're teaching engagement and fun and entrepreneurship and innovation skills," which sets students up "to be creators of technology," he said.

Lessons use aspects of youth and pop culture, such as viral dance challenges, to teach algorithms. Students might deconstruct a dance into steps and sequences, or consider what problem an artist is trying to solve by creating a song. They could also use design thinking to identify a problem in their community, and create their own dance challenges with steps and sequences that can be translated through code.

What do participants need to succeed? For teachers to be more open to incorporating nontraditional curricula into their classrooms. Code Scty also offers professional development for teachers who want to use its curriculum, and the organization is working toward distributing their content to nonprofits, schools, and museums. "The idea is to help them cast a wider net and engage more young people into their pipeline," said Somoza.

What does the organization need? In addition to funding, one challenge Code Scty has faced is that many technical teachers studied computer science and teach as way they were taught. "It perpetuates a very specific cycle; most aren't trained in pedagogy, and that isolates and excludes so many people," Somoza said.

They've experienced resistance to their approach among some in academia and computer science. But once skeptics experience a pilot, and see students get excited about the concepts behind "lofty technical jargon" such as algorithm and abstraction, they tend to change their minds, according to Somoza.

Cooper Union STEM Saturdays

STEM Saturdays is a hands-on engineering and design program for high school students from underrepresented backgrounds in STEM.

Who is served: High school students from underrepresented backgrounds in STEM. Students are typically high-achieving academically and “come in interested in creative problem solving,” said Elizabeth Waters, associate director of STEM Outreach for Cooper Union’s Albert Nerken School of Engineering.

Number of participants: 24 per cohort

Location: Cooper Union

Frequency/Duration: 1 session per week, 6 hours per session, for 11 weeks; fall and spring cohorts.

Eligibility Criteria: No prior experience is required. The program seeks to include students from all 5 boroughs and from groups that are underrepresented in STEM.

Curriculum: Project-based engineering design curriculum that teaches students to use computer-aided engineering tools as well as engineering design and rapid prototyping techniques to solve a real-world problem. Skills taught: design thinking, collaboration, presentation skills, and computational thinking. Students use design software such as Arduino, CAD, Onshape, and microcontroller programming, and employ 3D printers, laser cutters and hand tools. “We’re not teaching anything to mastery, but to sufficiency. The goal is for them to see what each of those [tools] can do, so that they can imagine how to implement it in their project,” said Waters.

Outcomes: Referrals to other STEM programs such as Intrepid Museum, AMNH, Rockefeller Neuroscience Program. College and career counseling sessions with Cooper Union staff. Student team that wins the final presentation receives a cash prize. The program aims to springboard participants into Cooper Union’s competitive Summer STEM program, which accepts up to about 50 high school students. Cooper Union’s incoming undergraduate engineering class is between 110-120 students; in 2018, about 45 participants of K-12 programs applied, and up to 10 percent of participants are on track to apply this year. Participants have also gone on to work as instructors for other CU K-12 STEM programs.

Partnerships: Cooper Union

Cost: Free, and students receive Metrocards and lunch.

Sources of funding: Private

What makes the program stand out? Many students have accepted the idea that coding is an essential skill, but perhaps fewer grasp the importance of honing softer skills around technology. STEM Saturdays is also one of just a handful of programs that foreground design thinking. “We want [students] to be fantastic designers and problem solvers, because from our point of view, [those] are the harder skills to learn,” said Waters.

Working within the theme of “Technology for Good”, students work in small teams to design and build a product to solve a current or emerging problem. Participants are also mentored by Cooper Union students in areas such as professional skills, from technical communication to teamwork, design thinking and giving presentations.

What do participants need to succeed? More mentors from diverse backgrounds. Participants pitch their product ideas to a panel of judges for the chance to win a cash prize; judges are typically people from the local community, of diverse backgrounds and ethnicities and working in engineering education or creative tech fields. “When we look for judges, we are usually looking for people who look like our students, so it’s another opportunity for them to be exposed to role models,” said Waters. However, she said, when it comes to mentors, because Cooper Union is largely Asian and white, “there’s a mismatch in what our mentors look like [in comparison to participants].”

What does the organization need? There’s a high demand for Cooper Union’s K-5 programming, but not enough space to accommodate demand. Waters would like to see more blended learning spaces for K-5 students that could also be open to the community. “We don’t always need to have 3D printers or laser cutters in order to teach kids how to do fabrication and work through the thinking involved in that, but sometimes we need space for students to use box cutters safely or to drill something,” she said.

iMentor

iMentor pairs mentors who are professionals in tech and other fields with high school students from low-income immigrant communities for a minimum of 3 years.

Who is served: Students attending high schools in underserved communities where a majority of students would be first-generation college students

Number of Participants: 3,563 mentor-mentee pairs

Location: In school: Marble Hill School for International Studies; Bronx Academy for Software Engineering; Bronx High School for Law and Community Service; Comp Sci High; Bronx Leadership Academy II; The Laboratory School of Finance and Technology; Frederick Douglas Academy II; Business of Sports School; Academy for Software Engineering; Urban Assembly School of Business for Young Women; Lyons Community High School at Lafayette; High School for Service and Learning; International High School at Lafayette.

Frequency/Duration: 1 class per week; 1 meeting per month; weekly online check-in; 3 to 4 years in total.

Eligibility Criteria: Mentors must commit to helping a high school student get into college; connecting online with mentee once a week; and meeting in person once a month.

Curriculum: The weekly class that participants take combines social-emotional skills with college preparation. Skills taught include growth mindset, setting goals, and building relationships.

Outcomes: Compared with non-partner DOE schools with similar demographics, iMentor partner schools have a 20 percent higher college attendance rate, and mentees are 25 percent more persistent than non-mentees after 1 year of participation.

Partnerships: Citi Foundation, Morgan Stanley, PWC, AT&T Foundation, BlackRock, AlphaSights Barclays, Bloomberg Philanthropies, Allen & Company, Capital One, Credit Suisse, Deutsche Bank, DTCC, Equinix, Ernst & Young, EXL Service, First Eagle Investment Management, Goldman Sachs, HSBC, Macy's, The Nielsen Foundation, UBS)

Cost: Free

Sources of funding: Private

What makes the program stand out? iMentor stands out for embedding in schools and guiding mentees on a regular basis, whether they need help applying for and financing college or want internship experience in the tech industry.

When iMentor partners with a high school, every student in that school gets a mentor. There are 2 models: beginning in 9th grade and continuing through 12th grade, or starting in 11th grade and lasting through the first post-secondary year. iMentor also places a full-time program manager in each school to teach a weekly class, supervise monthly mentor-mentee events, and provide general and college counseling.

Matching is driven primarily by the student's interests and preferences. In most cases, if a student desires a mentor who works in tech, that can be accommodated. iMentor has brought on mentors from Google and various startups, according to the New York office's executive director, Max Polaner.

What do participants need to succeed? iMentor has learned that, when it comes to mentoring, "the more structure you provide, the better it works," said Polaner. iMentor provides content for mentors to draw from during monthly in-person meetings and weekly online check-ins with mentees. Mentors are also provided with resources to help them understand the city's post-secondary landscape, and build relationships with students across different backgrounds. Nationwide, 42 percent of the organization's mentors identify as people of color and 28 percent are first-generation college students, compared with 94 and 65 percent of student mentees, respectively.

What does the organization need? While iMentor is the second largest mentoring organization in New York City after Big Brothers Big Sisters (an iMentor partner in other cities and states), Polaner sees room to grow. Financial obstacles stand in the way; partner schools pay a portion of the program's \$1,200-per-student annual cost. iMentor raises the remainder of funding and would like to see more support from the city.

Citizen Schools: Apprenticeships

Citizen Schools places community volunteers in underserved middle schools to teach a variety of STEM subjects using hands-on activities and emphasizing social and emotional skills.

Who is served: Middle school students from underserved communities; more than 90 percent of students are eligible for free or reduced price lunch.

Number of Participants: 350

Location: After school: Renaissance School of the Arts (Manhattan, East Harlem), Isaac Newton Middle School for Math & Science (Manhattan, East Harlem), Urban Assembly Unison School (Brooklyn, Clinton Hill), P.S. 157 Benjamin Franklin Health & Science Academy (Brooklyn, Bedford-Stuyvesant)

Frequency/Duration: One 90-minute session per week for 10 weeks

Eligibility Criteria: Students attending partner schools

Curriculum: Volunteer teachers from the community lead 10-week courses using curricula and lesson plans provided by Citizen Schools. About half of the courses are in STEM subjects, including electrical engineering, solar cars, robotics, coding with CSS and HTML, and design thinking. Lessons involve hands-on activities and emphasize social and emotional skills, growth mindset and collaboration. Volunteer teachers pitch their apprenticeships to students at the start of fall and spring semesters, and students can choose to take up to 4 classes in 3 different topics over the course of the school year. An Americorps member with an interest in teaching helps volunteer teachers lead each lesson. Skills taught include social and emotional skills, growth mindset, teamwork, and collaboration. STEM subjects might also emphasize additional core skills such as coding, design thinking, and engineering.

Outcomes: Citizen Schools does pre- and post-program surveys of students' social emotional skills. They are beginning to track how the program connects to high school and beyond, including students' interest in STEM careers, where students go on to high school, and how likely they are to go

on to major in STEM in college. 8th graders can apply for Coding Academy, a year-long program in which students are paired with an engineer from a corporate partner (Amazon, Capital One, and Google). Students meet with their volunteer coach at the coach's corporate office every other week. The program includes mentorship and one-on-one instruction in coding with Python, for example, or video game design, based on the student's skill set.

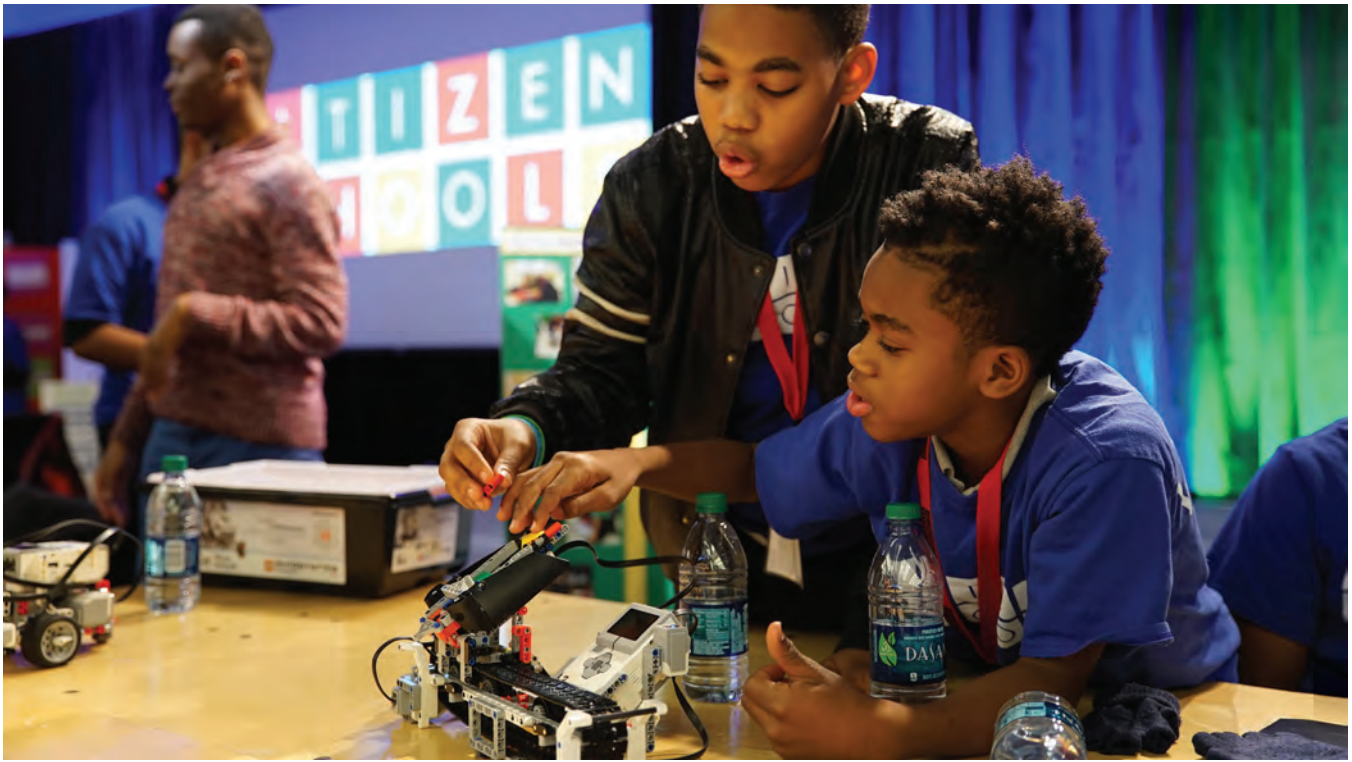
Partnerships: Amazon, Capital One, Google

Cost: Free

Sources of funding: Mixed (DYCD foundations, and corporate partners)

What makes the program stand out? Computer science is not offered at any of the organization's 4 partner schools in New York City, and with few nonprofit STEM programs focusing their efforts in Bed-Stuy and East Harlem, the apprenticeship may be the only opportunity for some students attending those schools to be exposed to CS or STEM. Discovering an interest in STEM in middle school can "kind of switch their brain into like, 'here's something I'm passionate about and I really want to go towards,'" said Nadia K. Selby, Executive Director for Citizen Schools New York. "If we can spark the interest of science and technology early on, they'll be more likely to pick a high school that will further that development."

Volunteers typically work in the field that they teach—Google engineers and Girls Who Code employees have taught apprenticeships—showing participants that they can, for example, "sit behind a computer and design a video game," as their career, said Selby. Most important are the connections participants begin to make between what they're learning in school and what they can someday do for a living. "That's what's helpful," Selby said.



What do participants need to succeed? The organization puts an emphasis on building participants' social emotional skills, using pre- and post-program surveys of students and employees created by the Student Success Network to uncover gap areas every year. Growth mindset (how to persist) and self-awareness (particularly in connecting with classmates) have emerged as social-emotional challenges among students, and focus areas for the organization, according to Selby, before students get to high school and college.

What does the organization need? 3 out of 4 after-school apprenticeship programs are DYCD-funded, while the fourth receives City Council funds, but Citizen Schools needs more funding or DYCD contracts in order to expand. "The schools themselves do not have additional funds to set aside to run an after-school program for us, so if you do find schools that really love our program and love what we offer, we also have to have the contract," said Selby. "A hiccup that we're facing, it's just how do we go into the school that doesn't have enough in their budget to pay for us to support the work? There's but so many DYCD contracts available for us to apply for."

Greater awareness among larger STEM organizations as well as tech companies could also give Citizen Schools a boost. "I'd like to see more folks in schools so that they can see what students are doing and learning," Selby said. "I think that's the gap, not necessarily seeing how it's impacting children." The organization has previously partnered with Google and Girls Who Code for apprenticeships. Potential partners benefit from the fact that Citizen Schools already "have the 'in' working with students," while students learn of additional opportunities around STEM, like Saturday programs or summer camps.

STEM Kids NYC – In School and After School Programs

STEM Kids NYC takes a hands-on, culturally responsive approach to teaching K–5 students computer science and STEM.

Who is served: K–5 students

Number of participants: 225 (includes all in-school and after school programs)

Location: 11 schools and 2 community centers in Brooklyn (Red Hook, Park Slope, Bay Ridge, Brownsville, Bushwick) and Manhattan (Washington Heights, Inwood, Harlem, Upper West Side, Midtown, Governors Island)

Frequency/Duration: After school: 2–5 sessions per week, 1–3 hours each, September–June. In school: treated as residencies (a DOE term) and are generally 1 day per week over a span of multiple weeks, based on a school's budget allocation.

Eligibility Criteria: The organization tries to provide 2 teachers for every 15 students; schools must be able to limit the number of students in the session to maintain that ratio.

Curriculum: STEMKidsNYC teaches STEM and computer science through a hands-on, learning-by-doing approach, with an emphasis on meeting students where they are and culturally responsive teaching. Topic areas include computer science, engineering, robotics, and creative technologies (Micro:bit, Arduino, Makey Makey, virtual/augmented reality). Lessons are aligned with the CSTA K–12 CS Standards. Students build critical thinking skills by regularly answering the question of “why” they are doing a particular activity. Computational thinking is also integrated into lessons.

Outcomes: Students have the option of joining STEMKidsNYC's STEM summer program for grades K–10.

Partnerships: The organization partners with several schools in Brooklyn and Manhattan, as well as 2 community-based organizations in Manhattan, but would rather not name them publicly.

Cost: Families sometimes pay, based on a sliding scale.

Sources of funding: Schools, families (sliding scale), STEM Kids NYC subsidizes through corporate donations it receives. No city funding.

What makes the program stand out? STEMKidsNYC puts a focus on teaching K–5 students computational and critical thinking skills. “If we don't ask students ‘why’, if we haven't had them take a minute to write down why [they] think it's happening, then we aren't helping them build their own critical thinking skills,” said founder Yvonne Thevenot, an Arthur Zankel Fellow at Columbia Teachers College, where she is researching and developing culturally responsive curriculum that utilizes a STEM interdisciplinary approach to teaching and learning. She builds lessons around “how a child would like to play,” and strives to bring a tech mentality into the school day, encouraging students to be “self-directed [because] if you're at a tech company, you need to get up and make it happen.” This is not the approach taken in most classrooms. “Tech still tends to be a separate construct to teaching and learning,” said Thevenot.

The organization's focus on culturally relevant curricula is also uncommon among nonprofit STEM programs targeting younger students. “All teaching and learning can be modified to respond to the children in front of you,” said Thevenot. “It's not just [students'] ethnicities; it's people's ideology, it's the culture of the school,” that should help determine how a lesson is taught. Thevenot requires that her teachers find and present to students “cultural icons who reflect their culture” and who are working in STEM.

What do participants need to succeed? Thevenot said that students need to be able to attend the in- or after-school program 5 days a week, for at least 1 hour per day, but that more funding is needed to make this possible. Most schools' budgets don't allow for such a schedule.

What does the organization need? Funding, participation in TechNYC, and better access to the DOE and CS4All so that the organization can share its culturally responsive STEM curriculum more widely.

Rocking the Boat

Rocking the Boat offers middle and high school students hands-on, inquiry-based activities that explore Bronx River ecosystems and ecology, with opportunities to become paid environmental apprentices.

Who is served: On-water classroom: middle and high school students from throughout the city. Long-term partner middle and transfer-high schools in the South Bronx.

Number of Participants: Roughly 5,000

Location: In school at Fannie Lou Hamer Freedom High School. After school at Rocking the Boat (programs on and around the Bronx River).

Frequency/Duration: Field trips of 2-3 hours, extended learning for partner schools

Eligibility Criteria: None

Curriculum: STEM curriculum centering on Bronx River ecosystems and ecology. Schools can choose from several different activities that connect back to what students are doing in the classroom. Hands-on activities focus on particular organisms, such as birds, fish, oysters and plankton. Students use basic lab equipment, and engage in data collection, such as measuring oyster growth and identifying companion species. A water-quality monitoring program has students explore human impacts on the Bronx River through testing salinity, PH, and dissolved oxygen.

Outcomes: 11th and 12th graders can apply to become paid apprentices through Rocking the Boat's contract with the Bronx River Alliance. The environmental apprenticeship, part of Rocking the Boat's youth development programs, has students working with professionals in the field, using scientific instruments to collect bacterial samples from the Bronx River, building and monitoring suspended wetlands, and surveying shore and wading birds for the City Audubon Society. "One of our goals for middle school programs is to develop a pipeline into our youth development program. We have social workers on staff that work closely with each student, give them tutors, and [counsel them about] scholarships and college admission," said public programs director Sarah Miles. Instructors of public programs have often grown up

through the organization. "They're college students who went through it and have been trained within all of our programs, so they bring a range of different skills and knowledge," said Miles.

Partnerships: NYC Parks, Bronx River Alliance, Bronx schools: Bronx Alliance Middle School, Fannie Lou Hamer Freedom High School, St Ignatius School (middle school), Bronx Arena High School (transfer high school), Jill Chaifetz Transfer High School.

Cost: Schools pay for field trips. Partner school programs are grant-funded.

Sources of funding: Public programs are privately funded. Youth development programs are largely funded by DYCD.

What makes the program stand out? Connecting classroom work to real-world applications of environmental science can incite students' interest in STEM. But the Bronx setting makes these programs especially powerful. "We have kids who are nervous, in tears, screaming when the boat starts to rock, and then high fiving" by the end of the program, said Miles. And that opens the door to more in-depth STEM learning. Students might wade into the Bronx River to collect plankton samples to examine back in the lab, revealing "all these organisms that were unknown [to them] in the river right here," said Miles.

What does the organization need? "A lot of our Title I schools have limited resources to spend on field trips," said Miles. Rocking the Boat is located in the "very industrialized and very underserved" Hunts Point area, and the organization provides youth development apprenticeship programs at no cost to kids. But Miles would love to be able to fund more out of school opportunities for schools in the surrounding community.

NYU Tandon: Innovative Technology Experiences for Students and Teachers

ITEST is a professional development program for high school science and math teachers that involves students and culminates with teachers creating a robotics elective at their school.

Who is served: NYC high school science and math teachers and high school students from 8 high schools around the city. Targets schools in underserved neighborhoods with diverse student bodies.

Number of Participants: 16 teachers and 32 students

Location: NYU Tandon School of Engineering

Frequency/Duration: 5 Sessions/42.5 hours a week for 4 weeks in July, 2 meetings per semester. During school year: implement elective robotics class and participate with students in a robot product design and business idea competition.

Eligibility Criteria: Two certified math, science, or CTE teachers from the same NYC high school apply as a pair, though single applications are also accepted. Teachers should have 3 years of full-time teaching experience, endorsement from the principle, and be able to teach a robotics course the following year. Each teacher selects 2 high school students from their school.

Curriculum: ITEST is a professional development program for New York City high school science and math teachers, who attend along with 2 students from their high school.

The four-week summer training program follows a NGSS-aligned curriculum developed by NYU Tandon's mechatronics lab. Teachers and their students work alongside each other to design and build a working robot, while learning engineering design practices. They return to school with access to the full curriculum and robotics kits. The curriculum is hands-on and project-based, and teaches students to put science and math concepts to use through robotics and entrepreneurship activities. Students who attend the summer course typically become assistant teachers or mentors to their classmates during the robotics elective throughout the school year.

Outcomes: An elective course for at least 24 students combining robotics and entrepreneurship becomes available at high schools around the city. Teachers leave with a stronger support network of colleagues trained

to teach the science and math behind robotics. During spring semester, school teams compete in a robot product design and business idea challenge. The winners may be offered internships (this past year, winners were offered internships with Silicon Harlem).

Partnerships: National Science Foundation. This year featured a partnership with Silicon Harlem.

Cost: Free, and project participants who successfully complete all requirements will receive a stipend of \$3,750. Student participants receive \$500.

Sources of funding: Private (National Science Foundation)

What makes the program stand out? ITEST is a unique professional development program because of its intensive focus on robotics, as well as its entrepreneurial bent. Additionally, the program takes the unusual approach of bringing students into the professional development process and having them help teachers carry forward the curriculum during the academic year. Teachers also gain a professional learning community and receive classroom visits from NYU Tandon graduate students during the academic year, supporting the program's underlying goal. "The really big idea is that we want to have an influence back at the schools," said Esner.

Another standout aspect is the integration of technology into the practice of science. "Nobody in a life science lab can get by without computer engineering or computer science," said Ben Esner, director of the Center for K12 Stem Education at NYU Tandon. And robotics integrates mechanical engineering, electrical engineering and computer science.

What do participants need to succeed? Teachers need to be committed to the program for the long haul, checking in with NYU Tandon graduate students throughout the year and supporting and empowering student teaching assistants. Teachers must also be involved in bringing students' robotics projects to life in the spring semester.

Upperline Code

Upperline Code provides standalone programs and courses in computer science and software development for middle and high school students, with a focus on practical and soft skills and a classroom culture where mistakes and questions are welcomed.

Who is served: Students ages 13–18. The organization is increasingly working with underserved students in New York City, such as through one-week intensive workshops for 250 10th graders through SEO (Sponsors for Economic Opportunity) and another intensive for about 450 women entering their first year of college at CUNY (through WiTNY, Women in Tech and Entrepreneurship in New York)

Number of participants served: 300 in summer 2018; 1,000 in summer 2019

Location: Curriculum / professional development consulting; Success Academy High School of the Liberal Arts, the Dwight School

Frequency/Duration: Summer intensive: 5 sessions, 2 weeks. Professional development: half-day, full-day, and multi-day sessions; twice-yearly exposure workshops for non-CS teachers

Curriculum: Standalone programming and software development courses. The curriculum is very hands-on and skills-based, focusing on full-stack web and mobile applications. “We focus on the languages that developers use in the real world” and “on teaching [students] skills that will last beyond high school and that they can [use to] get an internship right away,” said founder Daniel Fenjves.

A three-week program includes databases using MongoDB. One-week programs center around front end work; students learn Javascript, HTML and CSS. A two-week Javascript course dives deeper into front-end development. An iOS development course is available, and Upperline is piloting 2 advanced courses in data science and ReactJS.

Partnerships: DOE/CS4All, Google, JP Morgan, Prep for Prep, SEO, Code Nation, Kipp, Success Academy Network

Cost: Summer 2-week courses: \$2,100. In 2018, 37% of Upperline students received scholarships or financial aid for classes; Upperline reserves approximately 20 percent of seats for need-based and diversity-based scholarships.

Sources of funding: Mixed: DOE/CS4All funding curriculum development and teacher training work that Upperline is doing for DOE; other funds from tuition for traditional summer camps; nonprofit and corporate partners that contract with Upperline.

What makes the program stand out? Class sizes are typically 15 students and do not exceed 20, and Upperline has 2 teachers and a teaching assistant in every course. About half of Upperline teachers have never taught computer science before; they’re put through an intensive training and then paired with more experienced teachers to lead summer courses. “Our philosophy is that it’s much more effective to take an excellent teacher and teach them to code than it is to take a developer and teach them to teach. Those soft skills and classroom management are a lot harder to teach,” said Fenjves. “That’s a way that we sort of give back, because there’s a huge shortage of computer science teachers and the pipeline is really small.” Upperline has seen many of those newly trained CS teachers, often math or science or English teachers, “actually go back to their school and start a computer science program.”

What do participants need to succeed? “Learning to code is hard. It’s scary for many people. And there’s a lot of resistance, especially for students who may not see themselves as coders. Generally, women or students of color,” said Fenjves. To help students thrive, Upperline goes above and beyond to cultivate a classroom culture “where students feel very comfortable asking for help, making mistakes, reaching out to peers, as well as to teachers.” The organization uses improv exercises and “teacher vulnerability,” which is aided by having non-CS teachers in classes. Projects also integrate students’ interests with the technology they’re taught during a course.

What does the organization need? “Finding affordable space in the city to run the classes is hard.” Another big challenge is finding qualified teachers who can train new teachers. “It’s quite expensive to train a new teacher,” said Fenjves.

Brooklyn STEAM Center

Brooklyn STEAM Center is a new approach to career and technical education that embeds Central Brooklyn high school juniors and seniors in a professional environment at Brooklyn Navy Yard.

Who is served: Juniors and seniors attending 8 high schools in Central Brooklyn. Majority are Black or Latinx and qualify for free or reduced price lunch.

Number of participants: Maximum enrollment is 300. The first 2 classes (1 junior class and 1 senior class) were smaller, but STEAM Center expects to enroll full classes of 150 students per year starting fall 2019.

Location: Brooklyn Navy Yard

Frequency/Duration: 5 sessions; half-days throughout junior and senior year

Eligibility Criteria: Students must have time in their junior- and senior-year schedules to attend class at the STEAM Center while still meeting graduation requirements. Each partner school receives an equal seat allocation and determines which students to enroll in the Center.

Curriculum: Students can choose among 5 pathways, including computer science and information technology; construction technology; culinary arts and hospitality management; design and engineering; and film and media. Students can earn industry credentials (listed below). Collaboration, presentation skills and a variety of professional skills, from arriving on time to writing emails, are also emphasized. “Soft skills development is baked into the DNA of the school,” said David Ehrenberg, president and CEO of the Brooklyn Navy Yard.

Outcomes: Industry credentials including OSHA 30 (construction technology track), Autodesk and Solidworks (design and engineering track), NOCTI Prep Cook and NYC Food Handler’s License (culinary track), Adobe Pro Premiere (Film track), and Microsoft’s Python, Networking, and Security certifications (CS/IT track).

Partnerships: The STEAM Center has an advisory council that is managed and convened by the Brooklyn Navy Yard Development Corporation. This includes over 50 institutions including Yard-based businesses like Russ and Daughters, Crye Precision, New Lab and others, as well as representatives of local education institutions

including New York City College of Technology, Brooklyn College, and Pratt.

The STEAM Center has 8 partner high schools: George Westinghouse High School, Benjamin Banneker Academy, Bedford Academy, Science Skills Center High School, Boys and Girls High School, High School for Global Citizenship, Science Technology and Research Early College HS at Erasmus, Medgar Evers College Preparatory High School

Cost: Free

Sources of funding: Mixed

What makes the program stand out? Too often, schools in the city’s most vulnerable communities have lacked “high quality CTE experiences that actually lead somewhere,” said Dr. Lester W. Young Jr., Regent at Large for the state Board of Regents, who played a critical role in developing the STEAM Center.

The Brooklyn Navy Yard location gives students unique access to more than 400 tech and manufacturing companies. Because students are embedded in a professional environment, they can develop relationships with engineers and architects, for example, who give guest lectures, work on projects with students or lead workshops with real-world applications, according to Ehrenberg.

What do participants need to succeed? Students need for educators to make career and technical education a greater priority, via financial investment in cutting-edge equipment and teachers with industry-relevant knowledge. Otherwise, students won’t take CTE seriously, and neither will industry leaders who might employ them.

What does the organization need? Bringing the project to life required significant private sector financial investment, and its success will demand continued willingness on the part of DOE and private industry to collaborate in ways that they haven’t before.

Verizon Innovative Learning Schools

VILS addresses barriers to digital inclusion for both middle school students and teachers by providing 1:1 access to technology coupled with ongoing professional development.

Who is served: NYC Department of Education middle school students, teachers, and school leaders.

Number of participants: 4,882 students and 481 teachers across 17 NYC middle schools

Location: Manhattan: P.S. 171 Patrick Henry School, P.S. 108 Assemblyman Angelo Del Toro Educational Complex, PS 96 Joseph C. Lanzetta School. Bronx: Soundview Academy for Culture and Scholarship, P.S. 004 Crotona Park West, Bronx Writing Academy, South Bronx International Middle School. Brooklyn: P.S. 041 Francis White, P.S. 184 Newport, Frederick Douglass Academy VIII, Highland Park Community School, I.S. 171 Abraham Lincoln, J.H.S. 218 James P. Sinnott Magnet School, Van Siclen Community Middle School, Vista Academy. Queens: P.S. 183 Dr. Richard R. Green, P.S. 042 R. Vernam.

Frequency/Duration: Up to 4 years

Eligibility Criteria: Middle schools that are designated Title 1 schools

Curriculum: VILS offers schools a comprehensive program to enhance how science and technology skills are taught and learned. The program provides underserved middle schools with devices for all students and faculty, as well as high speed wireless connectivity. In addition, the program offers professional development and coaching resources to teachers—as well as school and district leaders—focused on strengthening STEM education and supporting technology integration. Verizon is also outfitting schools with Verizon Innovative Learning Labs, which offer hands-on access to emerging technology like augmented and virtual reality.

Outcomes: Data on the VILS program nationally finds benefits for both students and teachers. For example, 78 percent of surveyed faculty said that VILS enhanced student engagement, 89 percent said VILS helped them explore new ways of teaching, and 85 percent said VILS allowed for more personalized instruction.

Partnerships: Verizon, Digital Promise

Cost: Free to schools, with a \$1.8 million investment per school.

What makes the program stand out? In addition to providing schools with devices and wireless connectivity, the program stands out for its focus on professional development. VILS schools receive three in-person training sessions each year, in addition to virtual training for STEM instructional coaches, IT staff, and school leaders. Participating schools are also connected to a nationwide network of coaches and teachers to discuss technology integration and share best practices. The program is also one of just a few initiatives focused specifically on expanding access to STEM education in middle schools. “Middle school is a time that really solidifies what children want to pursue,” says Verizon’s Alex Servello, who helps to manage the VILS program in New York City.

What do participants need to succeed? Participating schools need a strong desire to enable students to develop the skills, knowledge, and capabilities to thrive in the digital world.

What does the organization need? Schools with passionate leadership that share VILS’ goal of preparing young minds for a digital world, and preparing schools for the 21st century and its ever-evolving technology. The program has grown from three to 17 middle schools as of 2020, but can only expand further with strong buy-in from school and district leaders.

Does it provide professional development? Ongoing professional development is offered to school and district leaders and on-site faculty through Digital Promise. Verizon Innovative Learning also provides a stipend for a dedicated, full-time instructional coach to support technology integration.