

Research and Recommendations for Technology Education at the City University of New York

CUNY OFFICE OF CONTINUING EDUCATION AND WORKFORCE PROGRAMS

Dear colleague,

The following document was originally researched and written in late 2019 and early 2020 – a very different, pre-pandemic labor market. Thus, some of the research and findings may need to be updated or reconsidered in light of the New York City labor market’s emphasis toward information technology, shipping and logistics, and health care – or the adaptation of these and other industry sectors in response to the COVID19 pandemic.

Nevertheless, we believe the central findings of this document are as relevant as ever – or of greater relevance to a socially-distant economy, has only grown its reliance upon the generation, analysis, and security of data. Through our research, we discovered many faculty and educators who are committed to:

- Curricular innovations that contextualize the use of important skill families – such as data analytics and information security
- Experiential learning opportunities – from meetups to internships – that offer students a low-risk way to develop key workplace skills and confidence
- Partnerships with public and private sector industry partners designed to support the quantity and quality of the previous two workstreams

Throughout the pandemic, CUNY educators have remained as committed as ever to the mission of CUNY – to be a vehicle for upward social mobility, and to provide a high-quality education to all New Yorkers.

We hope the priority skills and promising academic modalities described in this document continue to be of interest to all participants in New York City’s recovery from the COVID19 pandemic, and that versions of these ideas, tailored for distance learning, can continue to position CUNY students for long-term, sustainable careers with family-sustaining wages.

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1. Introduction

As the nation's largest public urban university system, the City University of New York (CUNY) serves as a leader among American higher education institutions in teaching the skills and competencies New Yorkers need to achieve economic mobility. Ensuring that curricula and student activities are aligned to the current labor market is an inherently iterative task, but one of central importance to the futures of our students.

CUNY students are smart, talented, hard-working, and diverse. Thousands of CUNY alumni work in America's most competitive firms, including Google, Amazon, Goldman Sachs, and others. However, these students often represent the highest achievers in their respective classes. For many other students, significant opportunities to achieve economic mobility remain untapped; among employers, CUNY's reputation as a talent pipeline varies widely. This high degree of variance for both stakeholders can be mitigated with careful action and impactful resources; doing so can create a more participatory economy for all New Yorkers, whether they are seeking or offering employment.

In 2019, the Research Foundation of the City University of New York (CUNY) received a research and planning grant from the New York City Economic Development Corporation (NYCEDC) to develop a roadmap of best practice in applied learning at CUNY. Because of the enormous range of degree programs at CUNY – from liberal arts to STEM – identifying a research team operating within CUNY's Central Office of Continuing Education and Workforce Programs conducted thorough research across the breadth of CUNY's system of community and senior colleges, and sought to answer the following questions:

- Which academic and extracurricular practices bring high-quality experiential learning to CUNY students, especially as relates to the tech economy?
- Are there any high-opportunity technology or computational skills that offer the following combination of features:
 - Labor market demand among New York City's key industries – both growth and net
 - Academic models, whether internal or external, which are proven and replicable for bringing these skills to a broad range of students across academic disciplines – especially beyond STEM majors
 - Interest among CUNY faculty in implementing innovative ways to educate students on these skills

To summarize our findings, our research team discovered the following:

Academic and extracurricular practice

- Many individual, per-program approaches to applied, experiential, and project-based education, especially where such education mimics the conditions and requirements of the modern, technology-enabled workplace;
- Off-campus experiential learning, chiefly in the form of paid internships;
- Per-department or per-program collaboration between faculty, administrators, and career services advisers, and industry professionals; and
- Many approaches to student soft-skill and professional network development, some of which suggest broad scalability to the CUNY environment.

High Opportunity Skills

- **Data science and analytics (DSA)** and **cybersecurity** emerged as areas of interest throughout our research process. This report will focus specifically on the potential to implement a **pathways-eligible gateway data analytics course** accessible to all CUNY students via ePermit, but we believe the approach identified in this document can be applied to other skill categories with equal success.
- Specific to data analytics and data science, CUNY faculty have identified **Data8** as a potentially replicable model that can increase student access to these skills, and set the foundation for the further application of data analytics to any major.

Finally, we hope these research materials can help point motivated stakeholders throughout the CUNY system toward the following:

- **A vision for success**
 - CUNY will become the first stop for New York City employers – present and future – seeking CS/DSA-ready students, regardless of field or sector.
 - CUNY will position itself as the public urban university of the future by integrating emergent skill sets and topics, such as DSA, cybersecurity, and ethical usage of AI, at both the general and specialized education levels.
 - All CUNY students will have access to on- or off-campus experiential learning that can prepare them for internships and jobs.
- **Creating a future-facing talent pipeline**
 - Many pockets of DSA integration and tech-focused applied learning exist according to individual faculty or department prerogative. Our research reveals an abundance of impactful activities happening in silos. As these activities grow organically, it is time to systematize and scale this work so that every CUNY student can participate as suits their individual goals.
 - General education courses can create the broad end of CUNY’s talent pipeline. Replicable progress has been made in developing and

implementing general education courses in computer science; similar models for data science and analytics are ready to be utilized.

- CS/DSA can be integrated into any major via the development of “connector courses”, student labs and activities, or new majors and minors.
 - Internships and extracurricular activities such as hackathons and meetups can give students time and space to apply these skills and further their skill- and portfolio-building. The number of CUNY students with access to these activities is currently too low to effectively produce a strong talent pipeline.
 - CUNY’s continuing education departments can offer bootcamps in data science and analytics and computational skills for working adults or recent graduates.
 - For CUNY’s employer partners - our neighbor companies, organizations, and institutions throughout the city in both the public and private sector - there are ways to collaborate on all of these activities and help develop the city’s talent pipeline of the future.
 - There is a very strong desire among faculty and administrators throughout CUNY’s colleges to participate in these innovations and to prepare their students for successful careers. The missing piece: resources and personnel. Leadership with strong subject matter expertise is also an essential piece of the puzzle.
- Partners
 - Employer partners: CUNY faculty are eager to collaborate on curriculum development and applied learning. There is much precedent to build upon and many individual programs are built on this kind of collaboration. CUNY also needs internship sites for our students - whether short-term three-week project intensives, or traditional academic year internships. Recently, CUNY has also focused on hiring adjuncts from industry to co-develop curricula and lead classes. The proposed pipeline structure can be tailored to any industry subsector or academic discipline where the need for CS/DSA and applied learning is aligned to demand and employer requirements. Work with CUNY to develop the talent pipeline of the future.
 - For philanthropic partners: Each of the innovations described above needs startup financial resources - but the impacts can be far-reaching. The proposed innovations can affect many students for many years to come as they become regular, reusable parts of the CUNY curriculum. The research team also recommends investing in leadership - which is often as much a missing piece as curricula, employer partnership, or faculty development - to guide this work and ensure a high level of accountability to all stakeholders.

1a. About CUNY

CUNY is home to approximately 274,000 degree-seeking students per year – a number which includes a growing number of students seeking STEM degrees. Ten-year trends in STEM enrollment reveal growing student interest across STEM fields – both in terms of pure enrollment in STEM majors and as a share of total enrollment.

Mean Enrollment for Selected Majors, 2014-2018

	Associate degree	Bachelor's Degree	Master's Degree	Total
Architecture and Related Services	N/A	795	124	919
Biological and Biomedical Sciences	1,256	5,462	212	6,930
Communications Technologies/Technicians and Support Services	1,376	83	N/A	1,459
Computer and Information Sciences and Support Services	5,623	6,823	496	12,942
Engineering Technologies and Engineering-Related Fields	2,578	1,810	N/A	4,388
Engineering	2,170	2,877	310	5,357
Mathematics and Statistics	277	1,459	374	2,110
Physical Sciences	6,107	1,652	163	7,922
Total	19,387	20,961	1,679	42,027

Ten-Year Enrollment Trends in Science, Technology, Engineering, and Mathematics

	Science	Technology	Engineering	Mathematics	Total	Total Enrollment - All Majors	STEM Share
Fall 2008	12,129	11,536	3,664	2,595	29,924	244,273	12%
Fall 2009	13,883	12,490	4,054	2,877	33,304	259,515	13%
Fall 2010	14,006	13,108	4,438	2,826	34,378	262,321	13%
Fall 2011	14,587	14,034	4,576	2,848	36,045	272,128	13%
Fall 2012	15,554	14,553	4,620	2,934	37,661	269,114	14%
Fall 2013	16,735	15,162	4,815	2,884	39,596	269,897	15%
Fall 2014	17,563	17,207	5,220	2,997	42,987	275,132	16%
Fall 2015	17,316	18,403	5,578	3,024	44,321	274,357	16%
Fall 2016	17,909	19,769	5,629	2,997	46,304	272,957	17%
Fall 2017	17,629	21,117	5,555	3,048	47,349	274,099	17%

1b. Developing a Strategy for the Public Urban University of the Future

To further inform this process, the working group also:

- Reviewed labor market information reports relevant to the technology sector;
- Interviewed stakeholders throughout the New York City education and workforce system, including CUNY educators, and industry partners and intermediaries; and
- Held forums with faculty from disciplines ranging from computer science to the humanities, designed to elicit insight as to how technology education and applied learning are and can be utilized on CUNY campuses in a wide variety of contexts.

As the project evolved, the project research began to set the foundation for a strategy for improving the quality and availability of technology education for CUNY's 274,000 degree-seeking students. We are grateful to the NYCEDC for their support and partnership in the creation of this report and in working with CUNY to ensure that New York City's single largest institution of higher education is performing its key function of preparing New Yorkers for sustainable, family-supporting careers and economic mobility.

The following report includes an accounting of the activities involved in this research and planning project, and the working group's early recommendations for those programs and practices which can ensure CUNY continues to meet its mission of helping New Yorkers achieve economic mobility and family-sustaining wages. The report also includes, in appendices, a list of the programs discovered through the research process; the labor market information reports synthesized by the working group; and the stakeholders who were interviewed. The report focuses on **computer science** and **data science and analytics** ("CS/DSA") as important technical skills that can be broadly integrated, and non-technical skills such as **teamwork, communication, critical thinking, and leadership** that can be developed through applied learning. Faculty professional development and collaboration between colleges and employers will be important means toward ensuring that academic content keeps pace with the ever-changing technology industry.

2. Review of Literature and Findings

The research team took a holistic approach in exploring the needs and resources of external hiring partners and internal stakeholders within the CUNY system. In preparation for those in-depth conversations, the team researched **workforce trends** within the tech industry, specifically Data Science and Analytics (DSA) and cybersecurity, with the understanding that computer science and computational skills have important, nuanced relationships to both areas; and assembled an **inventory of tech skills resources across the CUNY** system (both can be found in the appendix of this report). Upon conducting 29 interviews with internal and external stakeholders and hosting two CUNY faculty forums featuring 23 faculty attendees from across 15 CUNY campuses, the research team received a variety of key insights that shaped our recommendations.

2a. The Workforce Case for Data Analytics

In the wake of the 2008 financial crisis, [Mayor Michael Bloomberg's administration made significant investments in growing the NYC tech sector](#). Since then, NYC has been a big draw for tech companies and subsequently--tech talent. According to [CompTIA's 2019 Cyberstates Report](#), NYC has the largest base of tech employment in the country at 659,260 workers. In 2018 alone, the city saw a net gain of 10,440 additional tech jobs--coming in 5th among large metropolitan areas featured in the report. In total, Cyberstates claims that NYC is home to over 24,000 tech business establishments and amounts to 8.8% of the New York state economy, valued at nearly \$137 billion.

Information technology jobs continue to grow in importance in the NYC labor market economy. It is evident that a person need not work for a tech company to have a tech job: a [2019 Burning Glass study](#) indicates that 89% of the 6.9 million IT jobs posted online in 2018 were in non-tech industries. For instance, of all 315,824 Software Developer/Engineer job openings posted in 2018, 10% came from tech companies whereas 90% came from non-tech industries. It's clear that the demand for tech skills cuts across nearly all industries. The NYC metropolitan area, specifically, contains the highest concentration of IT jobs. The 515,106 IT job postings featured in the report amounted to 32% of all NYC job postings in 2018.

Cybersecurity as an academic field can be described as a holistic approach toward the protection of data and information systems. The combination of technical, business, and policy studies around principles of database applications, systems administration, and data recovery are the foundation of cybersecurity education.

Data Science & Analytics is an increasingly essential area of study emerging from traditional academic fields such as mathematics, statistics, and computer science with a central focus of leveraging datasets to identify streams of information that present a meaningful message or story.

While the demand for tech talent is high, the demand for cybersecurity talent is reaching critical levels. A [2018 report from Cybersecurity Ventures](#) claims there is an “estimated 350,000 open cybersecurity positions in the US and a predicted global shortfall of 3.5 million cybersecurity jobs by 2021... the industry clearly has a massive problem regarding supply and demand.” [In NYC, nearly 5,000 cyber-related jobs are posted each year](#) and take longer to fill than tech jobs overall--many of which go unfilled due to a lack of qualified talent.

In-demand Cybersecurity Salaries in New York City, 2019

IT Security Consultant

[Average NYC Salary: \\$97,116/yr](#)

Security Engineer

[Average NYC Salary: \\$136,747/yr](#)

Information Security Architect

[Average NYC Salary: \\$134,954/yr](#)

Employers are also finding it difficult to identify and secure talented staff with strong Data Science & Analytics (DSA) skills. [According to a recent Burning Glass report](#), the demand for jobs with DSA skills is projected to grow by 15% by 2020. The demand for fast-growing roles such as Data Scientists and Advanced Analysts are expected to spike by 28%. At [WorkingNation’s 2019 town hall event](#), WorkingNation Founder and CEO Art Bilger echoed the significance of data science in today’s workforce, “I really believe data and analytics might be the fastest-growing job area in this country over the next 5-10 years because there won’t be an aspect of business, government, or the not-for-profit world that isn’t driven by data and analytics.” In addition, both Data Scientists and Analysts are well-compensated with a median-base salary of \$108,000 and heralded as one of the best occupations in the country by [Glassdoor’s Best Jobs in the Country](#)--for the fourth year in a row.

“The nationwide shortage of data scientists is a relatively recent problem, giving colleges little time to adapt. Just four years ago, there were more workers with data science skills than there were jobs that required them. From 2015 to 2018, job postings for data scientists on Indeed.com rose by 75%. That trend continued in 2019, with a 56% year-over-year increase in data science job openings, according to an annual report from LinkedIn.”

In-demand Data Science and Analytics Salaries in New York City, 2019

<p>Data Scientist Average NYC Salary: \$115,815/yr</p>
<p>Analytics Manager Average NYC Salary: \$112,173/yr</p>
<p>Data Analyst Average NYC Salary: \$71,589/yr</p>

2b. Data Analytics: Growing Demand Across Occupations

Demand for data analytics skills spans many occupations, and a broader range of occupations has begun to demand data analytics skills over time. Of particular interest to our goals and vision: many of the occupations where the presence of data analytics is in highest demand fall outside of traditional computational occupations.

Unique Job Postings Demanding Data Analytics	500-1000	1001-2000	2001-3000	3001+
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Occupation	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Management Analysts	2,986	3,748	4,018	4,389	4,076	4,229	4,218	4,988	5,341	5,509	5,926	5,396	5,781	4,148	4,528
Market Research Analysts and Marketing Specialists	2,359	2,954	3,234	3,505	3,328	3,481	3,801	4,423	4,551	4,868	5,129	4,619	5,080	3,376	3,341
Software Developers and Software Quality Assurance Analysts and Testers	1,306	1,717	1,865	2,333	2,380	2,328	2,555	3,314	3,188	3,611	4,617	3,504	3,945	3,096	3,228
Marketing Managers	1,654	2,042	2,171	2,483	2,363	2,500	2,665	3,112	3,424	3,913	4,099	3,868	4,138	2,964	3,039
Unclassified Occupation	1,178	1,491	1,542	1,681	2,077	1,856	1,884	2,324	2,382	2,711	3,108	3,205	3,334	2,550	2,718
Computer Systems Analysts	1,282	1,502	1,595	1,786	1,498	1,595	1,854	2,188	2,146	2,346	2,784	2,158	2,371	1,829	2,157
Computer Occupations, All Other	1,048	1,360	1,561	1,618	1,525	1,580	1,673	2,022	2,099	2,152	2,818	2,095	2,384	1,903	1,982
Financial Managers	835	950	1,153	1,284	1,021	1,017	1,056	1,338	1,305	1,443	1,637	1,431	1,494	1,247	1,294
Computer and Information Research Scientists	421	532	549	796	711	828	915	1,112	1,205	1,357	1,556	1,323	1,472	1,238	1,301
Medical Scientists, Except Epidemiologists	485	639	786	778	678	763	737	735	878	1,022	890	891	975	997	1,209
Accountants and Auditors	912	1,068	1,150	1,187	900	1,085	1,194	1,211	1,371	1,528	1,638	1,608	1,642	1,079	1,193
Computer and Information Systems Managers	677	728	819	916	971	936	1,017	1,226	1,243	1,434	1,659	1,386	1,494	1,058	1,110
Financial and Investment Analysts, Financial Risk Specialists, and Financial Specialists, All Other	704	926	994	915	879	943	1,014	1,069	1,030	1,092	1,160	1,170	1,291	928	972
Personal Service Managers, All Other	523	632	701	738	712	775	766	874	1,023	970	1,157	938	1,038	790	832
Natural Sciences Managers	349	471	515	573	496	549	566	663	720	812	712	618	776	648	743
Project Management Specialists and Business Operations Specialists, All Other	369	419	490	690	485	502	494	548	633	706	798	755	822	608	637
Sales Managers	408	530	522	565	500	457	561	668	688	741	906	892	888	643	620
General and Operations Managers	290	297	362	410	444	473	520	560	665	729	930	804	822	622	616
Industrial Engineers	285	358	416	469	446	497	575	673	756	832	961	744	867	567	542
Information Security Analysts	254	346	342	376	373	456	450	470	492	557	648	558	592	475	443
First-Line Supervisors of Office and Administrative Support Workers	272	308	288	340	318	339	394	416	480	533	588	454	569	394	395
Computer User Support Specialists	325	341	327	365	302	338	341	398	382	463	539	483	505	360	376
Operations Research Analysts	225	313	351	386	339	374	411	443	548	532	528	467	567	384	372
Medical and Health Services Managers	366	387	369	427	341	465	510	542	566	574	634	523	557	397	353
Human Resources Managers	212	268	275	304	251	260	310	338	353	484	555	522	550	366	348
Total (Including occupations not shown)	26,511	32,706	37,321	36,476	36,761	38,043	40,276	46,743	49,243	53,695	59,550	52,505	57,057	42,710	44,518

These occupations demonstrate not only a growth in the net demand, but also in the percentage share of job postings looking for data analytics-ready workers. For example, the top five occupations in this list have generally seen a gradual increase, with the rate of increase fluctuating from quarter to quarter, in the percentage share of postings requesting data analytics skills.

Occupation	2016		2017		2017		2018		2018		2019		2019		2020
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Management Analysts															
Total Job Postings	14,750	17,979	19,343	21,100	17,719	18,614	19,427	22,927	23,632	24,860	26,631	23,668	25,051	19,132	19,963
Data Analytics %	20.2%	20.8%	20.8%	20.8%	23.0%	22.7%	21.7%	21.8%	22.6%	22.2%	22.3%	22.8%	23.1%	21.7%	22.7%
Market Research Analysts and Marketing Specialists															
Total Job Postings	15,505	18,020	19,321	19,865	18,873	19,531	20,569	23,422	24,332	26,209	26,833	23,489	25,376	17,482	16,853
Data Analytics %	15.2%	16.4%	16.7%	17.6%	17.6%	17.8%	18.5%	18.9%	18.7%	18.6%	19.1%	19.7%	20.0%	19.3%	19.8%
Software Developers and Software Quality Assurance Analysts and Testers															
Total Job Postings	33,861	41,121	45,429	53,164	48,880	53,352	57,622	71,614	70,389	77,985	102,732	77,241	82,353	64,649	69,515
Data Analytics %	3.9%	4.2%	4.1%	4.4%	4.9%	4.4%	4.4%	4.6%	4.5%	4.6%	4.5%	4.5%	4.8%	4.8%	4.6%
Marketing Managers															
Total Job Postings	26,684	32,690	33,664	37,708	35,481	36,862	40,331	44,545	48,114	53,065	55,199	48,668	52,413	37,515	38,275
Data Analytics %	6.2%	6.2%	6.4%	6.6%	6.7%	6.8%	6.6%	7.0%	7.1%	7.4%	7.4%	7.9%	7.9%	7.9%	7.9%
Computer Systems Analysts															
Total Job Postings	11,457	13,362	13,919	14,939	12,702	12,923	13,967	16,535	17,472	19,843	25,179	17,726	19,098	14,633	16,194
Data Analytics %	11.2%	11.2%	11.5%	12.0%	11.8%	12.3%	13.3%	13.2%	12.3%	11.8%	11.1%	12.2%	12.4%	12.5%	13.3%

For larger versions of these tables, please visit: [Google Drive](#)

2c. Preparation needed for in-demand tech jobs

Technology - and data analytics and cybersecurity in particular - are rapidly evolving fields as the information economy captures an increasing volume of data from multiple sources and uses data to support making decisions in different workplace functions and sectors. Cybersecurity continues to grow in importance as safeguarding this data becomes a standard requirement throughout the American economy.

The research team reviewed several data science and cybersecurity skills labor market reports and competency frameworks produced by reputable organizations like the [Business-Higher Education Forum](#), [IBM](#), [Fullstack Academy Cyber Bootcamp](#), [General Assembly](#), and [National Initiative for Cybersecurity Education \(NICE\)](#). While skills competency frameworks for cybersecurity and data science are fairly new, they form a critical backbone for defining the learning outcomes of any new course and program and help align employers and educators. Successful CUNY programs, such as Baruch's data analytics track for accounting majors, have worked with employers to create such frameworks so as to understand the skills and knowledge that will be valued and identify how to fill the gaps for students.

The existing frameworks allowed the research team to structure intentional conversations with both CUNY faculty and administrators, as well as industry professionals. Faculty spoke to potential ways curriculum can be updated or newly developed, administrators informed the research team of skills-based programs outside of the classroom, and industry professionals shared insight around talent gaps as well as potential pipelines to employment in NYC. Through these conversations, our team identified some notable key points:

1. **CODING AS A FOUNDATION:** Some degree of exposure to computation is foundational in today's tech economy
2. **CYBER CREDENTIALS:** There are several recognized credentials that outline the skills for Cybersecurity roles and have market currency
3. **SKILLS VS. DEGREES:** There is both pressure to move away from screening by degree and expected demand for highly trained (masters or PhDs) and identifying other methods to assess specific competency
4. **ON-CAMPUS EXPERIENTIAL LEARNING:** Experiential learning matters to employability. Recent research by the State University of New York finds that students "...who majored in business, management, and public administration and had experiential learning opportunities earned \$8,000 more than students without. In the visual and performing arts, as well as communications technologies, these experiences made a \$16,000 salary difference. In mathematics and computer and information sciences, the difference was nearly \$23,000. In short, experience counts."
5. **CUNY CONNECTIONS:** CUNY's formal feedback loops between employers and educators are weak, but are powerful when they work, including discipline specific advisory boards; most programs seem to be developed based on limited market labor information due to time, expertise and resource constraints
6. **DEVELOPMENT OF BOTH BROAD AND SPECIALIZED SKILLS:** Tech knowledge combined with other domains will become more important as "every company becomes a tech company"

and combining increasing and complex data sources becomes more essential to decision making. Within CUNY, faculty describe “CS Plus X” (e.g. Computer Scientists tackling a social good challenge to apply coding skills) and “X plus CS” (e.g. Biology using large data sets and computational methods) approaches.

2d. Program Inventory

Through researching this report, the team learned of many innovative tech partnerships with experiential learning within the CUNY ecosystem both inside the classroom and outside of it. A variety of cross-sector collaborations have been forged by faculty, administrators, and senior leadership in an effort to introduce and upskill students for the tech economy--both inside and outside of the classroom. These partnerships manifest themselves into different types of applied learning programs and initiatives.

In conducting this report, the research team assembled more than 90 examples of applied learning initiatives across the CUNY system. Several basic categories for experiential learning emerged from the inventory that foster employability: tackling “real-world” problems and data, internships, especially those that yield a finished project or product, and networking and interview preparation. We are confident that there are many more applied learning initiatives taking place at CUNY’s campus partner institutions, especially among student clubs, adjunct professors, and advisors.

We also observed that most of the successful external models for experiential learning, career preparation and tech education are being tried somewhere in the system. For example, “The Zicklin Full-Time MBA Program’s continued rise in the rankings is the result of an innovative curriculum that includes data science and analytics, machine learning, and cybersecurity,” said [H. Fenwick Huss, PhD, Willem Kooyker Dean of the Zicklin School of Business](#). [CUNY’s School of Professional Studies Master’s of Science in Data Science online degree program](#) was ranked in 2017 as one of the top [Master’s in Data Science](#) worldwide as well as one of the [Best Value Online Big Data Programs](#). The MS in Data Science online degree program offers foundational knowledge and hands-on programming competencies, resulting in project-based work samples similar to that of a programming boot camp.

CUNY 2X Tech is an umbrella initiative on several senior college campuses that has been successful in expanding the number of Computer Science graduates and embedding experiential learning. CUNY2X Tech is an initiative to double by 2022 the number of CUNY students graduating annually with a tech-related bachelor’s degree and equipped with the skills and experience needed to compete for entry-level jobs in tech. The five-year, multi-million dollar initiative was designed to develop the comprehensive pipeline needed for Mayor Bill de Blasio’s vision for a thriving and inclusive NYC tech ecosystem, fueled by homegrown talent. Its design reflects partnership between the NYC Tech Talent Pipeline, NYC tech employers and senior college academic leaders to better align tech education with industry needs and expand access to quality tech career.

In Computer Science, CUNY 2x has successfully increased full time faculty, with two full time lines added in the participating colleges, bought tech practitioners into the classroom as adjuncts, particularly for specialized topics, and provided quality internships (about 25 per year per campus). These investments need to be sustained and enhanced to meet the expected further growth. Computer Science enrollments continue to grow, but despite CUNY 2x support, in many cases enrollment outstrips instructional capacity. As a consequence, it can be difficult for students to get seats,

class size can be larger than optimal (although some faculty have creatively redesigned large courses), and there is not enough excess capacity for faculty to develop or update courses.

CUNY has initiated a “Computer Science Zero” initiative, also known as CS04All. Almost all colleges currently offer an introductory computer science course that can meet a student’s General Education Requirements in either the Quantitative Reasoning and/or Scientific World Pathways bucket. Faculty have the flexibility to shape the course, but it must include 3 weeks of coding experience and meet the goal of getting students to understand the field enough to decide to go into it and to have foundational tech literacy. These courses are one example of using centrally conceived and awarded grants to spur faculty led course innovation at the college level. A library of syllabi and course content modules is available to all faculty to use to make it easier to create the course and keep it current. One CS0 variation reserves the last 2 weeks for students to work online on a coding project in area of interest. An experimental introductory CS class for Macaulay Honors College, based on a Harvey Mudd model, integrated examples from various sectors to help students engage and understand the value of understanding CS.

As with other technology course offerings demand outstrips availability given constraints of qualified instructors and student access to computers and/or computer labs (which are essential for this hands on course). The large enrollment Introductory CS class (about 600 students) that was developed at Lehman and is currently offered at Hunter can address the challenges in recruiting the (usually full time) faculty in CS needed for introductory classes. Berkeley’s “Data8” course uses a similar format and approach with a focus on introductory data science and analytics, for example the coding section is based in Python and topics include data visualization, statistics and machine learning.

3. A Vision and Strategy for Technology Talent Development at CUNY

The following section includes a summary of the research team’s vision and goals for developing and scaling CUNY’s capacity as New York City’s primary engine of technology skills education; a further discussion of the strategies that can help achieve these goals; and specific implementation recommendations for all stakeholders.

3a. Vision and goals

CUNY’s core mission is to develop our students’ knowledge and economic mobility. The research team’s two-year vision--derived from the research described previously--includes making progress towards the following:

- Every CUNY student, regardless of major and discipline, has access to courses that build foundational skills in technology, including data science and analytics, cybersecurity, and computer science, with these courses reaching large segments of the CUNY student population;
- Every CUNY student with the interest to pursue technology skills in more depth has access to meaningful courses, majors, minors, or other credentials
- Every CUNY student pursuing technology and DSA skills has access to experiential learning opportunities throughout their academic career, both on and off campus, including applied learning courses and activities, internships, and bootcamps;
- Every CUNY student can leverage their college education to develop the social and professional capital and networks, especially where these are not necessarily concomitant with their individual backgrounds;
- Every CUNY college has a strong reputation for collaboration with employers--whether public or private sector--and productive collaboration becomes a normalized practice wherever opportunities to develop curricula and inform pedagogy arise; and
- For CUNY to be the first stop for local, diverse talent development for any New York City employer.

The research team does not propose that every CUNY course and academic activity be subject to this vision, but rather that each CUNY student, faculty member, and administrator can align with this vision as appropriate for their individual goals, and that all members of the CUNY community can tap into these educational modalities.

3b. Strategies

Strategy 1: Expand entry level awareness of and foundational skills for “tech for everyone” to develop foundational knowledge and motivation to learn more. It is widely accepted that tech and data literacy will be required for many jobs, both within and without the tech sector. The

CS04All initiative has established a foundation. Enough seats need to be made available and all students need access to laptops.

An introductory “data zero” course* should be offered on every campus to give a large number of students a broad perspective and foundational skills. The course design guidelines include showing data analytics in different use cases, providing exposure to one or more of the simpler platforms to show transferable concepts and having several case studies and application projects to connect students to what data analytics can do to solve problems not just how it works potentially grouping sections by students interests (public policy, health, marketing). Campuses can determine their best path. For some it may be a new standalone course, for others it may be a redesign of their CS04All course or current entry level statistics offering, for others it may be the introductory statistics within disciplines (like the natural sciences, economics, finance, sociology). Some campuses may combine

Most students would also benefit from a basic understanding of risks in the digital world and understanding of cybersecurity. This should be incorporated into these introductory courses and other parts of the curriculum, whenever students are expected to use online or digital tools or data sets or otherwise learn about managing risks. A mandatory CUNY online tutorial on how to be safe online was suggested as a companion to other safe behavior requirements.

Outside of these introductory courses, awareness of data ubiquity, of career opportunities and of employer expectations need to be embedded into early career development materials and programs, freshmen orientations and courses, the advisory curriculum, career development programs and on campus speakers and panels. LaGuardia is developing guided pathways for students (and advisor) linking coursework and co-curricular activity to tech skills and jobs, using models from Dallas and Georgia. All these program offerings and guidance need to convey that students also need to take initiative. Employers expect this kind of independence and the ability to keep learning since there is always something new.

Strategy 2: Sustain and expand CUNY to grow the number and proficiency of CS majors/graduates. These degrees provide the pipeline for technology creators, advanced data scientists and cybersecurity experts. CUNY projects the number of graduates to increase to 3084 grads in 2017, up from 1543 in 2008, The program is considered successful to date in building instructional and course innovation capacity and supporting internships, which serves as a model for related fields (see below).

A few areas for focus going forward include expanding the data analytics and cyber track/opportunities within Computer and Information Technology majors. This is underway with the recent hiring of cybersecurity specialists by the Tech Talent Pipeline to focus on cyber needs such as the target competencies and recruiting tech in residence experts. The program has market feedback loops that can enable the curriculum and internship support to stay current through the internship coordinators and Tech in Residence instructors but may need to capture and share this information more broadly. Outer borough and smaller colleges may need more access. Determine how to scale the

development of professional success skills, such as communications, interviewing and networking, in the classroom and in supplemental programs, as described in Strategy 4.

Strategy 3: Expand and evolve data analytics course and degree offerings. There is a growing awareness and interest outside of Computer Science about the need to educate students in data analytics. Our research faculty in many disciplines experience firsthand a move to computational strategies using large data sets but the skills and capacity to translate this to educating students and keep up is challenging. CUNY can leverage learning from CUNY 2x successful approaches to bring in more applied learning opportunities, current expertise and more capacity.

To accomplish this well and efficiently, faculty need stronger connections to the market, specifically a clearer understanding of the valued competencies and largest scale labor market opportunities as well as technology developments. From there faculty can identify and address gaps in the curriculum.

There are existing skills templates in DSA & Cyber credentials and assessment platforms (such as General Assembly, Microsoft Education, the Business Higher Education Forum, and Degreed) that can serve as a starting point. At the campus or cross campus level, faculty benefit from direct access with employers and communication of findings beyond those in the room. CUNY central's sector specialists can enable the right employers, representatives and sector clusters and faculty peer councils, virtual forums can help disseminate. Starting with a specific sector such as healthcare or finance can establish a model. Employers are not so far along in documenting the introductory competencies so a collaborative approach can also establish commitment on their side for recognition or "badging" opportunities and job pipeline for successful students (internships) and graduates (jobs).

CUNY needs a more reliable and efficient way to assess labor market opportunities, as a resource for all colleges to capture, research and analyze job opportunity trends and entry level competencies. There are multiple examples of assessments based on public data and proprietary job posting scraping tools. But for many faculty and program developers such an assessment requires bandwidth, access and specialized experience they just don't have (not is it necessarily worth it for each acquire). Therefore, many program decisions are made on very little data, without as clear a focus on the learning outcomes as is available. Note these learning outcomes are likely to continuously evolve so the process to maintain and communicate them needs to be nimble.

In addition to a solid alignment on the learning outcomes, CUNY needs to make it easier for faculty to design, redesign and offer an efficient and competitive sequence of courses. Many faculty have undertaken this work on their own. Many colleges have designed and redesigned degrees to develop tech and data skills. Faculty have innovated with course design to increase enrollments effectively and provide more applied experiences. But faculty note the challenges of time, knowledge, access to existing content, approval processes, physical space, and conflict between disciplines.

A formalized approach to educate Data Science and Analytics (DSA) talent, can dramatically increase the number and skills of students for a range of careers and sectors. CUNY 2x as a program
Tech Education Strategy at CUNY

can be a model for such a branded push, albeit with potentially different components. Sometimes referred to as “**X plus CS**”, such an initiative includes additional colleges offering a **Data Science and Analytics (DSA) minor***.

In addition, **DSA literacy and tracks need to be integrated into non tech disciplines** that have growing data intensity and computation. Models exist, for example at City Tech for Biology (Biomedical Informatics), Lehman for Sociology, Baruch for Accounting and Marketing and Hunter for Geography and Biology. Providing recognition for DSA skills “across the curriculum” through badges or transcript notes can help students seek and value these skills and fields.

Faculty need support in order to develop and redesign courses and programs. A collaboration with the Business Roundtable has successfully used **course development grants** and industry expert partners to mobilize and support faculty (and puts less pressure to release faculty from teaching in order to develop courses) Administrators have leveraged existing courses, capstones, independent study and special topics courses to fill curricular gaps quickly, and minimize approvals. Gearing up colleges to enable more faculty and students to manipulate complex, large data sets in a safe environment is likely to require additional licenses, computing capacity and **technical support**.

Faculty in many disciplines are aware through their research of the techniques and demand for this expertise and currently make ad hoc attempts to integrate new methods. There seems to be significant “reinventing the wheel” and understandable inertia about knowing where to begin or what works. Faculty and administrators can benefit from forums where they can learn about innovations within and across disciplines, explore translating them for use at their college, be made aware of industry trends, receive professional development in evolving tools and techniques and articulate common obstacles requiring system-wide solutions. Either establishing structured forums across colleges or providing a grant for faculty to convene their peers could address this need.

Libraries of **accessible, shared content*** for many subjects have been established as part of the CUNY Open Educational Resources initiative. Both CS04All and Tech in Residence have been assembling applied learning exercises as well as syllabi and lectures on the CUNY AcademicWorks site (<https://academicworks.cuny.edu/oers/>). The applied learning exercises can enable faculty who are less familiar with experiential learning to integrate it into their courses. Faculty download data-related course curricula most from current Tech-in-Residence Corps. Site. For a broad sector of faculty to take advantage of these resources and as the libraries grow in size and complexity, investments in navigation, how-to support and an awareness campaign are likely in order to fully leverage these resources

Instructors with current skills and ready applied learning examples need to be brought into the classroom. The CUNY 2x Tech in Residence program should be expanded or duplicated to **bring DSA practitioners into the classroom***. Through formal outreach to companies and professionals, training, faculty buddies and administrative handholding, the program has tapped into an additional pool of adjuncts (despite their high external compensation) and brought many of the latest tech topics to our

students. The need for specialized instructional capacity seems to be more acute for smaller programs and outer borough campuses and those with less full time tech and data science faculty.

In some cases, third parties have already created course syllabi and content that map to learning outcomes that employers have identified. Many of these providers are interested in exploring partnerships with CUNY colleges that could fill some current gaps. In addition to helping students find and access these resources (see below), some make be appropriate to plug into courses or to consider as credit bearing modules. CUNY needs to insure that when the content involves a specific platform (e.g. Infor, IBM, Salesforce, and Microsoft) students can easily translate the concepts and skills to other platforms so they have longer term learning, in addition to a current credential that may have value to employers right now. Many employers screen resumes based on specific tags, so CUNY should help students identify and recognize valued skills regardless of where they acquire them.

Strategy 4: Students need **practice opportunities beyond the classroom** for both technical and professional skills. To the extent that CUNY can provide recognition vehicles and pathways to receiving credit towards a degree or other credential, more students will be able to access these opportunities.

Students need exposure to professionals, work environments and opportunities to use skills in a real world setting to be equipped to pursue their career after graduation and to be competitive. Women in Technology in New York (WiTNY) industry-funded **Winternship** program* has taken advantage of CUNY's three-week January term to place small groups of students in a company to work on a real tech project. Expanding this strategy to include DSA and cyber would give more students a taste of the opportunities out there, understand and start to learn workplace skills and be able to talk about how their education is relevant in an interview. "Winterns" have gone on to longer internships and jobs as employers also get familiar with CUNY talent - the short-duration, immersive model has proven to be low-risk, high-reward for both students and employers.

To enable longer term meaningful work experience, CUNY colleges have many, often small, **programs to support internships***, beyond what is offered through career development office postings, scattered across departments and offices. Examples that seem worth duplicating in the tech, cyber and data sphere include CUNY's Service Corps, which has matched thousands of students with community-based organizations and government agencies for paid internships and the Tech Talent Pipeline's Tech Residency. All of these internship support programs require an administrative hub to reach out to employers and to students and to screen, place and prepare students so that the placement is successful from both sides and employers will take future interns. While some employers want CUNY to expand the top of the funnel (e.g. Amazon) other employers' value some more personalized selection or filtering of students who apply.

CUNY and other colleges have created **labs, incubators*** or other physical spaces where students can work on projects. These spaces can also provide a hub for other activities that expose students to opportunities and information. They can reach beyond the university to engage and support the community through collaborative projects, "upskill" training and promoting local entrepreneurship, Tech Education Strategy at CUNY

such as the CSI Tech Incubator or Tech Incubator at Queens College. CUNY Start Ups provides a university-wide entrepreneurship hub for students to gain training, industry exposure and teamwork experience, and would like to expand its program to leverage large data sources as the basis for startup ideas.

CUNY needs to host or at least sponsor **noncurricular practice opportunities*** where students finish a show-able project whether or not there is a data lab. A good example is the CUNY-IBM Watson Social Impact Challenge hosted at Baruch. It is a semester-long experience where CUNY students select a project and explore creative ways to use artificial intelligence and cloud technology to solve social problems. Workshops, boot camps, and mentoring help support student teams throughout the competition. CUNY Codes and the CUNY Tech Prep are examples of CS noncurricular programs where students work in teams to code and create a product or app. These examples can be replicated at other locations across the system to reach more students. These programs often imbed professional skill training and industry exposure. Industry advisory boards and partners can help define recognizable credentials to brand these experiences in a way that has currency in the market. Student clubs and associations have initiated successful practice experiences such as Hackathons. Again, being able to share how to templates may enable others to replicate.

CUNY colleges need to continue to find ways to **help students with their “packaging”** (e.g. communication, presentation, confidence, and networking) which are considered weaker than their core skills. Coding, data analysis and cyber jobs require specific application and interview preparation, and often exceed the expertise of the (already swamped) general career development offices, so when this preparation happens it is often decentralized. CUNY can facilitate candid employer guidance on requirements and application strategies as well as ways to share the learning, tutorials and training methods between campuses. CUNY Tech MeetUp provides a safe space for students to practice networking and build the confidence and tactics to attend industry events, perhaps in cohorts or with an experienced mentor at first.

Strategy 5: Empower CUNY’s continuing education departments to offer shorter-term, targeted upskilling classes and bootcamps to working professionals

CUNY’s continuing education and workforce training departments serve anywhere between 180,000 to 250,000 students in a given year. The speed of innovation in the tech sector calls for education, training, and upskilling solutions that can be developed and deployed at a more rapid cadence than their degree program counterparts. To empower these departments to respond effectively and decisively to the tech sector’s labor market demands, the research team recommends:

- Investment in bootcamps and similar education formats. These could follow the precedent of #CUNYCodes, which is described in further detail below;
- Investment in programs that align a stackable credential structure with industry-recognized certifications, such as those offered by Amazon Web Services Educate, Microsoft Azure, Google, and others;

- Investment in structured collaboration between continuing education programs and degree programs, so that non-credit offerings are designed to serve as an entry point to a more advanced academic credential where appropriate;
- An impactful, highly visible marketing campaign to ensure the availability of these programs is recognized by working professionals and other target stakeholders.

Strategy 6: Engaging employers is critical to the success of all five strategies above. Companies, community based organizations and government agencies have partnered with individual faculty, departments, colleges and the system in a variety of ways to support student career success. However, changes in individuals (on both sides) and funding undermine the ability to expand or even sustain these efforts to meet mutual needs.

Employers find it difficult to navigate to find the right match and some are unclear about what CUNY is, its breadth and quality and which colleges are part of it. CEWP's **Sector Innovation Specialists** have started to provide an account management type approach and portal for employer outreach, information and matchmaking.

In addition to confirming the many pockets of innovation, the applied learning inventory (see Appendix A) can help connect employers with the right people at CUNY and make internal connections. CUNY's Office of Continuing Education and Workforce Programs is exploring a better tool, such as a **CRM platform*** to provide this kind of information transparency that can break down internal silos, facilitate program replication, make it easier for employers to engage and save time.

Employers need engagement options that align with their capabilities and perceived return on investment. Clarifying the portfolio of options may make it easier for employers to get started and commit, with the right people at the table, have a good experience that can lead to a more intensive engagement. Options are likely to include market advise (Employers can provide occasional input to curricular and co-curricular initiatives or join an Advisory Boards that meets regularly), content (Employers can provide existing content from their training programs and case examples or work more extensively with faculty to create a course), staff time (Employers can send staff to come to campus as class guests, panelists and meet up or fair participants (low investment) or to lead a workshop or to be an instructor for a course) and direct workplace experience (Employers can commit to invite students on site for a few hour visit, a few week "Winternship", longer internships or full time job openings). A targeted **marketing campaign** for employers would promote the value proposition of supporting and hiring CUNY students for tech and data jobs, clarify the ways to participate and link to easy action steps. A **DSA advisory group** for CUNY or similar to the NYC Cyber could help sponsor and shape a communications approach as well as provide other valuable support.

3c. Implementation Recommendations

The research team's recommendations for meeting this vision follows the following roadmap. In each area, courses, programs, and practices exist that can be scaled and replicated, although some may require a greater balance of development versus replication.

Proposed Academic Pathway Structure

Foundational skill development

Data Science and Analytics

Computer Science and Computational Thinking

Ethical Use of Technology (e.g. cybersecurity and AI)

Applied learning courses and workshops

New majors and minors, i.e. Data Science Methods and Applications Interdisciplinary Minor (Lehman College)

Bootcamps – non-credit or embedded in degree programs – i.e. CUNYCodes

Courses, i.e. CSCI 380-04 Selected Topics in Computer Science: Mobile Application and Product Development (John Jay College + NYC Tech in Residence)

Extracurricular activities

Meetups

Workshops and hackathons

Student club activities and competitions

Internships

Short-term Winternships

Academic Year Internships

Summer Internships

Graduation

Foundational Skill Development

CS04All: CUNY has made progress in implementing CS04All, a general education computer science course. To ensure that a wide range of students are introduced to computational thinking and coding, the research team recommends expanding CS04All to additional campuses and leveraging the Tech in Residence framework to raise the limit of how many students can enroll in the course. Expanding CS04All will ensure that students are well-prepared for more intensive academic and skill-building work - such as specialized courses in majors, bootcamps and hackathons, and internships - as they progress in their academic careers. At Hunter College, introductory computer science education has been reformatted for large lectures; this structure can be best utilized by implementing autograding technology, such as OK.py.

General education courses in data science and analytics: CUNY has a working model for broad-ranging computer science education. To meet the same goal in data science and analytics, the research team recommends supporting CUNY faculty who are interested in adapting interdisciplinary, foundational data science skills, especially those that build upon the “Data8” model created by University of California at Berkeley.

Course Innovation: CUNY’s recent experimental course innovation design process can be expanded in scope to include undergraduate data science education. Through a competitive application process, select courses will receive funding to launch entirely new--or enhance existing--curriculum that incorporates data science and analytics. Faculty across CUNY, STEM and non-STEM alike, will be eligible to apply for Course Innovation grants. Grantees will be paired with industry advisers that are willing and able to provide industry insight on curriculum. Faculty will provide CUNY students with exclusive feedback as it relates to content that is relevant to in-demand skills and expected industry opportunities. CUNY’s Course Innovation Grant collaboration with the Business Roundtable in cybersecurity and data science were featured in Forbes late last year.

Specialized Applied Learning

Specialized content: The Data8 model includes an explicit focus on developing and delivering “connector courses”, which apply DSA skills in the context of other majors and disciplines. This focus is in line with the increasing need for DSA skills among a wide variety of employers. UC Berkeley offers connector courses ranging from “[Data Science for Genetics and Genomics](#)” to “[Data Science & Immigration](#)” to “[How Does History Count? Exploring Japanese-American Internment through Digital Sources](#)”. The research team recommends the release of course grants for faculty in a diverse array of majors, leading to the availability of courses that ask students to deploy DSA skills in context.

Bootcamps and hackathons: Bootcamps such as CUNY’s #CUNYCodes and CUNY Tech Prep include applied learning frameworks that can be utilized as either degree-program capstone courses, extracurricular activities for degree program students, or tech training bootcamps offered via continuing education. Hackathons can provide a similar experience for CUNY students in shorter time durations. In each of these use cases, a strong general education framework must precede bootcamp implementation to ensure that students are well-prepared to make the most of these experiential learning activities.

Internships

Off-campus experiential learning: As students develop marketable skills, the arenas in which these skills can be deployed and practiced increase in sophistication and utility beyond the classroom. This strategy calls for investment in CUNY’s internship programs, especially via expansion of campus capacity to develop relationships with employers. CUNY’s central academic leadership will work with colleges to develop each campus’ ability to support students and employers in operating shorter-term

Winternships and longer-term academic year internships.

Execution and Leadership

To lead this strategy, the research team recommends the creation of a centralized **Data Science Education Center**, accountable for establishing resources for colleges to improve data science and analytics skill development for students in humanities, social sciences, and non-computer science STEM disciplines. This Center will serve as the central location for labor market intelligence development regarding data science and analytics skills at CUNY. The proposed office will leverage this knowledge to direct curriculum and infrastructure development resources to CUNY colleges.

Tech in Residence Corps: Since 2018, adjuncts hired from industry through the Tech Talent Pipeline's Tech in Residence Corps have taught 73 CS courses to over 1500 CUNY students. Currently, the Tech in Residence Corps provides CUNY senior colleges with adjuncts recruited directly from industry partners. The research team recommends scaling this program to additional senior colleges and to CUNY's community colleges. As the availability of CS04All increases, utilizing a deep "bench" of Tech in Residence adjuncts will be key to ensuring there are enough course sections to meet need. By scaling the Tech Talent Pipeline's "Tech-in-Residence" initiative, CUNY proposes developing a similar 'Professionals in Residence Corps' where Data Scientists, Analysts and Engineers serve as in-classroom instructors. This industry-academic model enables CUNY students to hear directly from seasoned professionals on how to put academic principles into practice. The goal of a Data Science-oriented 'Professionals-in-Residence' would be to engage students on three different levels:

- A. **INTRODUCTORY:** Glean insights from data to help businesses make more intelligent decisions
- B. **INTERMEDIATE:** Understand what's required to conduct complex, sophisticated analyses using advanced statistical, programming, and other skills to produce more powerful insights.
- C. **ADVANCED:** Build the frameworks and infrastructure to capture and store data that are easily accessed and utilized by end-users (e.g. Data Analysts).

Empower CUNY colleges to offer 'large-format' courses in Data Science and coding that can be scaled to reach a larger CUNY student audience: CUNY is uniquely positioned to reach students at scale. With this in mind, 'large-format' courses can provide access to industry-informed Data Science curriculum to up to 800 students per course. This can be accomplished by running additional sections of a single course to run simultaneously. By leveraging large classroom space and available faculty, CUNY can ensure large shares of students are learning Data Science each semester. To achieve this goal, faculty will lean on instructional efficiency tools - such as the auto-grading tool OK.py, or similar - and a corps of teaching assistants who are provided with training and professional development.

Suggested Key Performance Indicators

- A. As they relate to a CUNY Data Science Center (DSC):
 - Size and scope of a data set inventory available to faculty
 - Ecosystem map of engaged tech CUNY faculty, non-tech CUNY faculty, private sector partners, and non-profit/civic stakeholders
 - Stakeholder engagement metrics with the DSC
 - Engagement metrics between DSC stakeholders (i.e. Hunter College students utilizing a dataset from NYC Small Business Services, private-sector sponsor hosting a Data Science hackathon for students, forums between government and/or private sector Data Scientists and CUNY

faculty, etc.)

B. As they relate to Data Science Course Innovation grants:

- Number and variety of applications across CUNY
- Employer partner involvement
- Student persistence and completion of new courses
- Course evaluations (e.g. student, faculty, employer)
- Internship and employment outcome surveys

C. As they relate to Data Science 'Professionals-in-Residence':

- Number and variety of courses across CUNY
- Employer partner involvement
- Student persistence and completion of new courses
- Course evaluations (e.g. student, PIR faculty, faculty department head)
- Internship and employment outcome surveys

D. As they relate to 'large-format' Data Science courses:

- Number and variety of courses across CUNY
- Section-by-section comparison (e.g. size, grades, instructor, etc.)
- Student persistence and completion of new courses
- Course evaluations (e.g. students and faculty)
- Post-course satisfaction/outcomes survey (e.g. likelihood of engaging with DSC, enrolled in more Data Science courses, pursuing Data Science professions, etc.)

Appendix #1: List of Interviewees

We are appreciative of the time and insights provided by the following people we interviewed for this work:

1. Jacklyn Kelly & Heather Sutton – LMIS
2. Ron Bergman – Lehman College, CIO
3. Mahima Hada – Baruch College, Marketing Analytics Professor
4. Frederick Burke – Graduate Career Development Baruch College
5. Remy Arteaga – CUNY Startups Director
6. Eva Fernandez – Queens College Associate Provost
7. Lauren Anderson – TTP Executive director
8. Naguib Attia – IBM Skills Academy
9. Sunil Gupta – BMCC Dean of Continuing Education and Workforce Development
10. Elin Waring – Lehman Dean and sociology professor
11. Seema Shah – LaGuardia College Director of Technology and Innovation
12. Erik Grimmelmann – CCNY (& NYU) lecturer, former NY Tech Alliance President
13. Mary Pearl & Lisa Brundage – Macaulay Honors College Dean & Digital tech educator
14. Julie Samuels – Tech:NYC
15. Marios Koufaris – Chair Information Systems & Statistics, Baruch
16. Andy Saldana – NY Tech Alliance
17. Martine Cadet – InFor, VP global Education Partnerships
18. Bethany Crystal – Union Square Ventures, & Will Rogers - CISO MParticle
19. Pamela Brown – City Tech Associate Provost
20. Alyssa Vine – CUNY director of adult learner initiatives
21. Rob Domanski – Tech in Residence director, TTP, SBS
22. Judy Spitz & Amy Furman – WiTNY Founder
23. Ellen Stein & Marion Viray – Career Development Center - Baruch
24. Diane Levitt – K-12 partnerships at Cornell Tech
25. Carlo Yuvienco & Eunice Anderson – EDC Life Sciences development team
26. Naguib Attia – IBM Global University
27. Nasir Memon – NYU Vice Dean and Professor, Cyber program developer
28. Mark Davis – Full Stack Cyber Boot Camp Director

Appendix #2: Sample Partnerships

Employer partnerships are essential to the success of the recommendations described in the body of the report, and to the success of CUNY students generally. Many employers, large and small, have proven to be impactful partners for CUNY students, faculty, and administrators in creating intentional and impactful connections to the world of work. Each of the three partnership examples below (JPMorgan Chase, Google, and Salesforce) includes aspects of the previous recommendations, whether in course development, student professional network development, internships, or others.

Partnership Example #1: JPMorgan Chase

CUNY and JPMorgan Chase have enjoyed a long, productive partnership, and as JPMorgan Chase's need for technology skills has increased, collaboration has necessarily expanded beyond traditional finance and banking to computational skills. Recent highlights and developments in this partnership include:

2015

- JPMorgan Chase supports CUNY's Tech Education and Employment Collaborative with \$1,000,000 over three years. The Collaborative serves as the first step in developing a CUNY community of practice devoted to building industry partnerships in the tech sector.
- Code to Work partners with JPMorgan Chase's Technology for Good team to place 95 students in jobs a year at JPMorgan Chase utilizing industry-verified technical and soft skills assessment tools.

2016

- In collaboration with industry partners and Cornell, CUNY launches Women in Tech NY (WiTNY), building a deeper bench of diverse talent for the digital workforce. JPMorgan Chase hosts WiTNY Winterns and provides volunteers to support the WiTNY Summer Guild.

2017

- Guttman Community College and JPMorgan Chase launch the Teller Pathways Program. 24 Guttman students are hired part-time as bank tellers while earning their degrees.
- CUNY.edu permanently hosts Banking on My Career (BOMC), a web tool which guides students through potential careers in banking. 20,918 students use the tool through 2018.

2018

- Here to Here supports CUNY with grants designed to bridge the gap between students, faculty, and industry: Bronx Community College (\$240,000), Guttman Community College (\$75,000), and Hostos Community College (\$110,000).
- JPMorgan Chase invests in the CUNY's Career Success Initiatives with a two-year, \$1,000,000 grant. Through these programs, 2,405 students gain paid internships and over 6,000 students attend industry Meetups in tech, finance, healthcare, and other sectors.

- 80 CUNY students join JPMorgan Chase Code for Good events, including the 2018 Code for Good hack-a-thon – won by a team of CUNY students. JPMorgan plans to match or increase this number in 2019.
- JPMorgan Chase hires ~50 CUNY graduates across the firm into full-time positions and 80 CUNY students as interns for Summer 2019.

2019

- The Business Roundtable supplies a group of employers – including Guardian Life, IBM, JPMorgan Chase, MasterCard, Pitney Bowes, and UPS – to work with CUNY on course development and internship placements. College grant recipients develop curricula that integrate more real-world, industry-relevant knowledge, skills, and experiences into the classroom.
- Here to Here partners with Jobs for the Future to develop a Bright Spot Analysis highlighting existing industry partnerships, and sponsors development on Butterfly, an app designed to aid in student career exploration.

Partnership Example #2: Google

Google's partnership with CUNY has developed more recently, but activity in this partnership has accelerated rapidly. In July 2019, over 50 representatives from across Google, CUNY central, and the CUNY campus partner system convened at Google's NYC office to discuss a variety of initiatives that would engage CUNY faculty, students, and alumni:

- **Faculty**
 - Recruit CUNY faculty for Visiting Researcher Program
 - Host CUNY faculty convenings
 - Source Googlers for CUNY Tech Talent Pipeline
- **Students**
 - CUNY On-campus Recruitment
 - Host WiTNY interns (aka "Winterns")
 - Launch Google IT Support Professional Certificate
 - CUNY TechWorks Learning Series
 - Grow with Google NYC Learning Center
 - Computer Science Summer Institute (CSSI-x)
- **Alumni**
 - Create and execute CUNY alumni/Googler engagement strategy



Naturally, as Google has expanded its operations in NYC, their offices have hired more CUNY graduates and have engaged CUNY campuses on an ad-hoc basis. With that said, CUNY and Google recently devised a strategy that would maximize their collaborative impact as it relates to supporting faculty and students as well as offering alumni with meaningful opportunities to re-engage with their respective alma maters. A series of goals have been set out to be completed by the end of the 2020-2021 academic year.

Faculty

NYC Tech Talent Pipeline

Google has been sitting on the Tech Talent Pipeline company advisory board for nearly two years, providing consultation and support on programs like Tech in Residence and CUNY 2x Tech programs. Google has shared curricula like Applied CS with Android to roll-out student-focused training and as a resource for faculty. To that end, Google nominated one CUNY faculty member (Hunter College) to participate in the Google Faculty in Residence program over summer 2019. Tech in Residence has seen at least two NYC Googlers participate and support on-campus partnership with faculty on curriculum development and delivery.

Students

CUNY On-campus Recruitment

College recruiting at public universities in big tech hubs like NYC is a crucial area of expansion. Google ran a collaborative pilot during the 2018-2019 academic year at CUNY, by going to six of the senior colleges with CS programs. Google reached over 3,000 students with 12 campus events, increasing their year-over-year hiring by 200+%. In 2019-20, Google is growing their presence to all eight CUNY senior colleges with CS programs, made possible by recruiting a large engineering volunteer workforce (40+ Googlers) across their NYC office to visit CUNY campuses during their peak campus recruiting season (September/October) with talks, workshops and events to support students applying to Google opportunities.

Computer Science Summer Institute-Extension

Google partnered with CUNY on rolling out CSSI-Extension (CSSIx) at Medgar Evars and Queens College since 2017, a program where Google trains university faculty to run the CSSI curriculum and program on-campus as a pre-college engineering pathway. The program has served 57 students from both schools, 80% of which plan to graduate with a CS degree post CSSI-Extension. Google is working with local partners to explore scaling CSSI-Extension to three more CUNY colleges in summer 2020, including one of the two-year colleges.

Grow with Google NYC Learning Center

CUNY and the CUNY 2x Tech program were opening launch partners for the Google NYC office and Grow with Google teams. Google has hosted at least 30 events with CUNY students, faculty and staff since April 2019.

CUNY TechWorks Learning Series

In partnership with Google, CUNY's Office of Workforce Development and CUNY TechWorks, plan to roll out a quarterly learning series for students enrolled in CUNY's A.A.S programs. The workshops will cover career readiness in addition to special topics in tech.

WiTNY internships (Winternships)

In January 2020, Google is planning to host five winterns for a two-week paid educational program on-site at one of their community learning spaces.

Google IT Support Professional Certificate

In collaboration with CUNY and Jobs for the Future (JFF), Google will expand its IT Support Professional Certificate to CUNY campuses in an effort to help students earn a credential that better positions them to access middle-skill IT support jobs in today's tech economy.

[Alumni](#)

Google has identified over 40 current employees that have graduated from the CUNY system. Moreover, these alumni have confirmed their interest in engaging with students that are interested in pursuing in the tech sector beyond graduation.

Partnership Example #3: Salesforce

CUNY has recently strengthened industry relations with Salesforce through a series of efforts that include:

- **Curriculum integration**
 - Borough of Manhattan Community College
 - Brooklyn College
 - City College of New York
 - College of Staten Island
 - Guttman Community College
 - Lehman College
 - LaGuardia Community College
- **Certifications**
 - Borough of Manhattan Community College
 - Lehman College
 - LaGuardia Community College
- **Salesforce Tower Event**
 - Lehman College & Bronx Community College
- **On-campus Info Session**
 - Borough of Manhattan Community College



In recent years, CUNY Central has embarked on a holistic approach to partnering with Salesforce as it relates to preparing students for jobs that require Salesforce CRM (Customer Relationship Management) skills. According to a [Salesforce sponsored study](#), approximately 3.3 million jobs requiring Salesforce skills are expected by 2022. In anticipation of filling these roles, Salesforce.org has introduced students to Salesforce careers and offered them opportunities to develop in-demand CRM skills through PepUp Tech, Salesforce Trailhead, and various information sessions.

Curriculum Integration

CUNY staff collaborated with Salesforce in 2019 to host a webinar information session to introduce seven campuses to [Salesforce Trailhead](#)--a library featuring over 100 online modules that incorporate CRM exercises within the context of relevant careers like sales, marketing, cybersecurity, healthcare data processing, etc. The webinar featured a non-CUNY faculty member from Algonquin College, showcasing the ease of integrating existing Salesforce modules into existing academic curriculum. Several CUNY campus partners indicated they plan on integrating Salesforce Trailhead into their upcoming classes.

Certifications

In addition to hosting CUNY students at their midtown Manhattan office, Salesforce has engaged CUNY students through a variety of on-campus initiatives in the Bronx and Queens. Through their [PepUp Tech campaign](#), Salesforce has executed weekend-long workshops at Lehman College and LaGuardia Community College as well as Borough of Manhattan Community College. PepUp Tech is a free virtual Salesforce bootcamp that prepares students to be certified as Salesforce administrators. To that end, Salesforce waives their certification exam fee (\$1,000) for students that successfully complete the weekend bootcamp. Of the three cohorts mentioned above, it's estimated that somewhere between 90-120 students have participated in PepUp Tech since 2018.

Salesforce Tower Event

In October 2019, CUNY staff worked with Career Services staff at Bronx Community College and Lehman College to host students at Salesforce Tower for a panel discussion on tech and non-tech Salesforce careers. The panel was moderated by Dr. Elin Waring, Interim Dean of the School of Health Sciences, Human Services and Nursing at Lehman College. Students were heavily engaged and asked poignant questions throughout the event. Salesforce.org fully sponsored the event and served dinner to students. It is worth noting that Senior Vice President of Solution Engineering at Salesforce (and Brooklyn College alumna) Valerie Wolloch joined the panel.

On-campus Info Session

And lastly, in October 2019, the Salesforce campus recruiting team visited a group of over 100 Borough of Manhattan Community College students for a panel discussion on various Salesforce careers as well as a live demonstration of Salesforce Trailhead. In addition to being better informed of their career Tech Education Strategy at CUNY

prospects within the Salesforce ecosystem, participating students walked away having earned a Salesforce badge.

Appendix #3: Faculty Forums

CUNY's Office of Continuing Education and Workforce Programs convened two forums of faculty from across CUNY as part of developing a roadmap to increase the number and job readiness of students for tech sector jobs, in particular in Cybersecurity and Data Science & Analytics (DS&A)

The first forum was held on **October 21, 2019** and convened faculty from Computer Science, Information Systems, Information Technology, and Mathematics Departments. Attendees included:

Baruch College

Kannan Mohan, *Professor of Information Systems*

Borough of Manhattan Community College

Maryam Vatankhah, *Assistant Professor of Computer Information Systems*

Brooklyn College

Sandra Kingan, *Associate Professor of Mathematics*

City College of New York

Huy Vo, *Assistant Professor of Computer Science*

School of Professional Studies

Arthur O'Connor, *Lecturer and Academic Director of Data Science and Information Systems*

Guttman Community College

Jinzhong Niu, *Assistant Professor of Information Technology*

Hunter College

Robert Thompson, *Professor of Mathematics and Statistics*

John Jay College

Shweta Jain, *Associate Professor of Mathematics and Computer Science*

Lehman College

Megan Owen, *Assistant Professor of Mathematics*

Medgar Evers College

David Ahn, *Professor of Computer Information Systems*

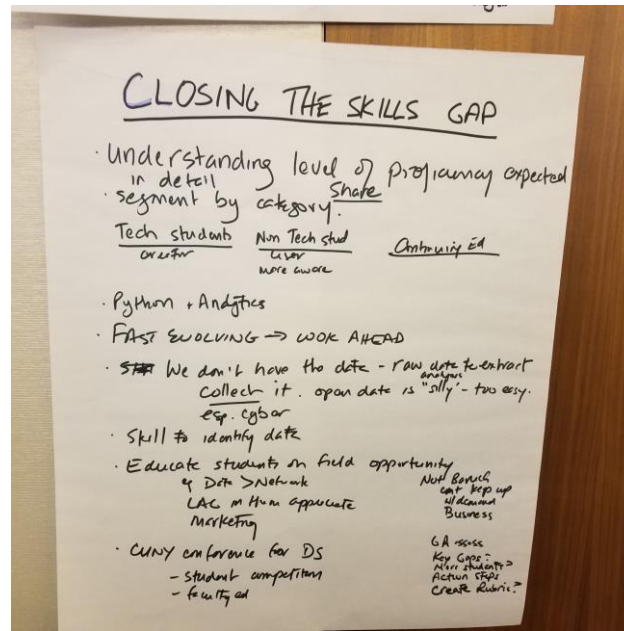
New York City College of Technology

Ossama El Hadary, *Professor of Computer Science*

York College

Thitma Srivatanakul, *Assistant Professor of Mathematics and Computer Science*

Fenio Annansingh-Jamieson, *Assistant Professor of Business and Economics*



Topic 1: Where are the tech career readiness gap of our students and how should we close them?

Note: A Data Science competencies framework prepared by General Assembly with industry was circulated as a discussion starter.

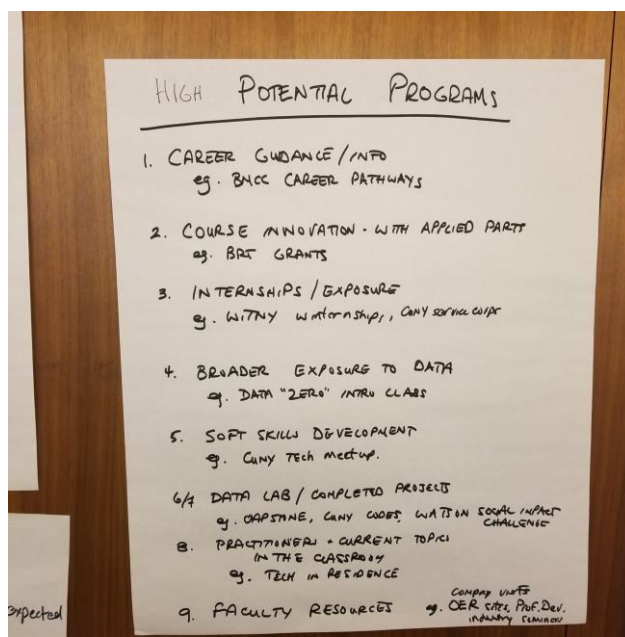
Faculty expressed a need to have more detail and clarity than what they have now as to the level of proficiency expected for specific entry roles. It was agreed that it is useful to differentiate between the skills needs of tech “creators” from tech “users, and to separate the needs of mid career education (whether continuing or masters education). It was agreed that the field is evolving quickly therefore faculty need to be able to look ahead at least 3-5 years if not 5-10 in order to shape curricula.

To “close the skills gap,” faculty identified specific needs:

- Applied learning
 - Specifically access to data so students learn how to identify, collect and extract it in more sophisticated ways. Current open data is “silly”, not reflective of real world situations or challenging enough. Especially in cybersecurity. “When we talk about Data Science, we're missing useful data sets. Available data sets are limited--you make graphs but then what?”
 - Math at some colleges do not have applied learning in capstone or widely in the curriculum. Lehman has been teaching a Math course using R to, look at data sets, define a goal, apply linear regression and post the results were on a webpage (in case students wanted to show to employers)
- Ways to educate students as to the opportunities in the field.
 - Baruch students seem well aware that DSA and cyber are growing (from their interest in fintech and other business areas, 80% of students are not from CIS (in finance, accounting

and so on). “They know they need Python training for financial institutions so they are demanding it now. ”

- other colleges observed that there was a lag between the market and what students considered good paths (the example was seeing studying network tech skills as more attractive than Data). And that students don’t know what data science is. a CUNY conference for DSA with a competition and a prize, that would raise awareness and knowledge for both faculty and students, was suggested
- *“We’re seeing the Number of Math minors is going up as students sense they are needing more math skills’*
- Greater exposure to industry through internships and conferences, for example
 - *“ Data science internships are key... need to develop better relationships with hiring partners...”*
 - *“The availability of internships also attracts students”*
 - *CS students at Lehman are really into data science. Some founded NESBE then SHIP (black and hispanic orgs) on data science (“that’s where they’re picking up data science skills”)... City College may have a chapter... Often times students host hackathons”*
- Conveying the role of data and benefit of using it, rather than just focusing on learning the mechanics and concepts . There was a difference of opinion between some faculty who want to move the “good stuff” earlier and those who argue that without foundational skills and concepts such exposure is not effective
 - *”Ok C++ is good, but what am I using it for? We don’t show that until the 3rd or 4th year*
 - Research in the classroom design can be a lot of work.
 - Bloomberg’s “Data for Good Grants” has been used
 - Bringing industry partners in the classroom can address this but there are current barriers to team instruction for example which would facilitate coverage of various topics.
- Of the competencies listed, there was agreement that there was a large gap in Communications skills.
 - *“Students need to work on Communications””Employers want to know if they can put students in front of a client?”*
 - *“In cyber you need skills to communicate to managers and non-IT people”*
 - *“We teach our students to write papers not PPT slides... industry wants PPT slides.... We don’t align ourselves with industry...”*



Topic 2: What high potential programs should we grow to expand the number and readiness of our students for tech jobs?

Note: The research team summarized programs that emerged from its research for feedback and discussion around implementation requirements. The team noted that many of the potential programs referenced had been mentioned throughout the forum. In addition, attendees suggested additional programs.

- Tech Faculty has not kept up with enrollments. In addition to the teaching component it is hard to create new courses in existing departments because you don't get new lines
 - "Salary for teaching a course is a deterrent for an industry partners. We had a prospect from Amazon who walked away when they heard it was \$3800" "That's why I always tell them the compensation up front"
 - The need for additional faculty to teach courses is paramount... we're overcapacity...
- Sharing of course design and materials
 - This is particularly helpful for smaller programs and to spread learning from more "progressive" departments. "Guttman is very small with 1,000 students total. We can't offer data science or cybersecurity at this time"
 - DSA is a broad field so we need to be careful how we define it and embrace a range of aspects of the field. "Data Science means different things to different people. It is hard to pigeonhole where it belong. Let it appear organically in each campus"
 - Forums with or advisory councils of industry would be very useful
- Streamline the approval process for courses to get the full value of grants and innovation especially bringing applied learning into courses
 - This is particularly true given the interdisciplinary nature of Cybersecurity and Data Science where two or more academic departments need to share the load and coordinate. Can we develop more Credit-sharing agreements?"

- *It is hard to CUNY students to do a minor (or take courses they want at another campuses (in regards to articulation agreements and access - it was noted that these courses are often highly enrolled by students at the host campus*
- Offer more ability to do a minor. Develop a baccalaureate Data Science degree program from A-to-Z.
 - *Offer Data Science online?*
 - *We may need to create Data Science departments rather than try to reinvent within traditional departments. Computer Science is not good for data science... they're not learning the application of data science... CS is learning programming C++...*
 - *John Jay social entrepreneurship minor is housed in graduate studies which is an admin unit*
 - *Constrained by not being able to add more faculty ("a huge problem")*
- Provide a six-month certification available for post grads. *Offer non-credit certifications to students (hosted by CUNY Central)...*
- CUNY should provide an open curriculum where students have flexibility to "mix and match" in a less rigid sequence *Rather than demand students to take specific courses, allow them to take the requisite courses for the job. Not a self-design curriculum, but students have the ability to take what they need for the job (i.e. not foreign language.) Allow students to jump around*
- Educate faculty about content by providing resources and concrete examples; *Provide resources for faculty to see what exactly industry is looking for (don't call it OER because people assume that means textbooks)*

A second forum was held on **October 22, 2019**, with faculty from non tech disciplines with an interest in applied learning, data analytics, and security. Attendees included:

Baruch College

Kannan Mohan, *Professor of Information Systems*

Borough of Manhattan Community College

Chris McCarthy, *Assistant Professor of Mathematics*

Brooklyn College

Tim Shortell, *Professor of Sociology*

City College of New York

Hank Nguyen, *Professor of Economics*

Graduate Center

Matthew Gold, *Associate Professor of English and Digital Humanities*

Hunter College

Jochen Albrecht, *Professor of Computational and Theoretical Geography*

Lehman College

Jenn Laird, *Assistant Professor of Sociology*

Macaulay Honors College

Kelly O'Donnell, *Professor and Director of Science Forward*

Medgar Evers College

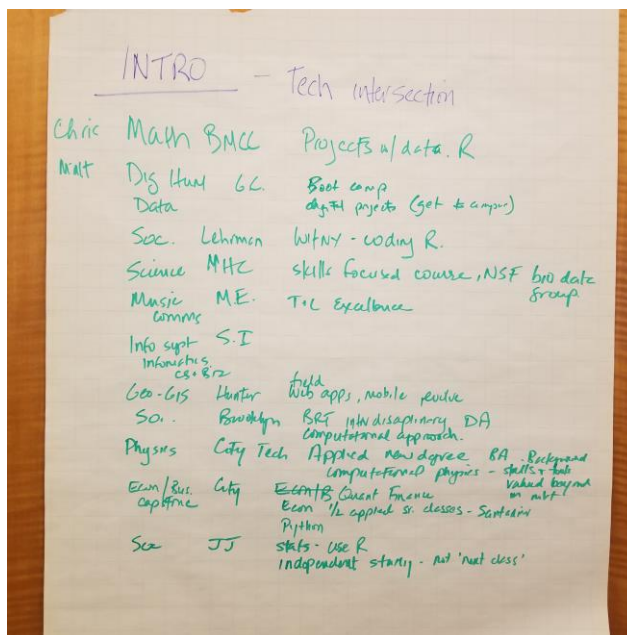
Moses Phillips, *Professor of Music*

New York City College of Technology

Giovani Ossola, *Professor of Physics*

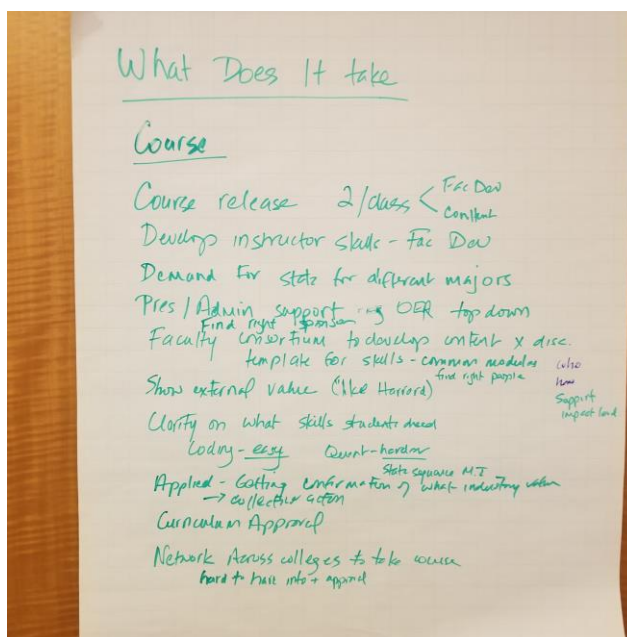
College of Staten Island

Soon Chun, *Professor and Director of Information Systems and Informatics*



Topic 1: What intersection do you have now with technology education?

Non-tech faculty forum attendees found unique entry points in leveraging tech to not only enhance their curriculum, but to also provide their students with opportunities to develop new, useful tech skills.



Topic 2: What does it take to implement these high potential program ideas?

When asked, “What would it take to implement high potential programs at your campus?”--forum attendees shared several different thoughts and ideas ranging from professional development, curriculum enhancement, student engagement, and so on.

Resources

“Show me where to go to find the datasets”

“There’s a difference between tech support and academic tech support”

“This CUNY campus has access to Qualtrics and Stata, but mine doesn’t. We need a repository of software licenses”

“Is AWS Educate really free?”

Several attendees indicated barriers to obtaining tech resources that would allow for skills-based assignments inside the classroom. Faculty voiced they would like access to a variety of large datasets so they can content that can be more applicable to their course curriculum. Another interesting note was the issue of infrastructure support. Stories of slow response rates and limited solutions on behalf of on-campus IT departments were shared by attendees. To that end, attendees underscored the limitations of on-campus IT departments when it came to troubleshooting academic systems and platforms, like Blackboard. It was also found that access to quality tech resources like Qualtrics and Stata vary from campus to campus across CUNY--making replication of tech-based curriculum and/or programs difficult.

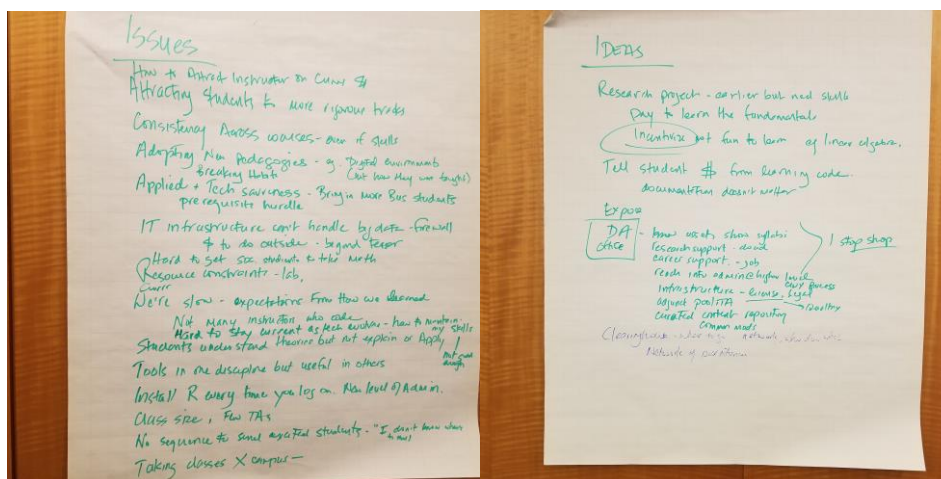
Filling in the gaps

"The Psychology, Criminal Justice, and International Relations departments come to me [Statistics] to bolster their curriculum"

"I'm a Data Scientist and--alongside my students--we're applying machine learning to astrophysics. How do we get noticed by industry?"

"It's difficult to manage my courses, support my students, meet my academic obligations and stay current when it comes to the latest tech trends."

It was made clear that a majority of attendees were introducing tech into their non-tech curriculum based on their own volition. In other words, very few Sociology or Humanities were required to incorporate tech in the classroom. Yet, faculty emphasized that a series of gaps surfaced as a result of enhancing their curriculum. For instance, one attendee has become highly sought after by neighboring academic departments. While initially flattering, this professor mentioned that sharing her expertise with her peers meant less time she could devote to her own students. Not complete...



Appendix #4: Select Applied Learning and Tech Training Programs at CUNY

The following list of programs, projects, and initiatives are bound together by a common goal of ensuring student career success, developing practical student skills, and collaborating with private and public sector partners on program design and execution. This list is far from exhaustive, and is intended to give a sense of the scope, range, and diversity of the activities at CUNY which we propose to build upon with cadence, intentionality, and scale per the strategy described in the main part of this document.

Key components:

GE: General Education provides students from a wide range of backgrounds and majors with foundational skills.

SC: Specialized Content applies foundational skills to more specific disciplines.

PN: Programs with a specific focus on developing students' professional networks and social capital

IS: Programs with a specific focus on paid internships

EC: Extracurricular and Continuing Education activities complement degree program studies, or are offered as non-credit programs.

Campus	Program Name	Description	Key Components
Baruch College	Computer Information Systems- Data Analytics Track	Students of Baruch's Computer Information Systems degree program receive a strong foundation in both the technical and managerial issues related to information technology (IT) including data analytics, cybersecurity, software development, and IT strategy.	SC
Baruch College	Student Clubs	Student clubs at Baruch College organize career preparation events, including the College's first Tech Careers Expo in 2019, featuring employers such as Amazon, Prudential, and Credit Suisse.	EC
Baruch College	Data Analytics symposium	Annual event open to CUNY faculty and doctoral students covering the latest in machine learning, data science, and data analytics. Industry leaders serve as keynote speakers and panelists.	PN, EC
Baruch College	Executives on Campus Mentor program/guest lecturers	Baruch students can connect with executive mentors who guide and develop their networking, interviewing, and other essential business etiquette skills to make Baruch students competitive in today's job market.	PN, EC
Baruch College	CIS 3920/STA 3920 Data Mining for Business Analytics	Students use industry standard tools and techniques to perform data mining and business analytics. This introductory module covers dimension reduction, regression methods, decision trees, clustering, and other methodologies. Emphasis placed on the entire context surrounding data mining. Students implement these techniques in big-data case studies throughout the semester.	SC

Campus	Program Name	Description	Key Components
Baruch College	Partnership with IBM: CUNY-IBM Watson Social Impact Challenge	Created in collaboration with IBM Corporate Citizenship and city government, this semester-long project challenges teams of three to five CUNY students explore creative ways in which artificial intelligence and cloud technology can be applied to improve public services. Workshops, boot camps, and mentoring support student teams throughout the competition.	SC, PN, EC
Baruch College	ATT Fast Pitch Competition	The AT&T and Baruch College Fast Pitch Competition is a business competition where teams have the chance to compete in one of three tracks: wealth, education and health, and enjoyment. Student pitches have included: Cloud based applications, advanced multimedia technology, social media and social networking, applications and analytics, location based mobile apps, cloud infrastructure and network element solutions, interactive digital signage, voice and video over IP infrastructure/network elements, LTE-IMS based solutions, mobile health applications, digital home applications and appliances, mobile video and gaming apps, video communications and multimedia collaboration applications, and social/interactive TV.	PN, EC
Baruch College	Financial Leadership Program (model for tech leadership program)	Sponsored by the Starr Career Development (SCDC), juniors pursuing finance careers can enroll in a year-long program covering corporate valuation, advanced Excel and financial modeling workshops, presentation skills, simulator training in all areas of investment banking, mock interviews with working professionals, and visits to financial services firms. Graduates are hired into finance internships at major Wall Street firms such as Goldman Sachs, Morgan Stanley, JP Morgan, Bank of America Merrill Lynch, UBS, and Credit Suisse.	PN, IS, EC
Baruch College	Data Analysis and Simulation for Financial Engineers	This is a “capstone” course for financial engineering majors which applies their skills in probability, stochastic processes, statistics, and financial mathematics by via hands-on analysis of data and simulation techniques needed for real world financial engineering applications. Course topics include time series analysis, Markov Chain Monte Carlo methods, hidden Markov models, and portfolio risk management.	SC
Baruch College	Master’s in Business Analytics	The three-semester graduate degree is designed for students who are analytically capable and have taken at least one statistics course at the college level in the last five years. The program introduces students to core concepts in Business Analytics and two specialized tracks – data analytics or marketing analytics. Offers hands-on experience using the latest software tools and programming languages, such as R, Python, Rapid Miner, Hadoop, Spark and SQL.	SC
BMCC	Cybersecurity Concentrations Grant	Federal grant-funded design of a cybersecurity concentration within BMCC's CIS and CNT associate degree programs, including six new courses and nine revised/updated courses.	SC

Campus	Program Name	Description	Key Components
BMCC	Maker Space Club	Students bring their ideas to life at the Makerspace Club by combining art, design and technology. Students join an amazing community of BMCC Makers and take advantage of all the equipment the Makerspace has to offer (3D printer, laser and vinyl cutters, Arduino, Raspberry Pi, etc).	PN, EC
BMCC	Guided Pathways	Wholesale reorganization of 51 majors at BMCC into eight industry sector-aligned communities. Includes customized career services, certificate program development, and web-based student guidance tools.	GE, SC
BMCC	Cyber program	Launched in 2019, high school students earn A+ and Cisco credentials that also lead to advanced standing in BMCC degree programs. The second, upcoming cohort will target seniors in NYC's computer science programs.	SC
BMCC	GuardianLife Partnership	Students in these internships get hands-on experience and access to cutting-edge technology from across a broad range of disciplines spanning security, cloud computing, data analysis, networks, mobile development, testing, project management, and more. Interns have designed and built hyper-converged DevOps labs, data-visualization dashboards to assist senior leadership, custom enterprise-wide applications, and VR technology for the Oculus Rift.	IS
Bronx Community college	Associate in Applied Science degree - Cybersecurity and Networking	The program, which provides education and training in cybersecurity and networking, is a response to soaring demands for information technology (IT) specialists who can protect computer networks from viruses and other malware and various kinds of cyber attacks. Students in the program can earn industry certifications while enrolled in coursework, or earn college credit with an existing certification.	GE, SC
City College	Bond Center	The J. Max Bond Center is a City College of New York Applied Research Center located within the Spitzer School of Architecture. Students combine Architecture, Data Science, Public Policy, Economics, Social Science, Health and Environmental Science to improve social and cultural cohesion, equitable architectural and urban production, and create a more resilient urban fabric.	SC
City College	MS in Data Science and Engineering	Applied data science graduate degree program with projects and training working with software and algorithms used throughout the field. Using R and Python in cloud-enabled projects, students gain hands on experience and work with faculty across fields in their capstone projects. Graduates apply data driven methodologies to a chosen domain specialization to meet the needs of society, communicate clearly and assume leadership roles, contribute to the field of applied data science, participate in professional societies, and maintain current knowledge in the field.	SC

Campus	Program Name	Description	Key Components
City College	Co-op program	Sophomores and juniors join this two-semester-long program, developed in partnership with the NYC Tech Talent Pipeline, earning up to 9 academic credit hours while working with local employers. The program delivers qualified tech talent to local employers and short-term professional opportunities to competitive NYC undergraduates.	SC, IS, EC
City College	Branded and Integrated Communications	Industry-sponsored, 36-credit, portfolio-driven master's degree program that combines theory and practice in an interdisciplinary, multi-tracked curriculum that addresses the opportunities and needs of marketing communications industries on behalf of both private and not-for-profit organizations. Program alumni who work at companies including Behance, Google, Adobe, and Capital One return to mentor current students.	SC, PN, EC
City College	Masters in Translational Medicine	Students gain expertise in applying translational science and engineering approaches to produce practical clinical solutions that will impact human health. The comprehensive curriculum can be completed in one year; students integrate of engineering, clinical exposure, research, and entrepreneurship training in a 3-semester interdisciplinary design-project experiential learning experience and a BioDesign Capstone project.	SC, PN, IS
City College	Masters in Cybersecurity	City College is developing new courses and stackable credentials in its cybersecurity masters' degree program as part of the CyberNYC initiative.	SC
City Tech	Tech Jobs Academy	City Tech in partnership with the NYC Tech Talent Pipeline and Microsoft has partnered to bring NYC residents a new Tech Jobs Academy. 50 trainees, selected from over 500 applicants, received 4 months of full-time intensive training for careers as Cloud Administrators at no cost.	EC
City Tech	Computer Systems Technology Internship Capstone	Three-credit internship course in City Tech's BTech degree in Computer Systems. Students interact with knowledgeable and experienced professionals, gain hands-on experience in their chosen field, discuss their professional plans with their internship supervisor, and develop professional relationships. Students have successfully completed internships in large, medium, and small companies in a variety of sectors, including Goldman Sachs, MTA, Versace, NYSE, and Union Settlement Houses.	IS
City Tech	Information Systems Technology Btech Degree	Students are prepared for the information technology (IT) industry by integrating theory, hands-on experience and industry exposure to applied skills through a required internship degree program component. It provides the student with the flexibility of choice in specialization areas: Database Systems, Networking and Security, IT Operation, Software Development. The program's structures will allow for timely changes in specialization course offerings as the information technology field evolves.	SC, IS

Campus	Program Name	Description	Key Components
City Tech	Biomedical Informatics	A rigorous core of courses provides students with a strong foundation from which to develop competencies in two interrelated component areas of Biomedical Informatics: Molecular Bioinformatics, centered on the use of conformational and genomic data to elucidate biological phenomena; and Health Informatics, focused on the secure electronic storage, retrieval, and use of biomedical information in healthcare delivery and research. These two subfields are seeing an exciting integration in cutting edge medicine as genomic information is used increasingly in medical diagnosis and care. The dual focus of the program seeks to prepare students for a range of career options and to adapt to changing conditions in the field. Students apply their knowledge to college-sponsored internships (for credit) at clinical and research locations in the NYC region.	SC, IS
College of Staten Island	CSI Tech Incubator	The CSI Tech Incubator fosters a community of tech innovators and entrepreneurs that are seeking to advance and grow their startups. The Incubator provides a robust technological ecosystem with strategic mentors, industry professionals, faculty, sponsors, government leaders and a dedicated tactical team with the mutual goal of supporting and elevating our entrepreneurs.	PN, EC
College of Staten Island	MakerSpace Lab	Through funding provided by the City Council, a new MakerSpace lab will provide an array of digital fabrication tools, electronic equipment and technologies within a communal area where faculty, students, researchers and entrepreneurs can freely design and prototype their ideas.	PN, EC
CUNY Multiple campuses	Cybersecurity and Data Analytics Course Innovation Grants	In collaboration with the Business Roundtable, CUNY hosted faculty and industry experts for a collaborative curriculum development project aimed at aligning student academic work with career success post-graduation.	SC
CUNY Multiple campuses	CUNY Tech Prep	Created by the CUNY Institute for Software Design and Development and the Tech Talent Pipeline, CUNY Tech Prep is a free, year-long program for 120 computer science students of CUNY's four-year colleges. The program includes: a 10-12-week, Javascript-based, full stack web application sprint, followed by a semester of additional project-based coursework, career coaching, and connections to tech roles in NYC.	PN, EC
CUNY Multiple campuses	CUNY Service Corps	Service Corps students work on projects that improve the civic, economic, and environmental sustainability of New York City. The program has provided thousands of CUNY students with paid work experiences in community-based organizations and government agencies since the program's launch in 2013, and has helped hundreds of employers benefit from the talent and hard work of CUNY's diverse student population.	IS, EC
CUNY Multiple campuses	CUNY Cultural Corps	Modeled after the CUNY Service Corps, the Cultural Corps aims to be a strong student pipeline for successful alumni into New York City's arts and culture institutions.	IS, EC
CUNY Multiple campuses	#CUNYcodes	Students with a strong fundamental coding background form teams and spend 10-12 weeks building real-world solutions from concept to delivery with professional mentorship while using industry tools and practices.	SC, IS, EC

Campus	Program Name	Description	Key Components
CUNY Multiple campuses	CUNY Tech MeetUp	The CUNY Tech Meetup puts CUNY and its community of students, alumni, faculty and supports front and center in New York City's growing tech sector. Members are offered the time and space to meet and network with industry partners on and off-campus.	PN, EC
CUNY Multiple campuses	NYC Tech-in-Residence Corps	The Tech-in-Residence Corps brings industry professionals from the NYC tech ecosystem into CUNY classrooms to teach in-demand advanced Computer Science courses, share their skillsets and applied knowledge directly with students, and collaborate with Computer Science faculty.	GE, SC, PN
CUNY Multiple campuses	Women in Technology NY - Winternships	The Winternship, a paid, three-week, mini-internship experience during the January academic recess, is an innovative program that creates a new pathway into those coveted summer internships. In just three weeks, 'Winterners' get immersed in their host company's business. The program both utilizes learned skills and challenges students to use teamwork and adaptability to complete company projects. Over 80 companies have hosted over 700 Winterners in the last few years and the results helped many women launch tech careers.	IS
CUNY Multiple campuses	WiTNY revised CS intro course	In partnership with Cornell Tech and Verizon, and with help from other tech companies, in 2016 the City University of New York launched an introductory computer-science class designed to appeal to women and increase that population at the start of the pipeline. Thus far, the course has been expanded to Queens College, LaGuardia Community College, City Tech, and the College of Staten Island.	GE
CUNY Multiple campuses	Institute for Urban Systems Building Performance Lab	Founded in 2006, the mission of the CUNY Institute for Urban Systems Building Performance Lab is to advance high-performance building operations and practices in existing commercial and public buildings. The Lab focuses on improving efficiency and optimizing building operations through continuing education programs for facility managers, building operators, and energy professionals, internships for CUNY students, and building systems research and development.	SC, IS, EC
CUNY Multiple campuses	CISDD	CISDD's mission is to promote economic development in New York City and encourage the growth of the New York software industry. CISDD was created by the Board of Trustees, as part of CUNY's economic development initiative, in January of 2000. CISDD provides the software industry, as well as CUNY faculty and students, with opportunities to learn about cutting-edge software products and methodologies. CISDD pairs CUNY's experienced faculty members with software industry professionals and governmental institutions to sponsor and develop the research and creation of new and marketable software technologies; and provides specialized IT courses to students and the community at large. CISDD is particularly interested in promoting work on core and new software technologies, including: operating system enhancements, server-side software, Linux, security issues with software, distributed computing, and data visualization.	GE, SC

Campus	Program Name	Description	Key Components
CUNY Multiple campuses	Google Computer Science Summer Intensive Expansion	Medgar Evers College and Queens College partnered with Google to offer the Computer Science Summer Intensive Expansion - a three-week full-time coding immersion program designed for prospective computer science students. Additional CUNY colleges are working with Google to implement the program.	EC
CUNY Multiple campuses	Revature partnership	CUNY students join the Revature team, and then receive intensive training in a team-focused setting where you can become certified in the latest enterprise-level, next-gen, and niche technologies. Revature has also added SPARK, a no-cost program designed for graduates of all majors who want to pursue a career in technology but have little or no prior coding experience. More than 100 CUNY graduates who majored or minored in STEM subjects have already been hired and trained by Revature, and moved into careers as software engineers, developers and analysts at Fortune 500 companies and large system integrators.	IS, EC
CUNY Multiple campuses	PIT-UN (Public Interest Tech University Network)	CUNY is one of the founding members of the Public Interest Technology University Network. Participating universities utilize the development of curricula, research agendas, and experiential learning programs in the public interest technology space to produce graduates with multiple fluencies at the intersection of technology and policy.	GE, SC, EC
CUNY Multiple campuses	CIS Fellows	In 2016, CUNY Central launched a paid, cybersecurity fellowship that provided students with four 12-week rotations among CUNY CIS units. Fellows gained practical work experience in areas such as Systems/Networks, Application Development, and Production Support, with an elective (e.g. Comms & MGMT Analysis, Proj MGMT, Disaster Recovery/Business Continuity, Security, etc.). Students were rising juniors, seniors or grad students in related majors. The fellowship included direct industry mentor and presentations to C-suite Cybersecurity professionals.	EC
CUNY Multiple campuses	Degree+	CUNY's Central Office of Computing and Informational Services worked with Lehman College and BMCC to provide students with Cisco Networking certifications aligned with their degrees and career pathways.	EC
The Graduate Center	Data Science Master's Degree	30-credit program prepares professionals and researchers to capitalize on the data revolution. World-leading data scientists and computer scientists — all full-time professors — teach courses that have immediate, real-world applications. Featured topics include artificial intelligence, algorithms for big data, data visualization, data mining, and machine learning.	SC
	Ethnographies of Work	Students investigate a range of careers with hands-on, off-campus experience in this two-course sequence.	

Campus	Program Name	Description	Key Components
Guttman Community College		Students apply critical thinking skills to learn about workplaces, occupations and career paths in an urban context; discuss myths and stereotypes about the work world; gain an appreciation of why work matters to individuals in a range of occupations; explore the changing nature of jobs in our fast-paced society; drawing connections between the self and work; and create an ethnography of their own journeys and future pathways.	GE, SC
Hunter College	Public Service Scholar Program	Public Service Scholars (PSS) work 20 hours per week from September to May in non-profit and government agencies and elected official's offices. During their placement, they contribute to solutions for a broad range of critical issues, including homelessness, supportive housing, workforce development, community and economic development, industry retention, hunger and poverty, early childhood education, environmental conservation, youth services, and women's issues. PSSP's environmental section places students in substantive internships at the New York State Department of Environmental Conservation.	SC, IS
Hunter College	Quantitative Biology/Biohealth informatics (QUBI)	Quantitative Biology is an intensive undergraduate program designed to train and mentor students in preparation for graduate studies and professions in 21st century biomedical research. QuBi concentrators will learn statistical and computational methods and how to apply those methods to the processing, storage, analysis, visualization and modeling of large-scale molecular biomedical data. They will also develop the research, communication and collaborative skills to contribute to the solution of problems in bioinformatics as members of a multidisciplinary team. The program also offers an exploratory summer workshop open to all CUNY students.	SC
John Jay	Masters in Digital Forensics and Cybersecurity	The Master of Science in Digital Forensics and Cybersecurity degree program offers a balance of practice and theory through study in computer science, law and criminal justice. The program produces professionals qualified as digital forensic scientists who can apply and sustain their expertise as new technological and societal challenges emerge; who understand the scientific, legal and criminal justice context of high technology crime; and who can effectively communicate their knowledge to others.	SC
LaGuardia Community College	Cyber Boot Camp	Supported by the NYCEDC, Fullstack and LaGuardia Community College, which has one of the largest tech training programs in the region, work together to prepare New Yorkers for good-paying job opportunities in cybersecurity.	EC
LaGuardia Community College	TechHire-Open Code	The goal of LaGuardia TechHire – OpenCode is to provide innovative, high-quality tech training and career assistance to young adults (17 – 29 years old), keep and create jobs in local economies, and provide employers with the skilled technology workers they need to grow and expand.	SC, IS, EC

Campus	Program Name	Description	Key Components
Lehman College	Data Science Methods and Applications (Interdisciplinary Minor)	The 15 to 18-credit interdisciplinary minor in data science methods and applications is appropriate for students in majors across various disciplines who are interested in learning methods for working with big, complex, and/or "messy" data and application to real world topics . The minor provides students with interdisciplinary course work focused on obtaining, managing, analyzing, interpreting and communicating about data in all of its forms. Students will learn Python and R programming, as well as other languages used by data scientists.	GE, SC
Lehman College	AR/VR training academy	Lehman's new AR/VR Lab offers a new 15-week/180 hour course on immersive media. Composed of eight modules ranging from Unity and Blender to project management and development for XR, the course will focus on the Unity platform as the means to developing content for Augmented and Virtual Reality.	EC
Lehman College	Using Big Data to Identify and Understand Educational Inequality in America	Students will develop CS skills and behaviors including but not limited to: learning what an API is, learning how to access and utilize data on an API, and developing their R coding skills and knowledge. Students will also learn basic, but important, sociological principles such as how poverty is related to educational opportunities in America. Although prior knowledge of CS and sociology is helpful, neither is necessary for student (or instructor) success on this two-week project. Three instructional hours per week (total of six hours over two weeks).	SC
Macaulay	Data Science Pipeline program	In 2016 25 Macaulay students completed new courses in Big Data, and Macaulay began offering a data-focused section of their core "Shaping the Future of New York City" honors seminar in spring 2017, as well as examining other opportunities to infuse data analysis skills across its existing curriculum. Currently Macalay is exploring paths toward developing a Data Science major in conjunction with the CUNY BA program.	GE, SC
Macaulay	Diversity in Analytics and Leadership	Developed in partnership with Kitamba and Breakthrough New York, the DIAL program trains and supports students in data analysis, preparing them to utilize these skills as they join the next generation of diverse public policy leaders.	SC
Medgar Evers	Tech in residence: Cyber Engineering	Introduction to core cybersecurity concepts, as well as their practical application to software engineering projects. Students learn to account for security during the design process. Covers the most important cybersecurity concepts in greater detail and illustrates the practical application of cybersecurity to familiar systems. Students apply cybersecurity knowledge to their own software engineering projects.	SC

Campus	Program Name	Description	Key Components
QCC	CUNY Techworks	Queensborough Community College (QCC) offers a software development training program covering the competencies needed for web client programming, systems design and implementation, and smart phone application development, and the creation of online portfolios and eventual job placement. Weekly workshops, career counseling, paid internships, and job placement assistance help participants successfully transition to work. Five college-credit classes can be applied towards the AAS degree in Information and Internet Technology offered at QCC.	SC, PN, IS, EC
Queens College	Pathways courses in Tech	NSF grant to design twelve pathways courses to embed tech with other disciplines. Students learn coding and algorithm development, design thinking, use of data, and career exposure through practical uses of tech.	SC
School of Professional Studies	Data Science masters	Students build portfolios of increasingly complex projects using R and Python. Students build predictive and prescriptive models, practice giving presentations. The program prepares graduates for a variety of technical and managerial positions, such as data scientists, business intelligence analysts, knowledge and informatics engineers, data analysts, data mining engineers, and data warehousing managers.	SC
School of Professional Studies	Masters for JetBlue employees	In partnership with JetBlue, crewmembers can pursue a new Master's Degree Pathway, an expansion of the existing JetBlue Scholars program, which will feature online degrees from CUNY SPS in the areas of business, data science , and psychology.	SC, PN