STEM Pathways to College and Careers Schools:

A Development Guide

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Introduction

The *STEM Pathways to College and Careers School Guide* is intended to help education leaders at the school and college levels, and business leaders in IT and other sectors, get started on the collaborative process of designing and building a STEM Pathways to College and Careers school (STEM-PCC school).

Generally, we define STEM-PCC schools as those that span grades 9-14 and target specific degrees in the applied sciences that have direct connections to entry-level jobs that connect directly to a career ladder.

No guidebook can provide all the answers or foresee every situation one is likely to encounter in the process of creating such a school. But, in this document, we map out some of the most critical decision points that we encountered while developing the initial design for the first such school—the Pathways in Technology Early College High School (P-TECH) in Brooklyn, New York. P-TECH is a collaboration among the New York City Department of Education, The City University of New York (CUNY), New York City College of Technology (City Tech), and the IBM Corporation.

When the collaborators began planning P-TECH in September 2010, the goal was never to create a single school. Rather, the express intent was to create an innovative, replicable model for education—one that united the expertise of the public and private sectors to provide new opportunities for young people, and addressed the need to strengthen the continuum from school to college and careers.

P-TECH opened its doors in September 2011. At this writing, it is only in its first year of implementation. We are learning and will continue to learn a great deal. During this process, we expect to refine the model as we uncover what works and what does not, what we can do more effectively, and what new elements and thinking we can bring to strengthen our efforts.

Background

As the first decade of the 21st century comes to a close, growing evidence shows that there is a skills gap in the American economy. Many young adults, both those with only a high school diploma and those with some college, lack the skills and work ethic needed for jobs in growing industries. As a result, these young adults are suffering. Fifty-nine percent of the American workforce has completed at least some college—up from just 28 percent less than 40 years ago. Over that same period, workers with at least some college education have displaced many high-school dropouts and those with no more than a high-school degree; as a result, these groups are no longer considered part of the middle class.

According to "Mobility Makers," a new study from the Center for an Urban Future, though young people understand the need to acquire the skills and education to qualify for 21st Century jobs, a stunningly high percentage of them fail to finish their college degrees. Inadequate academic preparation and lack of guidance and support are two of the biggest reasons for low college completion rates.

These low graduation rates come with substantial financial implications for students and taxpayers. According to the study, each community college dropout costs New York City more than $17,000 in federal and state aid, and in city and state funding. In addition, the lifetime earnings of those without college degrees are nearly 85 percent less than the earnings of college graduates. Were we able to increase graduation rates in just six New York City community colleges by 10 percent, the 30-year earnings of one graduating class would increase by $3.4 billion—with a one-year income increase of $631 million.

The "Pathways to Prosperity" report by the Harvard Graduate School of Education argues that American schools have been too narrow in their one-size-fits-all approach of preparing students to go on to four-year universities. The report states that "preparing for college and preparing for a career should not be mutually exclusive options." Because while preparing for college has become the nearly exclusive focus of educators, the fact is that six in 10 Americans do not earn a bachelor's degree by their mid twenties. Moreover, at community colleges in large American cities, less than 30 percent of students obtain a two-year associate's degree, even after three years. This is a huge missed opportunity with a significant cost because, as the report points out, "in the next decade, half the new jobs will be 'middle skills' occupations suited for those with associate's degrees."

To bridge the gap between where we are and where we need to be, stakeholders in education and STEM (Science, Technology, Engineering, and Mathematics) industries are considering more holistic education options that prepare students for postsecondary education and the workforce.

Pathways in Technology Early College High School (P-TECH)

In September 2011, the New York City Department of Education, The City University of New York (CUNY), New York City College of Technology ("City Tech") and the IBM Corporation opened Pathways in Technology Early College High School (P-TECH)—an innovative public school spanning grades 9-14. P-TECH's mission is to provide students with a personalized pathway towards mastery of the skills and knowledge that they will need to make the transition from education to industry. P-TECH students will graduate with a no-cost associate degree, and will be positioned to secure entry-level positions in the highly competitive Information Technology field(s) and/or complete their studies in a four-year higher education institution.

P-TECH opened in Brooklyn, New York with 104 students in the ninth grade, and will add a grade each year for six years. Students come from all boroughs of the city, but predominantly from the surrounding neighborhoods. They were not screened for admission, and no tests were required. However, students did have to demonstrate their interest in P-TECH by attending a school fair or a parent meeting. P-TECH is 67 percent male and 33 percent female, and many of the students will be the first in their families to earn a postsecondary degree.

P-TECH was never planned as a single or charter school serving a small number of fortunate students. The broader goal always has been to apply the knowledge and experiences developed in this pilot school to serve as a model for use by other traditional high schools in New York City, nationally and globally. P-TECH is designed to be the first in a series of similar institutions, and an exemplar of how K-12 schools, higher education institutions and public/private partnerships can substantially raise graduation rates, prepare greater numbers of students to fill good paying jobs in the IT or other fields, and enable more students to successfully pursue postsecondary education.

Components of the P-TECH Program

P-TECH provides students with a high school-college-career continuum that helps them understand the direct links between what they are learning today and the worlds of college and work. The school's rigorous program is designed to inspire students to focus and strive. While P-TECH is a comprehensive school with a number of significant elements, the following provides a brief overview of the core components of the program.

> ***Focus on Early College:*** Student learning is focused from grade nine on, through a six-year scope and sequence of high school and college coursework to ensure that students will earn an Associate in Applied Science degree in either Computer Science Technology or Electromechanical Engineering Technology, awarded by New York City College of Technology at CUNY, the school's lead college partner. The curriculum is also aligned with the Common Core standards as the foundation for learning in college, particularly higher education institutions with strong math, science and engineering programs. As part of creating the early college culture, students immediately participate in other aspects of the college environment, engaging with college faculty and students.

Focus on Careers: Students participate in an ongoing, sequenced Workplace Learning curriculum informed by current and future industry standards that includes career goals, mentoring, guest speakers, workplace visits and internships. Minimum requirements for entry-level IT jobs, as provided by IBM and other industry partners, have been mapped to the curriculum and are serving as academic benchmarks and targets. A coalition of industry advisors is assuring that the program aligns with industry needs as the IT field evolves. To serve as an added incentive to students, IBM also is making graduates first in line for entry-level jobs—thereby strengthening the continuum from school to college and career.

Focus on Personal Pathways: Each student moves through a personalized academic pathway that is closely monitored by his or her teachers and advisors, based on their individual needs and performance. While the school meets all state mandates for regents and courses, the pace at which the student moves through the high school and associate degree requirements is personalized, and the requirements sequences are intricately intertwined. While all students are expected to meet high school requirements and earn their associate degree in six years, some may proceed at an accelerated pace to earn their associate degree in a shorter time.

Extended Learning Time: In addition to extending college level coursework into what has conventionally been the high school years, the school day and year also are being extended beyond the traditional schedule to include even more individual support for students.

Specialized Staffing: In order to ensure that the model is adequately supported, both the college and industry partners have provided a full-time position to the school: an Early College Liaison and an Industry Liaison. These positions work directly with the leadership, staff and students. In this way the model is continually monitored to ensure effective practice.

Describing this Guide

The purpose of this document is to illuminate the elements that could be critical to starting a school modeled on P-TECH, and provide guidance for developing a program that reaches beyond the traditional goals of any new school.

Each section of this guide describes how we approached a specific aspect of planning and implementing an effective college and career-ready program for all students. While certain features of this model are fundamental, others can be tailored to the unique needs of specific constituencies and community partners.

Organization of the Guide

The guide emphasizes eight design principles that are core to building a new school. Although these principles are relevant to any school model, we highlight the key decision points for each principle that are unique to the STEM-PCC model. Examples from P-TECH also are provided throughout the text to illustrate the core concepts.

The guide is intended to support a discussion among key stakeholders as they develop their own version of a STEM-PCC school. Each section offers a number of direct questions that should help stakeholders focus their discussions. The design principles are:

1. Building an effective partnership
2. Leading with a clear vision and shared decision making
3. Designing a rigorous and focused curriculum
4. Creating an integrated college experience
5. Creating an integrated workplace experience
6. Building a strong and collaborative teaching faculty
7. Fostering family and community engagement
8. Using resources purposefully

Finally, the design principles are followed by a discussion of the issues of sustainability, measures of success and media.

Recommendations for Using this Guide

The strategies and lessons offered in this guide were commissioned by the IBM Corporation and compiled by the Center for Children and Technology through a series of visits and interviews over the course of one year. While this guide will offer insight into the critical decision points and components of P-TECH, this model is still in its early stages of implementation with a long road ahead and many unknown challenges. Therefore, we recommend using this document as one of many resources to inform your planning process.

The STEM-PCC Model: Early College and Career Readiness

There has been a growing trend nationally to establish early college schools that seek to provide students with rigorous learning environments, accelerate their movement into college and prepare them to do well once they get there. There are several different models of early college.

The STEM-PCC school model is based on the early college schools that CUNY has founded and supported over the last seven years. This model includes a fundamental partnership with a college administration and faculty, a six-year Scope and Sequence of college courses leading to an Associate degree, and the embedded role of the Early College Liaison. The STEM-PCC model includes these elements, and has introduced the following five.

Fundamentals of the STEM-PCC Model

Grades 9-14: Nationally, some early college schools fold college and high school into four years, compressing the number of years in which students earn a high school diploma and a college degree. CUNY's model typically starts in the 6th grade and introduces college coursework as early as the 10th grade, culminating in a dual degree award at the end of the 12th grade year. This model both extends time and accelerates rigor for students. This six year model has informed the STEM-PCC model and the development of P-TECH.

The STEM-PCC model is grades 9-14, which means students start in the ninth grade (Year One), begin college coursework in the 10th grade (Year Two), and gradually earn their way through the second (and final) year of an AAS degree. STEM-PCC extends the typical four-year high school to create a seamless six-year academic experience that provides students the training they need to earn an AAS, as well as a high school diploma.

Scope & Sequence and Multiple Pathways: The academic program of the STEM-PCC model is the six-year Scope and Sequence of high school and college classes that students take. This Scope and Sequence provides the fundamental blueprint or pathway for all students to earn their college degree. At P-TECH, students are offered the foundational courses for two different degrees through Year 4. All students move through the same sequence of courses, but depending on their strengths and needs, may move through them at different rates. However, once they have finished their core requirements, they can choose which degree they want to complete by Year Six. Some students may accelerate through the program in as few as four years. Some may take the entire six years to complete their degree. In each case, the Scope & Sequence of courses provides the seamless integration of high school and college requirements. In this way, STEM-PCC schools provide sufficient structure and support to allow any student to complete their degree in six years.

Career Ladder and Workplace Learning: STEM-PCC schools target specific degrees in the applied sciences that have direct connections to entry-level jobs that connect to a career ladder. Thus the curricular sequence is less flexible than in the liberal arts and sciences. Many other early college programs focus on courses in the arts and sciences (i.e., not applied fields).

STEM-PCC schools also incorporate a six-year sequence of Workplace Learning from ninth grade on as a fundamental component of their experience. This sequence is closely aligned with an integrated early college Scope & Sequence. Workplace Learning includes a variety of experiences for students, including coursework, mentoring, workplace visits and credit-bearing internships.

Open Admissions: STEM PCC schools are open to all students and are specifically dedicated to providing college and industry access to historically underserved students. They are unscreened, with no tests required for admission. However, students should show an interest in attending this very focused and rigorous model by demonstrating interest and commitment, for example, by expressing written intent at a student fair or by attending a family information session.

No Cost to Families: Finally, as an added incentive to students—and to support their achievement—the AAS degree is provided at no cost to students' families. Because STEM-PCC schools are designed to serve students from historically underrepresented backgrounds, access to a no-cost postsecondary degree removes a critical financial stumbling block and helps students focus solely on learning.

Additional best practices of new and early college schools

In developing the concept for P-TECH, we visited several innovative schools and consulted various experts in STEM-focused career and technical education. Our research has shown that the following 10 elements are essential components for any new school, and for starting an early college school:

> ***Strong Partnerships:*** Establishing a close working relationship and a formal agreement with a college or university, a corporate partner and other community partners is crucial for developing a sustainable and effective school model.
>
> ***Well-Structured Collaborations:*** Many of the most successful corporate-school partnerships are designed as collaborations where there are clear expectations of each partner's commitment and obligations—especially where the partnership is based on more than just providing financial resources. For example, corporations need a clear understanding of what types of resources—internships, mentors, summer jobs—are needed from them, and for how long.
>
> ***College-going Culture:*** Many highly effective schools have sets of organizational practices that reinforce an effort-based, college-going culture in which all students

are supported as full members of a community of learners striving to achieve high standards. Examples of creating a strong college-going culture include engaging students in college coursework, tutoring and advising, and instruction on key “college knowledge” academic and personal behaviors such as time management, study skills, communication and tenacity.

Engaging Family and Community: Parents and community members are crucial partners and allies in providing college opportunities to every student. In seeking to engage parents in school activities generally, and support for early college specifically, many successful schools have established parent-liaison positions, developed substantive parent academies, and created multiple points of access to engage parents in meetings and events.

College preparation courses: Many students begin with “College 101” courses that arm students with the skills and knowledge they will need to succeed in college. Among the topics covered in these courses are how to manage time and tasks; tips on studying and test taking; and stress management skills—all aimed at helping students adjust to college life. Students typically earn one to three college credits in these courses. Similar credit-bearing courses are taught to many college freshmen.

Professional Development: Many successful STEM programs and early college schools emphasize ongoing professional development as a tenet of student achievement. These opportunities range from support and exchanges during the year to technical-assistance workshops, principals’ leadership institutes, student leadership conferences, and summer professional development institutes. Workshops cover such topics as literacy throughout the curriculum, the role of peer review, inventing new forms of student support for college classes, creating e-portfolios, using wikis to conduct inquiry projects, and using data to provide targeted instruction.

Critical Issues for Early College Schools:

Bridge Courses: In many cases, freshmen and sophomores participate in programs, typically offered in the summer, that move quickly through subject areas where they need additional reinforcement. These programs help to create a bridge to success in the regular school year. Some schools also refer students to content-specific summer enrichment programs.

Focus on Writing and Math: Many early college schools teach writing throughout the curriculum, and many double up on time spent on math or English, depending on student needs. Students also have access to tutoring and other comprehensive support services during and after regular school hours.

Seminars: Some early college schools offer high school seminars that students take in conjunction with specific college courses. The seminars parallel the work of the college course, providing students with practice in developing pertinent discussion skills, vocabulary, and study habits. Students also collaborate in the seminars to develop strategies for understanding assignments, solving homework problems, and taking assessments.

Stretch Courses: Some early college schools increase the time it takes to complete college credit-bearing courses—for example, by transforming semester courses into year-long courses. This provides additional time for students to master the rigorous material.

STEM-PCC Design principles

1. Building an Effective Partnership

The STEM-PCC school begins with a strong partnership consisting of the school district, college, and the private sector. The partners essentially comprise a three-legged stool, with each leg critical to the success of the school and its students.

Determining Whether the School District is Ready

Establishing a STEM-PCC school is a significant commitment for a school district. Building a STEM-PCC school may require different types of resources than those required to open a new four-year academic high school. STEM-PCC schools differ from other specialty high schools by blurring the line between high school and college, breaking down the traditional structure of high school as four years, and requiring a complex partnership with three major stakeholders—the district, a college partner, and a corporate partner.

As with the creation of other schools, creating a STEM-PCC school requires careful reflection on curricula and staffing. However, the school district's lead representative will have additional responsibilities. Because the school is supported by a partnership of stakeholders, the school district lead will need to communicate and collaborate with corporate and college partners. The school district lead also may benefit from deep public policy experience and relationships with the state department of education to navigate related policy requirements. Because a STEM-PCC school does not follow traditional models, this can be a complex process.

Office of Postsecondary Readiness at the New York City Department of Education

The Director of the Office of Postsecondary Readiness (OPSR) is the lead representative from the New York City Department of Education (DOE) on P-TECH's steering committee. Although OPSR receives close support from the Office of New Schools, the Director of OPSR is leading the DOE's involvement in the school because his unit has deep experience in bridging the gap between high school and college. The mission of the OPSR is to ensure that every student will be equipped with the knowledge, skills, and competencies to successfully pursue a rigorous postsecondary pathway.

OPSR is building a portfolio of educational models to meet the needs of differentiated segments of the overage and under-credited population, and bring them to graduation prepared for success in college and career. OPSR is now building on its track record of success to provide a comprehensive vision of postsecondary readiness. P-TECH is a new model designed to enable students to pursue both academic and 21st century labor force options.

The district leadership should carefully consider whether the district is ready to embark on the STEM-PCC design process.

Does the district have a process for creating new schools from an organizational, budgetary, space and quality perspective?

Does the district have previous experience working with corporate and higher education partners?

Does the district have experience with early college programs?

Is there a senior administrator with sufficient experience, vision and commitment who can oversee the design process?

Is the district flexible enough to accommodate the potential needs of STEM-PCC schools? (Many of these needs are discussed below.)

Selecting a College Partner

The college plays a fundamental role in the STEM-PCC program and selecting a partner that understands the model and shares a commitment to its goals and approach is essential. Because the STEM-PCC model strives to blend high school and college experiences, the college selected should demonstrate a willingness and ability to work closely with the high school faculty, think creatively about how to ease the transition to college work, and make challenging content accessible for students in the program. The college does not necessarily have to be a community college, but it must offer associate degrees that align with industry needs. It is helpful if the college partner is flexible in their requirements and has prior experience working with high schools and high school students, or has shown a commitment to developing these relationships.

Participating in the STEM-PCC partnership also has benefits for the college. Working closely with high school students will increase the number who enter their college programs prepared to do college-level work. Additionally, early exposure to the college will give students a chance to meet faculty and become familiar with the various programs and departments. Students who continue at the school beyond their STEM-PCC experience already will be acquainted with program options and more likely to have a clear academic direction. Developing a relationship with the industry partner also is beneficial to the college partner. This relationship can help keep faculty current on what students need to be successful in future jobs. It also can create mentoring and internship opportunities internships that will benefit the college.

New York City College of Technology

The New York City College of Technology of The City University of New York is an ideal partner for P-TECH in both the fields of study offered and the approach to teaching. City Tech, as it is commonly known, enjoys a long-standing reputation for its involvement in economic development and business assistance. A study by Center for an Urban Future identifies City Tech and its Business & Industry Training Center as “one of CUNY’s leading job training and business assistance centers with a strong set of programs that many employers have come to rely on.” (Hilliard 2011) City Tech’s 28 associate and 19 baccalaureate degree programs provide a rare blend of specialized technological instruction and broad education in the liberal arts and sciences.

Like P-TECH, City Tech has a commitment to innovative teaching using hands-on, real-world activities to engage students and ground their learning. The School of Technology & Design at City Tech offers programs in engineering, design and media technologies that are application-driven and prepare students for communication, production and management positions in corporate, industrial and creative professions.

For the college to engage most effectively with the project, it must be willing to devote administrative and faculty resources in a structured and ongoing way. The model requires that the college and high school create a seamless institution. High-level administrative guidance and clearly delegated roles for participating department chairs and faculty members are key.

Specifically, the college partner of a STEM-PCC program should commit to the following responsibilities:

- Be an active and equal partner on the steering committee
- Determine which department(s) will best articulate the school's goals
- Involve faculty from the participating departments in identifying appropriate college courses to include, and developing their scope and sequence
- Collaborate with high school faculty to ensure that course content will prepare students for college work
- Collaborate with corporate partners to align college coursework with relevant technical skills and workplace competencies
- Provide professional development for faculty who need support working with high school students

CUNY School Support Organization

P-TECH is lucky to benefit from the knowledge and expertise of two higher education experts on the steering committee. The Director of the CUNY School Support Organization serves as The City University of New York's lead representative on P-TECH. CUNY has been providing support services to New York City public schools through a dedicated full-time staff, as well as through the extensive involvement of campus-based faculty and staff with knowledge and expertise in a wide variety of relevant areas. The School Support Organization coordinates CUNY's involvement with the city's public schools through its collaborative programs (College Now, affiliated schools, early college schools, and Middle Grades Initiative/GEAR UP) and its numerous teacher education programs.

Questions for the college partner to consider:

Does the college offer AAS degrees that align with industry needs?

Does the college understand the STEM-PCC model, and will it commit to its goals and approach?

Is the college willing to work closely with the high school faculty to develop and support a Scope and Sequence of courses to ensure that students are prepared for college level work?

Is the college willing to work closely with industry partners to align coursework with relevant technical skills and workplace competencies?

Is the college willing to be flexible yet rigorous in its requirements?

Does the college have prior experience working with high schools and high school students?

Selecting a Corporate Partner

One of the fundamental goals of the STEM-PCC model is to build partnerships with industry leaders to develop clear pathways founded in standards students must meet to compete successfully in the 21st century job market. Selecting an appropriate lead corporate partner is critical for this venture. Partners should be selected based on their demonstrated dedication to improving public education, and their understanding and support of the STEM-PCC model. Partners also should have the capacity to provide input into the specific skills required for jobs in their sector, and should be able to provide meaningful work experiences and a sustainable commitment to the program—including visits and internships for students, and professional mentors.

By providing input into the specific skills required for jobs, corporations help develop better prepared workers. In addition, corporate partners strengthen their recruitment efforts as young people learn about their company and the range of available jobs, and establish relationships with employees who are serving as mentors or speakers. Corporations also may strengthen their citizenship portfolio and increase public awareness of their philanthropic efforts.

The lead corporate partner of a STEM-PCC program should commit to the following key responsibilities:

- Be an active and equal partner on the school steering committee.
- Create an up-to-date skills map for their industry that identifies relevant and realistic job requirements.
- Work with school and college faculty to align technical skills and workplace competencies with college partner offerings and other curricular resources.
- Take the lead on the work-based learning curriculum sequence.
- Create other workplace learning opportunities, including professional mentoring, site visits and credit-bearing internships.
- Provide dedicated staff to work on the initiative, including a dedicated Industry Liaison position to work with the school.
- Strongly consider graduates for jobs or make students first in line for jobs.

IBM and P-TECH

IBM is serving as the lead corporate partner for P-TECH, and has a team working with the school — including an Industry Liaison solely dedicated to fulfilling IBM's commitments and working with the principal and the school's workplace learning staff to ensure the long-term success of the overall workplace learning strand. During PTECH's first year, IBM has provided information on the skills required for jobs that require an AAS degree, and has worked with school and college faculty to match those skills to the curriculum. To complement this effort, IBM has led the development of the P-TECH's workplace learning curriculum in cooperation with teachers and faculty. IBM also has assigned professional mentors to each student, is hosting site visits at its research and manufacturing facilities, and, beginning in year three, will provide internships that could be components of credit-bearing courses. In addition, IBM will build a technology solution for the school to help fill a needed education gap, as identified by the principal, teachers and staff.

To support P-TECH over the long-term, IBM also is helping to build an Industry Coalition to support all workplace learning aspects within the school. To attract companies to serve in the coalition, IBM, working with the Partnership for New York City, invited interested New York-based companies to a breakfast meeting to hear from leaders from each of the school's partners and from Principal Rashid Davis. This initial meeting is being followed up with a series of individual discussions about how companies can specifically get involved with P-TECH.

Collaborate with the school's Workplace Learning Coordinator to sustain the school's workplace learning components over the long-term.

It's important to note that a single corporation cannot provide all the mentors or workplace learning experiences needed over the long term—either in terms of sheer numbers or to provide students with dynamic and varied opportunities. To that end, while the role of Industry Liaison is key, an overall Workplace Coordinator—or other appropriate staff—on faculty, who is responsible for all aspects of the workplace learning strand, is critical to the future viability of the model. This position will have overall responsibility for workplace learning at the school, collaborating with the Industry Liaison as the model expands and evolves.

One primary aspect of the lead corporate partner will be to work with a coalition of industry partners throughout the development of the school. The industry coalition serves to confirm the technical skills and workplace competencies identified by the lead partner, provide internship opportunities and mentors for students, and commit to considering program graduates as job candidates. The industry coalition is essential to providing the school with a comprehensive industry perspective and ensuring sustainability.

Selecting the School Site

Once you decide to create a STEM-PCC school, finding a school building can be a unique and complex process. Most school districts already have an existing process to site a new school or redesign an existing school, and the partnership will need to work within that process. It may be best for the district representative on the leadership committee to coordinate with the relevant agencies. In addition, it is important to remember that siting the school may involve trade-offs among competing goals. It is also important to remember that schools are not islands unto themselves; they exist within—and are integral members of—their communities.

Beyond the standard concerns for any new school building (i.e., meeting safety codes, obtaining sufficient classroom space) there are a number of questions specific to a STEM-PCC school that should be considered even though the final decision may be shaped by external constraints.

Finding a home for P-TECH

Led by the school district's Office of Portfolio, P-TECH was successfully co-located within the Paul Robeson campus. The campus includes Paul Robeson High School (which is being phased out) and another new small school, the Academy for Health Careers.

The Robeson site offered a number of benefits:

- existing building owned by the district;
- easy commute to City Tech;
- near major subway line;
- sufficient space to house the 9th grade and room to grow;
- located in a Federal turn-around school which provides some financial resources; and
- provides a new educational opportunity for the community.

To ensure that the community welcomed the school, P-TECH leadership met with community leaders, including the Brooklyn Borough President, its New York City Councilman, and other key government and nonprofit leaders. P-TECH's partners presented the school and its goals and fielded questions to allay any concerns. These conversations have continued as the school evolves as a demonstration of the partners' commitment to respond to the community beyond the school walls.

Questions to consider when selecting a school site may include:

Will this school be housed at a new site, will it be a redesigned school, or will it be a program within an existing school?

What will be the most effective way to include the community in the process?

Is it important for the high school site to be close to the higher education partner? Is there good public transportation between the two sites?

Must the school be located in the community being served?

Does the building have sufficient classroom and office space for the first year, and is there room to grow?

Does the building have sufficient laboratory space that may be required for specialized AAS-degree courses?

Is it important for the school to be near the corporate partner(s)?

Since STEM-PCC schools are intended to support traditionally underserved communities, it may be desirable to find a building in such a community. However, STEM-PCC schools may draw students from neighborhoods throughout a city, and travel to the school may be an issue for students who live in other neighborhoods. Furthermore, the location of the school will impact parents' ability to participate in school events. Finally, there may be public safety perceptions about some neighborhoods that could influence whether parents and guidance counselors from other parts of the city would encourage students to apply.

Should the partners establish the school in a failing school building, the school would become eligible for school turnaround funds. However, the school would also face challenges. The STEM-PCC school must be sensitive to the concerns of a surrounding community that may be losing an important neighborhood institution with a history of community involvement. In such circumstances, the STEM-PCC school should meet with community members proactively to hear their concerns, allay any fears, emphasize the potential positive impact of the school, and determine other ways the school can contribute to its surroundings.

2. Leading with a Clear Vision and Shared Decision-Making

Developing and sustaining strong leadership is fundamental to successfully promoting the idea of a STEM-PCC school, building effective partnerships, and overseeing the creation of a new school. When establishing a STEM-PCC school, there are two levels of leadership that need to be considered. The leadership of the STEM-PCC initiative must be a partnership that involves stakeholders from organizations linked to the key areas of action: Local Education Agency (K-12), higher education, and the private sector. But each STEM-PCC school needs to have strong on-the-ground leadership centered in a visionary principal. The two levels of leadership need to collaborate closely and the principal must be on the initiative partnership committee.

The partnership that spearheads the initiative should be based on a solid long-term commitment to developing a STEM-PCC school, a commitment to developing an applied vision of what a STEM-PCC school would be like, and a commitment to meeting the needs of their communities. But the partners also need to be flexible on the details as long as the end goal is met.

Role of the Steering Committee

Designing and launching a new school is a long, complex process that requires intense and committed partner participation. The partnership should create a formal Steering Committee consisting of key leaders and staff from each member organization. The Steering Committee should meet weekly or biweekly during the planning stages, before moving to monthly and as-needed meetings once the school gets under way. All committee members should have input into the agenda, which can encompass such aspects as creating a shared vision, outlining the practicalities of student recruitment and retention, determining teacher hiring and professional development, developing curricula, and making decisions regarding technology, infrastructure, and funding.

With a variety of expertise and perspectives at the table, it is important that the committee designates responsible parties for each decision, and establishes clear procedures for providing timely feedback. While decisions should take into account each stakeholder's input, the partners must have mechanisms in place to ensure that issues do not get lost in endless discussions—especially as the number of required decisions increases.

The Steering Committee's first key decision will be to develop a shared vision. This can be a surprisingly lengthy and challenging process as the school moves from conception to reality. However, the committee's guiding vision will serve as a common thread throughout most of the school's planning activities.

Role of the Planning Committees

While Steering Committees are decision-making bodies, the partnership should create sub- or planning committees responsible for moving specific topics forward. For example, one such committee could be charged with developing aspects of the school curriculum, culture and programs. These smaller committees would include appropriate representation from each partner, meet on at least a weekly basis during school development, and be responsible for taking specific actions—which could include vetting curricular resources, reviewing possible assessments and identifying a technology platform.

It is key that the Planning Committee include members of the Steering Committee who are empowered to make real decisions as the design process moves forward. While planning committees would be empowered to make decisions, though they would bring more significant issues to the full Steering Committee for review.

Role of the District

School districts have their own processes for developing new schools. It is important that the district's new school development process be incorporated into the Steering and Planning Committee membership. If a district does not have prior experience with developing early college schools, this will be especially important.

Creating a Timeline for School Development

It is key that the model receive the attention and time it needs in the development process, as once the school is up and running, many formative decisions have already been made. At least a full calendar year should be devoted to the planning process to ensure greater success for all involved. Specifically, there are key constituents who must be present from the beginning of that process, including the principal, the early college liaison, the industry liaison, college administrators and faculty, the district, and ideally teachers-in-waiting for the school.

Selecting the Principal

Selecting the school leader is one of the most critical decisions in the school start-up process. The principal of a new school has the challenge of channeling the vision and providing leadership for all components of the school, including the structures and supports needed to meet the STEM-PCC model's rigorous goals. Thus, it is critical to bring the principal in as early as possible when designing the school. The principal will guide the partners during this process and during the school's actual operation, and his or her immediate ownership of the school and its relationships will be integral to its success.

The principal must be passionate about and experienced with working with the STEM-PCC model's target student population, and should show a deep understanding of the model and a commitment to its goals. A track record of leading student achievement, particularly in the STEM areas, and experience working with partnerships also is essential.

While each district has its own processes and criteria for selecting a school leader, the ideal principal should have substantial experience and capabilities in the following areas:

Instructional Leadership

Has demonstrated capacity to drive exceptional student outcomes.

Is dedicated to working with underserved students and their families.

Can communicate a strong pedagogical vision to staff.

Can provide effective feedback to teachers about their instruction.

Knows how to establish systems and structures to support a reflective, collaborative professional community.

Has experience providing high quality professional development.

Can model the role of a passionate learner.

Has the demonstrated ability to think about time and the school day in original and practical ways.

Managerial Skill

Has an accomplished educational and career background.

Has an effective communication style.

Can empower staff and distribute leadership by establishing shared decision making processes.

Can identify appropriate systems to establish expectations and monitor the quality of the curriculum and the student experience.

Works well with the local schools authority.

Understanding of the STEM-PCC Model

Knows how to establish a college-going school culture.

Can discuss curricular coherence and strategies for integrating the college and high school experience.

Recognizes the challenges and opportunities of the model, and identifies strategies for addressing those challenges.

Has experience working with partners on complex projects.

Capacity to Plan a New School

Has a vision of and passion for starting a new school—including teacher recruitment and support, curriculum planning, instruction and assessment, and school culture.

Is a strong critical thinker who can pull together all of the pieces of the development process to form a coherent whole.

Early meeting with New York City School Leaders

The P-TECH partnership knew that no school reform effort could be successful without broad-based support, and the engagement of experienced principals and assistant principals was key. They also were keen to hear from school leaders about best practices—and pitfalls—when starting a new school or improving any school. Thus, the partners collaborated with New York City's Council of School Supervisors and Administrators—the New York City school principals' union—to host a reception for 25 school leaders at IBM's offices in Manhattan during the early phases of planning. At that reception, the school leaders learned more about the wide range of factors under consideration for the design and development of this new school and school program.

One person in the audience that evening was Rashid Davis, who would eventually be chosen—after a rigorous selection process—to serve as P-TECH's principal.

3. Designing a Rigorous and Focused Curriculum

A rigorous and focused curriculum is the hallmark of any successful school, but it is particularly important to the STEM-PCC model. As a school with no prerequisites or testing for admission, the commitment to graduate all students in six years with an associate in an applied science degree, P-TECH's instructional activities must be carefully and purposefully designed. The curriculum must drive toward helping all students develop the skills and knowledge they need to graduate high school and earn an AAS degree—regardless of their level upon entering the program. Three key activities are central to the curriculum development process: (1) selecting the AAS degrees, (2) designing multiple scope and sequence pathways, and (3) constructing four central curricular strands.

A. Selecting the AAS Degrees

First, the selected AAS degrees should lead to a professional career path and prepare students with employable skills and content expertise. Industry partner(s) should identify the skills relevant for jobs that require AAS degrees, and college faculty should identify which AAS programs will provide students with these skills. It is important to consider which skills will provide the best employment opportunities and offer options for career progression and growth.

Selecting AAS Degrees at P-TECH

P-TECH offers two associate in applied science degrees: Computer Information Systems (CST) and Electromechanical Engineering Technology (EMT). These degrees were chosen based on their relevant skills for jobs at IBM and other major IT employers.

The CST and EMT degrees share many prerequisites. A third degree was considered, but ultimately was not included because it did not share enough prerequisites and would have required students to select a focus much earlier in their P-TECH experience. The two AAS degrees have 24 credits in common, which will form a common dual-credit sequence for P-TECH students. Programming and problem solving were identified as "bridge skills" that everyone, regardless of degree, would be required to develop. The P-TECH team describes this approach as creating a long trunk, representing the common core coursework for all students, with short branches, representing the specialized coursework for a specific degree. With the degrees P-TECH selected, the "branching" won't happen until the later years of the program (years 4-6).

For the Industry Partners:

Which jobs require AAS degrees? What are the skills required for these jobs?

Are there jobs that currently require a Bachelor of Science degree that could actually be filled by a qualified candidate with an AAS degree?

Are these jobs the start of a career ladder or are they jobs in which there are limited opportunities for advancement?

A second consideration is selecting AAS degrees that share prerequisites or core courses, or have overlapping electives. This allows the school to develop a scope and sequence that postpones as long as possible the point when students must decide which degree to pursue. Having a longer time to decision gives students more opportunities to discover their interests and strengths. Additionally, postponing the degree concentration decision enables the school to establish a shared foundation that all students will master in the first years of the program.

For the higher education partner and the Local Education Agency:

What AAS degrees map to the industry-identified skills?

What are the required courses for these AAS degrees, especially in the early years? How much overlap is there — either in required courses or in electives?

Will the common courses allow the STEM-PCC school to build a common scope and sequence that will be appropriate for high school students (with appropriate additional support)? In which year will students need to make a decision about which degree to pursue?

How many credits toward each AAS option will students have earned by the time they need to choose a major? Will this be an issue for any of the college departments involved?

B. Designing Multiple Scope and Sequence Pathways

A core component of any school development effort is the academic Scope and Sequence. The Scope and Sequence outlines the courses that students will be required to take at different points in time, and how different strands of learning will build on one another(for example, how the Workplace Learning curriculum will complement the college coursework in a given year). The scope and sequence also establishes the pace for students through the six-year program and is particularly essential for early college programs as a mechanism for connecting high school and college learning experiences into integrated strands of study.

Building scope and sequence pathways is a complex process that must take into account the high school graduation requirements, the college entrance requirements, and the requirements and prerequisites of the AAS degrees being offered. Decisions made about the scope and sequence have implications for many other aspects of the school, such as teacher hiring (i.e., which content areas are needed and in which year) and workplace learning (i.e., where is the time in the school day for workplace learning and how does it align with the academic content).

Fast and Faster: P-TECH's Scope and Sequence Pathways

P-TECH's leadership made a conscious decision to develop a scope and sequence that envisions every student as successful in six years. After much consideration, P-TECH built a core scope and sequence that provided sufficient time and learning resources to enable any motivated student to potentially earn the high school diploma and AAS degree in six years, regardless of their incoming ninth grade skill level. This goal is built into the scope and sequence since the entire ninth grade year is focused exclusively on mathematics, English and technology — the building blocks to success in high school and in AAS fields.

In ninth grade, the scope and sequence provides double blocks of math and English, and the technology and workplace learning courses also reinforce those content areas. For the many students who entered P-TECH performing at eighth grade levels or lower, this intensive focus, coupled with extended instructional time after school, during the summer, and on weekends, allows them to catch up and be ready for college-level work in electromechanical engineering by Year Two. For the students who were on track when they entered, the focus on math and English in ninth grade opens up two different pathways. In one sequence, students will still be in the program for six years but they will start doing college-level work in English by year two, in math by year three, and in social studies by year four. But, for those students who can accelerate, a third pathway would enable them to use college-level courses to meet all the high school requirements for English and math by their third year — thereby enabling them to complete all the college courses for the AAS degree by year five or sooner, if they take advantage of summer courses. The three sample scope and sequences from P-TECH (see Appendix A) are only suggestive; each student's actual pathway is customized based on his or her strengths and weaknesses and the AAS degree chosen.

As an unscreened school, a STEM-PCC program will need several scope and sequences to provide the opportunity for all students to earn a high school diploma and an AAS degree within six years. Students will enter the school with different levels of readiness for the intensive STEM focus, and not all students will be able to move at the same pace. The curriculum's scope and sequence must foresee the needs of incoming students and provide sufficient time to master the content before moving on.

Some students will need additional resources and supports to successfully complete both a high school diploma and an AAS degree in six years. Efforts to bring students up to grade level should be front-loaded—especially in English and mathematics, as these skills provide the foundation for success in other courses. Other scope and sequence pathways should provide opportunities for students who are able to move more quickly through the content. These students may be able to complete the AAS degree in fewer than six years, or may accumulate additional college credits in math and science.

For the higher education partner and the Local Educational Authority:

Which college entrance requirements must students meet? What are the implications of sequencing high school coursework to meet these requirements before taking college courses?

What exams at the state or college level are included in those entrance or graduation requirements?

What are the high school graduation requirements, and when should students meet them?

What are the funding and policy implications once students have met the high school graduation requirements? Will students lose access to certain funding streams and will other funding streams be available?

How and when will the school provide additional resources to help bring students requiring remediation up to grade level so that they can still attain an AAS degree within six years?

C. Constructing Four Central and Interrelated Curricular Strands

At a STEM-PCC school, four curricular strands run throughout the six-year experience: English language arts, mathematics, technology and workplace learning. These content areas are the central focus of the program, with other subjects such as foreign language, science, and history woven into the curriculum at appropriate points. These strands must be designed to support and reinforce one another and develop students' knowledge of STEM areas and the specific content needed for the AAS degrees selected.

Each content strand should have an expert curriculum planning team, consisting of school, college faculty and business representatives dedicated to developing lesson plans and materials. Curriculum planning should align with the Common Core standards and state standards, and should address college pre- and co-requisites and workplace readiness skills.

Because proficiencies in language arts and mathematics are fundamental building blocks to success at college level courses, a STEM-PCC school may choose to concentrate course work in these areas early in the program. This could help ensure that students are able to begin college course work as soon as possible and begin accumulating college credits.

Appendix B provides a snapshot of coursework at P-TECH, showing that year one focuses exclusively on English, math, technology, and workplace learning. Coursework outside of these four central strands is not incorporated into the program until the second year. This structure is a direct outgrowth of the principal's skill with utilizing time differently for student achievement.

As students move through the program, the content strands should be designed to reinforce each other. Since STEM-PCC schools are moving towards AAS degrees, it is important for the math, science, and technical courses to be closely aligned so that students will enter their technical courses with a command of core math and science skills. The high school and college faculty will need to collaborate on designing and aligning their courses. It is perhaps easiest to see the alignment in the STEM-related courses, but the workplace learning and other content areas also can be integrated. Authentic projects are a core element of STEM-PCC workplace learning experiences, and well-designed projects allow students to apply their growing STEM knowledge to a real-world problems.

Combining Math, English and Technology to start thinking about careers

Early in P-TECH's ninth grade workplace-learning curriculum is an activity that brings together math, English and information and communications technology as students begin exploring careers. Using the Internet, students explore their selected career, find out what people in that profession do, what degrees are required, and what colleges offer those degrees. Students also need to explore what it would cost to earn the degree in question, and the projected salaries in the profession.

This classroom activity is augmented by professional mentors from IBM, who are paired with students and work with them primarily online. Mentoring has been integrated into the workplace learning curriculum, with weekly assignments assigned to each mentor/student pair.

For all partners:

How will the language arts and math content strands align with the workplace learning sequence and the technology sequence? How does each strand support and reinforce learning in the other strands?

How are these strands integrated? What opportunities exist to work across strands?

4. Creating an Integrated College Experience

Designing the college experience and integrating it into the program is a central challenge of any early college program. Schools must blend high school and college level work into a single academic program and provide academic and social supports that help students succeed in a challenging course of study.

Because of their focus on specific technical degrees, STEM-PCC schools may have greater difficulty integrating their curricula with colleges than other early college programs geared towards liberal arts and science degrees. STEM-PCC schools must integrate three realms of experience instead of two—blending the critical workplace learning strand in addition to high school and college work to ensure that students meet all the requirements for an AAS degree by the sixth year. Meeting these requirements calls for additional coordination and planning to develop the curriculum as a coherent unit. Additionally, the technical focus of the AAS degrees and targeted careers requires a more focused program to ensure students gain the skills and knowledge they will need to be employable.

A. Building College Courses into the Scope and Sequence

This guide has discussed how to select the appropriate AAS degrees above, but there also needs to be careful reflection on how college courses are built into the scope and sequence. Since most college programs have a sequence for their core courses, students will likely follow that basic sequence with some adjustments to accommodate the students' needs.

Degree programs vary in the amount of flexibility they provide students in selecting courses. Some programs may provide many options to satisfy requirements while others provide few. But, for a STEM-PCC school with multiple AAS degrees, the college departments may need to be flexible so that the STEM-PCC scope and sequence can blend the requirements and prerequisites for both degrees.

For those AAS programs that provide more opportunity for choice, one consideration is whether a course could satisfy requirements for both high school graduation and the AAS degree. Other considerations are how the course addresses workplace readiness skills, and how it fits into the scope and sequence and relates to content from other strands.

Additionally, effort should be made to give students equal exposure to courses in the departments representing the AAS degrees selected. This will help students choose which degree to pursue.

For the higher education partners:

Can all the prerequisites fit into a combined scope and sequence that will enable students to achieve the AAS degree(s) in six years? Which prerequisites for each degree are essential, and which can be replaced?

Which courses can satisfy both high school and college requirements? Which courses can provide dual credit?

Are there competing prerequisites that are similar and can be combined (i.e., different basic computer programming courses)?

To ease some of the demands on students' time and learning curve, can some of the aspects of the prerequisites be built into the high school courses?

How soon must a student choose a major? Will students have had equal exposure to each degree program's area of study by the time he or she needs to decide? How can the college departments work together to ensure that students have been exposed to each choice?

In addition to the educational goals, there are a number of logistic and policy constraints that need to be considered up front. One limitation may be whether students take college courses in groups or individually. For example, many STEM-PCC schools may need to have students take college courses in high school cohorts because of cost concerns—especially in the early years. These college courses may be offered in sections that are only for STEM-PCC students. The cost of college tuition is a policy decision that both the local education agency and colleges need to resolve for students and their families.

Additionally, local regulations may require a certified teacher to be present for all college classes. Another limiting factor may be whether courses are offered at the high school campus or at the college campus. Depending upon the locations of the high schools and college campuses, it may not be feasible for students to travel back and forth between the campuses each day, and STEM-PCC schools may prefer to offer some college courses on site. For example, if the ninth grade students are only taking one college course, it may be more efficient to have the college faculty teach at the high school. It will be important to consider how high school faculty can become college adjuncts in order to teach certain college classes as well.

For the higher education and the school partners:

Which courses should be taken at the college and which at the high school?

How convenient is travel between the campuses, and when are students mature enough to travel on their own?

Which college courses require special equipment or facilities that are not available at the high school? (This may dictate when those courses can be in the scope and sequence if the younger students cannot get to the college campus.)

Who will teach these courses? High school teachers who have adjunct status, or professors from the college?

Which courses will be taught on a semester schedule, and which courses will become year-long "stretch" classes?

Which courses would benefit from a team-teaching model?

B. Blending High School and College Learning

Designing a schedule that includes both high school courses and college courses is challenging. However, the goal is to blend the two learning contexts into a seamless whole so that students are naturally able to progress and meet the increasing demands of the program. Traditionally, most college freshmen experience an adjustment period as they get used to a different model of teaching and learning and the increased demands of college. This is also a time when many students drop out of college. To increase the chances for students' success, a STEM-PCC school should ensure a smooth transition by designing an integrated curriculum that builds from high school to college-level work, and aligns the teaching models.

As students move through the school, it is important to consider whether students will be ready for each new course in terms of pace, content, and pedagogical approach, and what additional supports they might need to be successful. Some college courses might be stretched from one semester to a full year to provide students more time to master the content. It may also be helpful for students to take their first college-level courses on the high school campus with their high school cohort. Additionally, some courses may be co-taught by college and high school faculty. However, there are also logistic factors (see above) that will help determine which courses can be offered at the high school campus. Scheduling considerations—such as whether there are college faculty available to teach the course for the program, and whether the course can be offered at a convenient time—also will play a role.

In addition to better alignment across the six years of the STEM-PCC school, the program must provide a variety of academic and social supports to help students succeed with college-level coursework. STEM-PCC schools should provide academic supports such as tutoring sessions where students can seek individual help, and support classes in such college skills as note taking, time management, and complex project organization. Early college seminars for high school students can support them Years 13 and 14 as they navigate a program of only college courses. The school should also recognize the importance of social and emotional support for adolescents who are embarking on such a rigorous academic program. Not only is it important to cultivate a supportive peer community, but the school should also provide counseling, mentoring, and access to social workers. Academic advisors at the school level can help to support individual students.

Blending High School and College Learning at P-TECH

City Tech may be unique among colleges in that is has an explicit focus on project-based instruction and student-centered pedagogy. This is evident in the course designs of the two departments that are collaborating with P-TECH—the Computer Engineering Technology Department and the Computer Systems Technology Department. City Tech's focus helps reduce some of the challenges of blending college and high school courses, and means students may have an easier time adjusting to their college courses.

City Tech faculty from both of the departments that collaborate with P-TECH joined the planning team to help select college courses. The team consisted of school, early college and IBM staff. College and high school faculty worked together throughout the summer before opening P-TECH to plan their curriculum.

For the higher education and the school partners:

What knowledge and skills will students need to be ready for each course in terms of pace, content, and pedagogical approach? Will students have had a chance to develop their knowledge and skills in time?

Which courses might be stretched across the year rather than delivered in one semester? What supports would be needed for success in those courses?

What other community support services might be needed?

It is essential that high school and college faculty work together to integrate the high school and college experiences. Curriculum planning must carefully identify the skills that students will need for their college level courses and ensure that they will have sufficient opportunities to master those skills prior to starting college classes. Ongoing collaborative curriculum development by high school teachers and faculty must continue throughout the school year.

Workplace learning must also be infused into this protocol. The industry partner should work closely with college and high school faculty to connect academic content to real-world situations and ensure that workplace readiness skills are also addressed. Similarly, the workplace learning strand should tie directly to core high school and college classes.

High school and college faculty also need to collaborate to refine instructional practices and establish consistency in their pedagogical approaches. This will help students make connections between classes, and will ease the transition between high school and college-level work. Additionally, having similar rituals and routines across classes will contribute to a more coherent experience for students.

For all partners:

How do you plan to ensure that students have sufficient opportunities to master the skills they will need for college-level courses before beginning those courses?

What connections to workplace learning run across the high school and college work?

What instructional practices will be used consistently across high school and college?

C. Building a College Culture

STEM-PCC schools have a nuanced perspective on what it takes to build a college-going culture. First, STEM-PCC schools offer a very specific view of what college is about. Popular discourse often presents college as a time for young people to learn to be independent and to explore opportunities. STEM-PCC schools introduce college as a rigorous and demanding experience focused on mastering the knowledge and skills needed for long-term professional success. It is important to create a community and a culture among the students that supports their long-term goals and helps students stay on track.

Second, as early college schools, STEM-PCC schools are not creating a college-going culture as much as an in-college culture. STEM-PCC students must feel that they are in college as soon as ninth grade starts, even though they are still developing the full range of skills and abilities that college will require. This will contribute to a school culture of high expectations, and will help students internalize the goals of the school. Taking college courses will begin building high school students' identities as college students early, and success in these courses can be a strong motivator for students, and can make the goal of an AAS degree feel more realistic and attainable.

5. Creating an Integrated Workplace Experience

Preparing students for 21st century careers requires providing them with meaningful workplace experiences throughout their time at a STEM-PCC school. Workplace skills and values should be embedded within the culture of a STEM-PCC school, as they will most likely be at the center of student and teacher collaborations with industry partners.

Workplace learning is a central strand of student learning, along with reading, mathematics, and technology courses. A Workplace Learning Coordinator embedded at the school and responsible for overseeing the workplace learning strand—including the workplace learning curriculum, mentoring, workplace visits and internships—is critical to ensuring that this is an equal aspect of the school, along with other academic areas.

Students regularly work with industry professionals through online mentoring, workplace visits, and projects based on workplace standards outside the school walls. Teachers also have professional development opportunities in industry-related content areas. The sum of these experiences should build a clear pathway to 21st century workplace competencies and the industry-specific technical skills that students will need to succeed in their future careers. In addition, a six-year program for a 14- or 15-year-old can seem like an eternity. A dynamic and focused workplace learning program can help students see the big picture as they engage in a rigorous and demanding academic program.

Ninth-Grade College Students at P-TECH

Even while recruiting the students as eighth graders, P-TECH's principal and teachers consistently tell the students that when they enter the building on day one of ninth grade, they will be entering college. The decision to enter P-TECH is the decision to choose college. In all the ninth-grade classes, the teachers let the students know that they are preparing to take on college-level work by the following year, and that they will be expected to develop the maturity to comport themselves as college men and women.

P-TECH students are proud that they have committed to the ambitious goal of getting an AAS degree, already view themselves as college students, and are sensitive about this distinction. In focus groups, a group of ninth grade P-TECH students spoke about attending a seminar on selecting a college at a local university. None of the students felt the seminar was relevant to them because they were not selecting a college — they were already in college. Even the P-TECH students who planned to obtain a bachelors or masters degree were more interested in learning about how to survive and thrive at City Tech than about selecting a future college.

Skills Mapping

The goal of skills mapping is to ensure that all partners of the STEM-PCC school are developing students with the credentials, technical knowledge and clear understanding of workplace expectations needed for real jobs that keep employers productive and competitive.

Skills mapping is an essential component to the STEM-PCC model because it is directly informed by actual job requirements. This complex process involves identifying foundational workplace competencies and technical skills in key job growth areas for candidates with an AAS degree. After these skills are identified, they serve as the focal points of the workplace learning course sequence, and also guide decisions about choosing the best curricula for students and teachers. Skills also must be verified and updated on an annual basis as job requirements evolve.

The skills mapping framework presents a complete range of career options to students, helps them discover their interests and passions, and empowers them to choose the educational pathway that can lead to success in high school, college and in their chosen career. These pathways also provide opportunities for local business and industry to interact with STEM-PCC programs through internships, externships, and work-based learning.

For corporate partners:

Work with human resources or other appropriate teams to identify available jobs and projected future jobs for candidates with an AAS degree, and identify the foundational technical skills and workplace competencies for each job role.

Confirm these skills with steering committee and other industry partners.

Verify and update skills on an annual basis to ensure that they reflect changing job requirements.

For all:

Once the school has identified the AAS degrees it will award, order each skill by its level of complexity in a scope and sequence.

Determine which technical skills naturally align to existing college course offerings, and which ones need additional curricular resources.

Align workplace competencies with 21st century skills curriculum provider, such as the Ford Partnership for Advanced Studies.

Work with teachers on an ongoing basis to create projects and workplace experiences that reinforce each skill.

Workplace Learning Curriculum

As the world of work has shifted, most skilled employment now requires a foundation of academic and 21st century knowledge and skills (critical thinking, problem-solving, communication, teamwork, creativity, and global awareness) that must be mastered in high school. This is in addition to education beyond high school, with community college technical programs emerging to fill an important part of the employment preparation spectrum. The skills map can help schools design a curriculum to meet these new challenges. In addition to the academic scope and sequence, the skills map provides the framework for the workplace learning course sequence and school-wide interdisciplinary projects.

An integrated, workplace-readiness curriculum taps into students' personal career interests while bringing teachers together for interdisciplinary collaboration. The combination of rigor and relevance engages all students in meaningful learning that is connected to their own lives and usable in the real world. The workplace learning curriculum enables students to relate what they are learning in school to postsecondary education, productive careers, and active citizenship.

Students acquire knowledge and skills as they work in teams to investigate significant issues, carry out long-term projects, and create projects that demonstrate their learning. This approach answers the questions that traditional academic programs fail to answer for many students: Why am I learning this, and how does it prepare me for the future?

To implement the workplace learning curriculum successfully, teachers should use strategies that encourage problem-solving, teamwork, communication, and creativity. Research shows that the following approaches to instruction help students exceed core academic benchmarks, succeed in college, and meet employers' workplace expectations.

Academically Rigorous: Teachers facilitate learning of essential knowledge, skills, and ways of thinking specific to the core academic disciplines, meeting state and national academic standards and college-readiness expectations.

Integration of Academic and Career-Related Knowledge and Skills: Teachers help students to develop career-related knowledge and skills in the context of academic courses and also to learn and apply academic knowledge and skills in the context of career-related courses.

Inquiry-Based: Teachers organize learning around the investigation of significant issues and problems. They structure these investigations, often through hands-on learning experiences, so that students acquire knowledge, skills, and understanding.

Project-Based: Teachers guide students in carrying out in-depth, long-term projects which culminate in presentations of students' investigations and results.

Real-World: Teachers use real-world situations—such as business and engineering challenges—to build academic knowledge and develop problem-solving, teamwork, and communication skills. Students have opportunities to interact with professionals in careers of interest to them, and venture into businesses, college campuses, and the communities as part of their learning.

Performance-based: As students apply the knowledge and skills they acquire through the curriculum's learning experiences, teachers use a variety of tools to assess students' progress toward meeting learning goals correlated with academic and, where appropriate, career technical education (CTE) standards.

Workplace Learning Curriculum at P-TECH

The first iteration of the introductory workplace learning curriculum at P-TECH draws from several project-based modules that link classroom learning with the challenges students will face in postsecondary education and in the workplace of the future. The course integrates academically rigorous, standards-based content with realistic applications in the workplace. The modules were adapted from the Ford Partnership for Advanced Studies (fordpas.org).

The course is designed to introduce students to the vast world of technology and the workforce. Each of the modules in this course builds a foundation on 21st century skills while investigating the world of work — past, present, and future.

The class allows students to explore various career pathways in technology and map them to the skills and education needed for each role. It emphasizes core workplace values — including problem-solving, accountability, collaboration, and communication — through various projects, interviews, and worksite tours at IBM research and manufacturing sites. Real-world learning opportunities and teamwork are essential components of this course.

The course is augmented by MentorPlace, a primarily online program in which each P-TECH student is matched with a professional mentor from IBM. The mentoring curriculum has been mapped to what students are learning in their workplace learning course, providing students with real-world insight and guidance.

Technology-Rich: Teachers engage students in using technology and media tools to conduct research, organize and analyze data, simulate complex systems, and communicate ideas. Students master a variety of technology and media tools and make good choices about their use.

Career-Relevant: Teachers and school staff structure learning so students are exposed to a broad range of career paths, become aware of the knowledge and skills required to succeed in a variety of careers, and know which education and training are required for entry-level and more advanced positions.[1]

All of these efforts require a culture of shared accountability and investment, in which all stakeholders—students, teachers, administrators, families, and business and community partners—work collaboratively to address student needs, participate in collecting and reviewing data to measure progress, and maintain a commitment to continual improvement.

Workplace Experiences and Internships

Each workplace experience should be designed to supplement the workplace learning course and provide additional opportunities for students to engage with industry professionals to further develop workplace competencies.

Workplace Visits at P-TECH

In the first year, IBM organized a series of in-depth site visits designed to inspire P-TECH students and introduce them to actual places where they might work upon graduation. Visits were aligned with the workplace learning curriculum and provided hands-on opportunities for students to use their developing workplace competencies and see technical skills in a real-world context. For example, in one workplace learning module, students learned about the process of bringing inventions to market by studying product design, development, planning, and manufacturing processes. At the end of the module, the entire school visited two of IBM's state-of-the-art research facilities in New York — the Industry Solutions Lab and the Thomas J. Watson Research Lab. At these sites, students saw demonstrations of a range of innovative technologies. They also learned about the roles engineers play in the design and development of technologies that are helping to improve the world.

IBM and industry coalition members will also provide credit-bearing internships beginning in year four. Through these internships, students will work on projects related to their AAS degree. These will be substantive engagements designed to provide real contributions to the company. Student interns will be evaluated on their performance based on work-place standards.

Mentoring

Mentoring is a vital component of student life in a STEM-PCC program. Each student should be matched in a one-to-one relationship with an industry professional who will provide an added measure of academic and career support.

Mentoring can take place online or in-person, but should consist of regular interactions and tied to student learning. Weekly interactions are recommended since it helps build mentor-student relationships and ensure that the program is core to student learning. A specific mentoring curriculum also should be developed by industry and school partners to ensure that the communication between the students and mentors is relevant to what the students are learning in the classroom.

1 Ford Partnership for Advanced Studies

Mentor Recruitment

Mentors will not need to have expertise in specific fields during the first year when workplace learning will be focused on 21st century skills. Rather, businesses can recruit mentors from all areas of the company, as long as those mentors are prepared to offer meaningful input and guidance to students. Businesses may want to consider recruiting mentors based on gender, which can help foster more enriching relationships between mentor and student. As the school matures and student needs change, the mentor recruitment process can be amended.

Security

Security in the K-12 environment is critical. Partnerships should ensure that they follow all legal requirements of both the school district and the businesses providing mentors. From the school district, this might include comprehensive mentor background checks, while businesses and schools may require parent permission forms in order for students to participate. Businesses also may wish to have their own guidelines for mentors.

Staff Requirements

Partnerships should designate at least two staff people to manage the mentoring program—one from the corporate partner and the other from the school—to ensure successful implementation. Together, this team will manage student data, make sure that all students and mentors communicate every week, work to ensure that online activities are implemented effectively, and help to coordinate any additional activities. This work will multiply as the school adds grades in subsequent years.

Mentoring at P-TECH:

Mentoring at P-TECH is based on IBM MentorPlace, a corporate volunteer program that matches IBM employees with students in relationships focused on academic activities. Through the program, IBM employees provide students with online academic assistance and career counseling with structured face-to-face opportunities throughout the school year.

IBM recruited volunteers from a range of areas within the company, including those where P-TECH graduates could potentially work. They included Software Group, Systems & Technology Group, Global Business Services, Research, Legal, Human Resources, and Corporate Citizenship & Corporate Affairs.

P-TECH Mentors are required to:

- Participate in at least two face-to-face opportunities (kick-off and end-of-year);
- Communicate with their student protégé every week over the course of the program (time commitment is approximately 30 minutes per week);
- Participate in training; and
- Follow all safety and security procedures.

Curriculum

IBM worked with P-TECH teachers to develop the mentoring curriculum to guide student and mentor interactions. The weekly online activities correspond to key workplace competencies such as leadership, teamwork, problem-solving, communication and ethics. The mentoring curriculum also includes homework, coursework, and long-term projects. The key is ensuring that all activities are meaningful and can be completed successfully in an online environment in a specified period of time. The activities were developed in the summer prior to the start of school.

Training

All program managers, mentors, teachers and students receive training before they can begin the program. Training covers such topics as roles and responsibilities, program rules, helpful hints for participation, and how and when the communications will take place.

6. Building a Strong and Collaborative Teaching Faculty

Nothing is more important to the success of a school than having effective teachers. Research shows that individual teachers are the most important school-related factor in student achievement gains, but that effectiveness varies greatly. Hiring, retaining, and supporting the best teachers possible is important for any school, but particularly for a new school that needs a strong faculty to develop the learning environment, implement a complex curriculum, and help create the right school culture and academic expectations.

A. Selecting the Teaching Staff

Creating a culture of high expectations for students starts with carefully selecting the teaching faculty. The school principal should select teachers who have a demonstrated commitment to the STEM-PCC model's goals, and who have prior experience with the school's pedagogical paradigm. It is also essential that the teachers have experience working with the expected population of students, and have a passion for working with struggling learners. It may also be beneficial to hire teachers who have connections to the targeted technology industries and who have geographic, cultural, and/or linguistic commonalities with the students. Ideally at least some of these teachers should participate in the planning process for the school.

Selecting the faculty begins with writing the job descriptions and posting them aligned with the school district's hiring process. The principal should work with the partners and the district lead to craft language that attracts innovative candidates who and are willing to work a little harder than in a typical teaching position. A rubric for judging resumes and interviews should be developed and agreed on by the partners—all of whom should be involved in the interview process.

Teacher Recruitment and Selection at P-TECH

P-TECH's principal held an open house for prospective teachers soon after the teacher positions were posted by the New York City Department of Education. All of the partners spoke at the event and provided information about the school's vision and what would be expected of school staff. There were small-group discussions by content area, and opportunities for the potential applicants to ask questions.

Hiring was done within the guidelines and structures provided by the district-union. The principal convened an interview committee that included representation from all of the partners and the union. The interview committee sought to hire teachers with a pedagogical perspective compatible with the P-TECH vision, and who had prior experience with new schools, early college programs, and mastery learning. Job candidates were asked to bring a portfolio of lesson plans, to explain their teaching philosophy, and to detail their experience with inquiry learning.

Six key criteria should guide teacher selection:

> ***Supporting College Readiness and/or Workforce Readiness:*** Demonstrates exceptional skill at developing curricula and instructional practice aligned to college and career readiness. Has experience working with college and industry partners. Discusses artifacts with confidence, and shows a clear connection to post-secondary readiness.
>
> ***Expertise in Area of Specialization:*** Demonstrates a high level of commitment to his or her content area, and shows evidence of significant professional growth in his or her subject at the high school level.

Commitment to Serving in an Advisor Role: Has served as a high school advisor (or in a similar role) and has worked as an advocate for a group of students as the primary contact for students' families. Has aided in the development of college prep and course plans, and has acted as a guide for students.

Evidence of Skill in Supporting Struggling Learners: Demonstrates a vast commitment to working directly with struggling learners in multiple ways in and out of the classroom. Shows evidence of having used classroom data to inform instruction of struggling learners. Shows use of formative assessment tools and effective re-teaching methods to promote mastery for struggling learners.

Use of Technology to Differentiate Instruction: Has experience—and/or a willingness to learn—to fully integrate state-of-the-art technology into all curricular areas and all aspects of classroom management. Has used technology to create differentiated instructional pathways for students (i.e., blended learning), including the maintenance of online course-related resources and collaboration tools.

Evidence of Collaboration: Shows strong experience working collaboratively with other teachers, college faculty, and/or other partners. Demonstrates ability to work with teachers across content areas in instructional teams. Has experience leading and serving on committees and/or leading activities to enrich, enhance and facilitate the academic and social goals of the school.

There may be less ability to select the college faculty, but there is still a desired profile. College faculty must be committed to the goals of a STEM-PCC school and believe that all students can succeed. They should also have experience using project-based and student-centered teaching models, and experience teaching adolescents. If it is not possible to find college faculty who meet these last two criteria, the STEM-PCC school should provide training and support to the college faculty. The college faculty should also have experience in and/or knowledge of current expectations in the targeted work fields. Even though college faculty will have a better sense of the job expectations, it is often hard for college faculty to stay current in the fast changing technical fields. Industry partners can play a key role by keeping the college partners up-to-date on changes in the work environment.

B. Supporting High Levels of Collaboration

In a school with such high expectations and an intense academic schedule, teachers must work closely to coordinate expectations for students and ensure that the program is rigorous, but manageable. A high level of teacher collaboration is needed to design and refine the curriculum and ensure that each activity or class supports and reinforces the others. Expectations for students must be consistent across subjects and with individual teachers so that students understand the rituals and routines of the school and know that their teachers are all on the same page. Additionally, teachers need time to discuss individual student problems and devise support strategies together as a community.
Time must be built into the daily schedule—and provided prior to the opening of the school—for teachers to organize the various types of work they must do together.

High school teachers and college faculty also need opportunities for collaboration. College faculty should be part of the curriculum design process. They will need opportunities to meet with the high school faculty prior to the opening of the school and throughout the school year. Each group of educators has different sets of expertise that can benefit the collective group. For example, while the college faculty may have more extensive content knowledge and familiarity with the skills incoming college students need, the high school teachers may have more experience working with adolescents and in designing student-centered lessons. Faculty meetings across the college and high school environments can help keep course expectations aligned and provide opportunities for faculty to work on content issues. These meetings will also provide a forum for educators to discuss issues concerning teaching adolescents or individual student problems.

The central focus of the time teachers spend collaborating with one another is on designing curricula and selecting resources. In designing the curriculum, teachers must look vertically across subject areas and horizontally across years. Teachers need to incorporate the core standards into lessons and create interdisciplinary lessons with components that cross subject areas. The faculty must agree on how teachers across subjects can convey similar skills in the same way so that students learn to recognize common concepts as they move among classes.

Faculty Collaboration at P-TECH

Educators at P-TECH are an intensely collaborative team and have many opportunities to work together.

Shortly after all of the teachers were hired, a faculty retreat was held to give them an opportunity to get to know one another and build the team culture. The retreat included college faculty and IBM staff, and established the foundation for the various partners to work together. Teachers also met three times a week over the summer to plan the curriculum. City Tech faculty participated, and planning occurred both within and across content areas.

During the school year, all teachers have a 45- minute common planning period each day. The focus of this planning time is different each day to accommodate all of their collaboration needs. For example, the teachers meet in inquiry teams one day, department teams another day, and in workplace learning teams on a third day. The teachers' schedule is blocked for these 45 minutes during the school day to support this ongoing collaboration.

College professors must work with high school teachers to help them prepare their students to meet college requirements. This also means that content and terminology should be consistent across high school and college courses. It is important to have the high school and the college faculty in each subject area collaborate on the design of the courses so that complexity builds over time and each course lays the groundwork for the next.

For the school leader and higher education partner:

How will you lay the foundation for professional collaboration among staff? What opportunities for teachers to work together will be provided prior to the opening of school? How will college faculty be involved? What will be the focus of this work?

What opportunities will be provided for professional collaboration on an ongoing basis during the school year? How will this time be structured?

C. Providing High-Quality, Targeted Professional Development

High quality professional development is essential to increasing educator effectiveness and improving outcomes for students. All successful schools are focused on continuous improvement and provide meaningful, job-embedded professional learning experiences that are grounded in students' needs. However, STEM-PCC schools have unique professional learning needs that should be addressed beyond those of other new schools. High school and college instructors need industry-based professional learning opportunities to prepare them to teach workplace learning skills and integrate real-world problems into coursework. There are various ways these learning opportunities might be designed. The school's industry partner may choose to provide mentors for the teaching faculty to work with them in an ongoing way, or they might design an on-site visit for the faculty. College faculty may also need professional development to provide pedagogical support for teaching high school students.

For all the partners:

How will professional learning experiences be designed? What data will be used to identify learning needs? What theory of adult learning will inform the design?

What role will industry play in professional development? How will high school and college faculty gain insight into the workplace their students are pursuing?

What other significant professional development needs does the high school and college faculty have? How will they be addressed?

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7. Fostering Family and Community Engagement

Research shows that parents are key influences on student academic success and on college matriculation and retention. STEM-PCC families will need significant support and guidance on how to help their children and keep them engaged on the challenging path they have chosen. Just as there is a scope and sequence for students that identifies the timing and sequence for what students need to learn, parents also have different learning needs throughout the course of the STEM-PCC experience. It is important to identify what messages, information, and support parents will need prior to the start of the program and in each year of coursework, and to develop a plan for addressing these needs.

A. Focusing on Families Throughout the Student Recruitment Process

School open houses, recruitment meetings, and orientation nights are key opportunities to begin educating parents about how they can help their students succeed. Messaging at these events should be designed to target parents as much as students. These events are opportunities to inform parents about the many benefits the school will provide to students, and also to let them know what will be expected of them as a family. Parents need to understand up front that the demands of this program require high levels of parental support to help their children succeed. This does not mean that parents need to understand the content of their children's courses, but they do need to encourage and support their children and give them time to study. For example, parents will need to keep up with their children's homework, avoid taking their children out of school for long periods of time, and allow and encourage their children to come to weekend and summer activities.

B. Creating a Parents' Academy to Build and Sustain Family Engagement

Creating a Parents' Academy is one tactic for providing ongoing support to parents and keeping them engaged in helping their students through the STEM-PCC program. Parents will benefit from a series of classes that address their needs at appropriate points in the program. Topics might include computer literacy, learning to use office productivity software, college finance, and helping students through the college application process.

P-TECH Parent Academy

P-TECH is offering a series of workshops to get parents involved in the program and to help get them into the school on a regular basis. Parents are surveyed early in the year about their interest on a number of topics. The topics range from developing skills for the parents — such as computer skills and CPR — to broader discussions on topics such as financial literacy, healthy living, and human rights.

8. Using Resources Purposefully

Because of the challenging goals that a STEM-PCC school sets for itself, it is important that all resources be wisely used to move towards the end goal. This guide reviews three areas: space, time, and technology.

A. Using the Building Space to Support School Culture

Designing and outfitting space is also important to creating a school culture. Overtime, as the school's population grows with each new class, students will begin to fill the entire school, but the STEM-PCC school needs to fill the entire space with its culture from the very beginning. The footprint for the school needs to be coherent and manageable, so that students and staff feel the boundaries of "their school". This is especially important if the STEM-PCC school is sharing the building with other schools. The space also should reflect the values, goals and work of the STEM-PCC school as well. This can be challenging for a new school that does not yet have a history, but it is important that the students feel part of something. The STEM-PCC school needs to have a name and a logo, along with signs and posters identifying the school and welcoming students and visitors so that the students know they are part of a community that has a distinct presence.

Creating a visual sense of the school's identity can be done with images recognizing the school's corporate and university partners, perhaps with bulletin boards or display cases that reflect the work of those partners (i.e., pictures of student life on the college campus or displays about the industrial fields the school targets). These displays can be replaced as the students generate their own work and honors. The school can even consider adopting an aesthetic that resembles the workplace.

B. Managing Time

Schools are always short on time, but STEM-PCC schools are particularly challenged in this area in their effort to graduate all students with an AAS degree in six years. Some of these challenges include the volume of content that students are expected to master, workplace learning experiences that may require travel and time at worksites, students who enter the school below grade level, and travel time between campuses and worksites.

P-TECH's school year and school day

P-TECH has an extended school day (8:15am to 4:30pm) with afterschool activities until 6 p.m. that students are strongly encouraged to attend. In its first year, P-TECH has an extended calendar and is planning to offer weekend and summer programs. The Principal also wants to run sessions over the winter break.

Within the school day, all ninth grade P-TECH classes are double blocks to provide sufficient time for teachers to work with students on the basic building areas of math and English. Additionally, the teachers and students are blocked together so that the same math and English Language Arts teachers work with the same students.

A STEM-PCC school clearly must provide as much dedicated learning time as possible. One strategy that helps maximize time is tightly focusing the scope and sequence on core courses to reduce the amount of time on other topics. (This is discussed in detail in the curriculum section.) Other strategies to add learning time include lengthening the school day with an early start or late finish, extending the school year, and offering weekend programs and summer courses.

In addition to expanding the number of hours available for learning, block scheduling can also help STEM-PCC schools use available teaching time more efficiently. Block scheduling allows teachers and students to more deeply engage with the material during each class, and provides greater flexibility for different pedagogical approaches. Focusing the scope and sequence on core courses may make it feasible to block more courses.

C. Using Technology to Enrich and Extend Learning

Having a strong technology infrastructure is important for any STEM-PCC school. A STEM-PCC school should offer one-to-one environments and technology-enabled classrooms. The schools may need advanced or specialized technology resources—such as a nanotechnology lab or robotic workcells—depending on the specific AAS programs that students will be pursuing.

However, creating a technology-rich learning environment entails more than providing laptops and interactive whiteboards. The school needs to have a virtual environment that supports students and teachers by providing access to everything from learning resources to administrative tools, data, social networks, and communications tools to support lesson planning, curricular resources, and a parent community.

STEM-PCC schools should use technology to support and deepen blended classroom instruction, to personalize learning, and to bring the students, teachers, parents and the community into a virtual community of learning. While the capabilities are clearly dependent upon the sophistication of such an environment, a virtual learning environment can give students access to a wide range of resources that can support their schoolwork, or it can be used for self-study and practice. By supporting communication and social networking among the students, a virtual learning community can help create a positive peer community to support the students through this challenging program.

Teachers can use this environment as a way to communicate with their classes or with individual students, posting homework and other resources. They also can communicate with other teachers, sharing strategies and other information, or for more formal kinds of professional learning.

Additionally, a virtual community can give busy parents unique insight into their children's learning by enabling them to view school events calendars, homework assignments, tests, and even information on how their child is progressing. Finally, the virtual environment can include the college and workplace mentors so that the students can feel part of a broader STEM community that will also support their success.

P-TECH's Technology Infrastructure

P-TECH established a web presence (the domain ptechnyc.org) and a Facebook page (http://www.facebook.com/PathwaysInTech) even before the doors opened. This public facing virtual presence was ready when students began receiving their acceptance letters. Students and parents began posting to the Facebook page as soon as they were accepted, building a sense of community among the students even before the first day of school.

P-TECH has a 1-to-1 laptop ratio, and Smartboards are in every classroom. Students have access to computer-based study aids in English and math to help them to prepare for the Regents tests and to improve their basic math and language skills.

P-TECH teachers are using a curriculum design platform to collaborate with the college faculty to create and upload the curriculum. Through P-TECH's participation in iLearn, teachers also are incorporating more and more blended learning techniques into their classroom instruction.

IBM is designing a technology solution to fill an education gap at the school as identified by the principal, teachers and staff.

Sustainability

A particular challenge for a STEM-PCC school is to develop a sustainable, self-supporting model.

Maintaining funding and retaining good teachers are concerns for any school, but there are aspects of a STEM-PCC school that may require additional planning. Three areas stand out: corporate partnerships, funding models, and policy challenges.

Cultivating Corporate Partners

Workplace learning and corporate partnerships are defining features of a STEM-PCC school, and will need to be maintained. A STEM-PCC school should have a lead corporate partner that is part of the steering committee. But the school also will need to have a broader network of corporate partners to sustain a strong workplace learning component. No single company can provide a sufficient number of internships, mentors, worksite visits, or guest speakers to support the school once all six grades are populated. Additional corporate partners will not need to make the same level of commitment as the lead partner, but they will be essential to the long-term success of the school.

Ultimately, workplace learning must emanate from the school itself—with the school designating a long-term coordinator who will coordinate the varied contributions from a range of engaged businesses. This person should be in place beginning in year two, when the school's needs will multiply significantly with the addition of another grade. However, the corporate partner will continue to play a significant role in the school's development and programming.

For all partners:

What are the different types of corporate support the school requires for workplace learning?

Can companies pick and chose what types of support they will provide?

What companies might be able to provide needed support — keeping in mind that companies in various fields may offer careers in your target degree areas? For example, financial institutions may have teams of programmers and applications designers.

How will other companies be recognized or branded so that they feel valued?

How will workplace learning initiatives be embedded in the school over the long-term? Who at the school will manage the overall program?

Funding

Funding is a complex issue for new schools. In addition to general operating costs of any school, there are additional costs that need to be considered when a school is new. There are new school start-up costs involved in modifying and readying a new building, and equipping a new school. There are also planning-year costs that need to be considered before the steering committee can even think about a building. Also, there may be more costly professional development needs if the school is implementing a new educational model that requires special training—such as workplace internships for teachers, or creating new curriculum.

Even once the school is through its start up phase, a STEM-PCC school may have additional costs when compared to a standard school, and the base level funding model for schools in the district may not be enough to support all of its programs and activities. The school should take advantage of any available funding, whether at the federal, state or local level. For example, if the STEM-PCC school is housed in an institution that was identified as a turnaround school, it would be eligible to receive federal School Improvement Grant (SIG) funds. These grants are made to State Educational Agencies that use the funds to "provide adequate resources in order to raise substantially the achievement of students in their lowest-performing schools."

The available revenue streams can be quite varied, and range from city, state, and federal programs, to corporate or foundation funding opportunities and support from local organizations. It will be important for the steering committee to have members who are well versed in the different funding streams.

The school also may need to consider creative approaches to funding—such as braided funding models that use a diverse, but coordinated set of programs, and funding streams to provide resources to students. It will also be helpful to identify or hire a staff person with grant writing experience who can help pursue external funding opportunities.

For all partners:

What would the school need to do to receive funding as a career and technical education program?

Can components of workplace learning or other programmatic aspects be supported through grants for informal learning or afterschool programs (i.e., mentorships or design competition)?

Are scholarship funds available to support the college courses?

Policy Considerations

Its is crucial that the steering committee has a solid understanding of the policies overseeing K-12 schools and college as it designs and implements a STEM-PCC school. Because STEM-PCC schools must function within two larger institutional frameworks—state and local K-12 education policy, and university policies—they face unique policy questions and challenges. Specific issues will vary since each state and city has unique policies, but a number of common themes will emerge with STEM-PCC schools across the United States. Some of the challenges the Steering Committee may have to address include:

> ***Funding.*** How does a K-12 Local Education Agency fund an early college model? Will different funding streams be needed once students have met high school graduation requirements? Will schools receive state funds for students who have been in the school for more than four years, have met requirements, but have not "graduated"?
>
> ***Seat Time.*** If students move more quickly through their high school course work, or take college courses in place of high school courses, will this impact state and municipal requirements on seat time or hours of instruction? Will the STEM-PCC school need special waivers or other modifications?
>
> ***Labor Policies.*** What are implications for teacher contracts if the school day and school year are longer than the standard? What are the implications of classes being taught or co-taught by industry partners and university faculty?

Credit Accumulation. What does early college and credit accumulation mean for students who want to apply to a four-year postsecondary institution at the end of their fourth year of P-TECH? How will their unique situation affect access to scholarships and other opportunities for financial aid?

College Entrance Requirements. Do STEM-PCC students need to meet the same entrance requirements to take college courses? How will this be arranged?

Measures of Success

Discussing metrics can be a complex and difficult process, especially for a school that represents a partnership of diverse sectors (school districts, universities, corporations, parents) and has such ambitious goals.

All schools need to meet external accountability targets and success indicators. As it develops over time, a new school may need to address additional indicators and measures set by the Local Education Agency.

But a STEM-PCC school should also maintain its own set of progress indicators and measures of success. This will be essential to helping the school adjust its programming to meet the needs of its students and to evaluate its own success as it evolves and grows with each new cohort of students.

A STEM-PCC school is beholden to many different stakeholders (parents, government, corporate partners, the students), and the school will need to consider its own diverse set of factors and possible measures.

P-TECH's Metrics

P-TECH uses a number of different yardsticks to assess itself and adjust its course, as well as to comply with DOE and Federal expectations. P-TECH uses some of the metrics of success for its conversations with parents, and other measures that are relevant to DOE. Finally, P-TECH uses internal metrics to help it refine and build its program.

P-TECH uses different strategies to assess students' progress throughout the year, and to make changes when necessary. For example, the ninth grade P-TECH students take web-based benchmarking tests in reading and math every three months to assess progress. The school also tracks how many students pass the New York State Regents exams in January of their ninth grade. This helps the school know how many students will be able to start college courses by 10th grade, but it also allows the school to reposition students to get the support they need to pass the Regents by the June administration.

For all partners:

Is it important to track the number of students from target populations who enroll (i.e., girls, low performing students, students living in poverty, African-American or Latino students), or the number of students retained?

Are students meeting college entrance requirements in time to take college courses?

What are the relevant accountability measures for the local school district, the state and any Federal programs the school is involved with?

Even though they will not graduate from high school in their fourth year, is it important for all students to meet graduation requirements in four years? Are they on track to do so?

Do certain courses or projects serve as a gateway to more advanced or autonomous work? Are students on track to overcome those hurdles?

Regardless of the indicators that the school finally selects, it needs to plan how to collect and analyze the data and develop a process to report findings back to students, teachers, parents, local and state authorities, and other stakeholders.

Outreach / Media

All partners should consider how to effectively communicate the creation of the new STEM-PCC school to ensure that the general public — parents, teachers, members of the community — is aware of the school and the opportunities available for students.

Aside from internal communications that a school district may already engage in to inform parents, teachers, principals and staff about the new school, local education or technology beat reporters can be excellent resources to promote key messaging around the STEM-PCC school. Some opportunities for local media coverage include key events such as in-person mentoring opportunities or workplace visits, high school fairs where parents and students are invited to learn more about the school, and informational meetings for parents and students at the designated college partner site.

Because this is a fledgling model, media is key to ensuring its successful replication. Local, state and national media that publicize the school, its students and its outcomes can rally leaders in government, higher education and business to create similar schools in other areas of the country.

Conclusion

This guide has attempted to illuminate some of the crucial design decisions that the steering committee building the STEM-PCC school will have to address. However the actual process will not be as straightforward. We have tried to reflect on our own experiences and distill an often complex process to a few core lessons that explain the design principals as clearly and concisely as possible.

As you embark on your own process of building a STEM-PCC school that fits your partnerships' strengths, career fields and community needs, you will encounter your own unique challenges. In our process, the steering committee had many intense but rich conversations about how practical details can shape the culture, climate and success of a STEM-PCC school. But we all accepted that our goal was to get "consensus" to move forward and not "unanimity" on every underlying detail. We encourage you to be committed yet flexible—committed to the long-term objective of helping young people prepare for exciting new careers through a STEM-PCC model, yet flexible in the details of how to create the school.

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STEM Pathways to College and Careers Schools: Appendices

APPENDIX A

P-TECH Scope + Sequence

Steering Committee - 2/23/12

Pathways in Technology Early College High School (P-TECH 9-14)

Students will follow a scope and sequence of courses that provide an opportunity to earn a high school diploma within the typical four years or less, and the option to pursue an Applied Associate in Science (AAS) degree within a 4-6 year time frame. The actual sequence of courses that students follow varies according to a personalized pathway; three sample pathways are shown in this document. In all cases, students begin taking college-level courses with their high school cohort students as classmates, and these courses may be taught on the high school campus. The initial college courses may be stretched over an entire year, rather than just one semester, to give students more time to master the content and skills. As students master the introductory sequence of college courses, they may have opportunities to take courses on the CityTech college campus. The starred courses (*) carry college credit - and will count toward high school graduation requirements. The ® indicates that a Regents exam is associated with that course. In addition, all students pursue a pathway of workplace learning experiences leading to a career entry position in an IT field. Each student's pathway through the workplace is determined by their interests and mastery of prerequisite skills.

Scope + Sequence: Pathway 1

	Year 1 Fall	Year 1 Spring	Year 2 Fall	Year 2 Spring	Year 3 Fall	Year 3 Spring	Year 4 Fall	Year 4 Spring	Year 5 ** Fall and Spring	Year 6 ** Fall and Spring
English	ENGLISH 1 & 2	ENGLISH 3 &4 ®	EFFECTIVE SPEAKING SPE 1330		ENGLISH COMPOSITION I ENG1101	ENGLISH COMPOSITION II ENG 1121	Courses in selected major concentration			
Math	ALGEBRA 1 & 2 ®		ALGEBRA 2 / TRIG 1 & 2 ®		GEOMETRY 1 & 2 ®		PRECALCULUS MAT 1375		CALCULUS I MAT 1475&	
Science			LIVING ENVIRONMENT 1 AND 2 ®		CHEMISTRY 1 AND 2 ®		PHYSICS 1	PHYSICS 2 ®	PHYSICS 1.2 PHY 1433	
Social Studies			GLOBAL 1 - 4 ®		UNITED STATES HISTORY 1 - 2 ®		AMERICAN GOVERNMENT GOV 1101	MACRO ECONOMICS ECON 1101		
Tech	Intro to Computers (HS)	CST A	LOGIC & PROBLEM-SOLVING EMT1111	TECHNICAL GRAPHICS EMT 1120	CST B	CST C	Student Choice: PROGRAMMING FUNDAMENTALS - CST 1201 DIGITAL CONTROL - EMT 1250 WEB PROGRAMMING 1 - CST 2309			
Foreign Lang	[Online language choice^^]		Online language choice^^		Online language choice^^		Online language choice^^			
Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health		
Arts					Intro to Digital Music	MUSICAL CONCEPTS MS1201 LAP*~	Introduction to Technical Theater	HISTORY OF THEATRE THE1280 LAP*~		
Workplace Learning#	Intro to Information Technology Careers		Problem-Solving in the Workplace		Work Readiness for IT fields / Internship for credit (CST 4900)		Leadership in the Workplace / Internship for credit (CET 4980-81-82)		Co-op Experiences	Co-op Experiences
	Mentoring		Mentoring		Mentoring		Mentoring			
Intensives: Acceleration or Enrichment		Optional high school credits, PSAT Prep, site visits, etc - through extended day or summer		Optional high school credits, SAT Prep, job shadowing, etc - through extended day or summer		Optional college credits, SAT Subject Prep, internship, etc - through extended day or summer		Optional college credits, internship - through extended day or summer	Remaining credits completed at City Tech	Remaining credits completed at City Tech
	HS Credits 17.2		HS Credits 19.2		HS Credits 19.2		HS Credits 19.2		College Credits	College Credits
	College Credits 2		College Credits 5		College Credits 13-16		College Credits 16-20			

Total HS Credits	74.8
Total College Credits	40 (Years 1-4)

*CST A, B & C is a tripartite course, combining CST 1100 and 1101 (total 6cr)

~Students may choose either MS1201 OR THE1280, but not both

^^ Foreign language requirements met through independent online courses

Students can earn an Advanced Regents Diploma using the technology sequence in lieu of foreign language regents sequence.

Workplace learning includes mentorships

** specific courses TBD based on departmental technology pathway being pursued at CityTech

APPENDIX A

P-TECH Scope + Sequence

Steering Committee, 2/23/12

Scope + Sequence: Pathway 2

	Year 1 Fall	Year 1 Spring	Year 2 Fall	Year 2 Spring	Year 3 Fall	Year 3 Spring	Year 4 Fall	Year 4 Spring	Year 5 ** Fall and Spring	Year 6 ** Fall and Spring
English	ENGLISH 1 & 2	ENGLISH 3 &4 ®	EFFECTIVE SPEAKING SPE 1330*		ENGLISH COMPOSITION I ENG1101*	ENGLISH COMPOSITION II ENG 1121*	Courses in selected major concentration			
Math	ALGEBRA 2 / TRIG 1 & 2 ®		GEOMETRY 1 & 2 ®		PRECALCULUS MAT 1375*	CALCULUS I MAT 1475*&				
Science			LIVING ENVIRONMENT 1 AND 2 ®		CHEMISTRY 1 AND 2 ®		PHYSICS 1.2 PHY 1433*	PHYSICS 2.2 PHY 1434*&		
Social Studies			GLOBAL 1 - 4 ®		UNITED STATES HISTORY 1 - 2 ®		AMERICAN GOVERNMENT GOV 1101*	MACRO ECONOMICS ECON 1101*		
Tech	Intro to Computers (HS)	CST A	LOGIC & PROBLEM-SOLVING EMT1111	TECHNICAL GRAPHICS EMT 1120	CST B	CST C	Student Choice: PROGRAMMING FUNDAMENTALS - CST 1201 DIGITAL CONTROL - EMT 1250 WEB PROGRAMMING 1 - CST 2309			
Foreign Lang	Online language choice^^		Online language choice^^		Online language choice^^		Online language choice^^			
Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health		
Arts					Introduction to Digital Music	MUSICAL CONCEPTS MS1201 LAP*~	Introduction to Technical Theater	HISTORY OF THEATRE THE1280 LAP*~		
Wrkplce Lrng#	Intro to Information Technology Careers		Problem-Solving in the Workplace		Work Readiness for IT fields / Internship for credit (CST 4900)		Leadership in the Workplace / Internship for credit (CET 4980-81-82)		Co-op Experiences	Co-op Experiences
	Mentoring		Mentoring		Mentoring		Mentoring			
Intensives: Acceleration or Enrichment		Optional high school credits, PSAT Prep, site visits, etc - through extended day or summer		Optional high school credits, SAT Prep, job shadowing, etc - through extended day or summer		Optional college credits, SAT Subject Prep, internship, etc - through extended day or summer		Optional college credits, internship - through extended day or summer	Remaining credits completed at City Tech	Remaining credits completed at City Tech
	HS Credits	17.2	HS Credits	19.2	HS Credits	19.2	HS Credits	19.2	College Credits	College Credits
	College Credits	2	College Credits	5	College Credits	21-24	College Credits	20-24		

Total HS Credits	74.8
Total College Credits	51 (Years 1-4)

*CST A, B & C is a tripartite course, combining CST 1100 and 1101 (total 6cr)

~ Students may choose either MS1201 OR THE1280, but not both

& PHY2.2 and Calculus are only required for EMT majors

^^ Foreign language requirements met through independent online courses

Students can earn an Advanced Regents Diploma using the technology sequence in lieu

Workplace learning includes mentorships

** specific courses TBD based on departmental technology pathway being pursued at CityTech

APPENDIX A

Scope and Sequence - Pathway 3

	Year 1		Year 2		Year 3		Year 4		Year 5 **		Year 6 **	
	Fall	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**
English	English 1	English 2	English 3	English 4	English 5	English 6 ®	ENGLISH COMPOSITION I ENG 1101		ENGLISH COMP II ENG 1121	Effective Speaking SPE 1330		
Math	Intensified Algebra		ALGEBRA 1 & 2 ®		GEOMETRY 1 & 2 ®		ALGEBRA 2 / TRIG 1 & 2 ®		PRECALCULUS MAT 1375			
Science			LIVING ENVIRONMENT 1 of 3	LIVING ENVIRONMENT 2 of 3	LIVING ENVIRON 3 of 3	CHEMISTRY 1 of 3	CHEMISTRY 2 of 3	CHEM 3 of 3	PHYSICS 1	PHYSICS 2 ®	PHY 1433	
Social Studies			GLOBAL 1 - 4		GLOBAL REVIEW ®	U.S. HISTORY 1	U.S. HISTORY 2	U.S. HIST REVIEW ®	AMERICAN GOV 1101		MACRO ECON 1101	
Tech	Intro to Computers (HS)	CST A	LOGIC & PROBLEM-SOLVING EMT1111	TECHNICAL GRAPHICS EMT 1120	CST B	CST C	Student Choice: PROGRAMMING FUNDAMENTALS - CST 1201 DIGITAL CONTROL - EMT 1250 WEB PROGRAMMING 1 - CST 2309		Courses in student's major concentration		Courses in student's major concentration	
Foreign Lang	[Online language choice^^]		Online language choice^^		Online language choice^^		Online language choice^^					
Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health	PE/Health				
Arts					Intro to Digital Music	MUSICAL CONCEPTS MS1201 LAP~	Introduction to Technical Theater	HISTORY OF THEATRE THE1280 LAP~				
Wrkplce Lrng#	Intro to Information Technology Careers		Problem-Solving in the Workplace		Work Readiness for IT fields / Internship for credit (CST 4900)		Leadership in the Workplace / Internship for credit (CET 4980-81-82)		Co-op Experiences		Co-op Experiences	
	Mentoring		Mentoring		Mentoring		Mentoring					
Intensives: Acceleration or Enrichment		Optional high school credits, PSAT Prep, site visits, etc - through extended day or summer		Optional high school credits, SAT Prep, job shadowing, etc - through extended day or summer		Optional college credits, SAT Subject Prep, internship, etc - through extended day or summer		Optional college credits, internship - through extended day or summer			Remaining credits completed at City Tech	
	HS Credits	17.2	HS Credits	19.2	HS Credits	19.2	HS Credits	19.2	HS Credits			
	College Credits	3	College Credits	2	College Credits	7-10	College Credits	9-12	College Credits	18	College Credits 7	

Total HS Credits	74.8
Total College Credits	24 (Years 1-4)

*CST A, B & C is a tripartite course, combining CST 1100 and 1101 (total 6cr)

~Students may choose either MS1201 OR THE1280, but not both

^^ Foreign language requirements met through independent online courses

Students can earn an Advanced Regents Diploma using the technology sequence in lieu of foreign language regents sequence.

Workplace learning includes mentorships

** specific courses TBD based on departmental technology pathway being pursued at CityTech

APPENDIX B

Coursework at P-TECH

Year 1-June 3, 2011

Year 1		Course Work
Scheduling for success What project can the faculty at City Tech and industry partners at IBM design for year 1? The curricula for year 1 will be designed in such that all courses have time to work on specific components of the project. Additionally, there should be connections from course to course for each module. Industry and college mentors should have a regular presence in the modules. The modules are built so that each class individually is 45 minutes. There will be double blocks of English, Math, Technology, and Workplace Learning daily. **Daily Schedule** 2 English 2 Math 2 Technology 2 Workplace Learning Lunch Physical Education	Module 1-23 days–September 7-October 13 (3 Holidays-5 Saturdays) Module 2-23 days-October 14-November 16 (2 Holidays-5 Saturdays) Module 3-23 days-November 17-December 21 (2 Holidays-4 Saturdays (Thanksgiving Saturday not counted) Holiday Break-December 22-January 2 Module 4-23 days-January 3-February 3 (2 Holidays-4 Saturdays) Intersession 1 February 6-17 (10 Days and 1 Saturday, February 18 not counted) Intensives/Enrichment/ College or Career Focus Winter Break February 20-24 Module 5-29 days-February 27-April 5 (No Holidays and 5 Saturdays) Spring Break April 6-13 Module 6-42 days-April 16-June 12 (2 Holidays and 8 Saturdays) Regents June 13-20 Intersession 2 June 21-June 27 (5 days and 1 Saturday) Module 7-25 days July 9-August 10 Regents August 13-17 (Aug 20-31 Off)	Needs Improvement- Less Than 65 Work in Progress 65-84 Approaching Mastery 85-92 Mastery 93 and higher Students will receive progress reports each module and after the 6th module, the students will receive grades. Thus, they have the entire year to achieve mastery. **June Regents** Students will take the English and Algebra Regents and for those who are accelerated, they will take the Geometry and or Algebra Trig Regents. We have to pay attention to the state Regents reduction plan. **August Regents** Module 7 can be used as a summer school schedule or introduce social studies. Will we follow a regular school schedule or summer school hours?

APPENDIX B

Bell Schedule at P-TECH

Period	Time	Course
1	8:35-9:20	Physical Education
2	9:22-10:07	English, Math or Technology
3	10:09-10:55	English, Math or Technology
4	10:57-11:42	English, Math or Technology
5	11:44-12:29	Lunch
6	12:31-1:16	English, Math or Technology
7	1:18-2:03	English, Math or Technology
8	2:05-2:50	English, Math or Technology
9	2:52-3:37	Workplace Learning
10	3:39-4:24	Workplace Learning
11	4:26-5:11	Tutoring or Extra-Curricular Activities
12	5:13-5:58	Tutoring or Extra-Curricular Activities