CENTER FOR APPRENTICESHIP & WORK-BASED LEARNING

JFF's Framework for a High-Quality IT Pre-Apprenticeship Program

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About This Report

This pre-apprenticeship framework outlines the six key characteristics of a high-quality pre-apprenticeship program with a focus on the IT industry. It builds on JFF's existing Framework for A High-Quality Pre-Apprenticeship and provides specific recommendations for aligning training in the IT industry and offers examples of promising practices for existing training programs.

Pre-apprenticeship programs can be delivered by a range of entities and are designed to prepare participants for success in Registered Apprenticeships or other high-quality apprenticeship programs and, ultimately, careers.

This framework can be used by new or existing programs to help guide their growth and development both in creating formal pre-apprenticeships and in strengthening their existing training practices.

About JFF's Center for Apprenticeship & Work-Based Learning

JFF is a national nonprofit that drives transformation in the American workforce and education systems. For 35 years, JFF has led the way in designing innovative and scalable solutions that create access to economic advancement for all, including apprenticeship and work-based learning. These programs are proven methods for connecting people to good careers while providing employers with skilled workers. The Center consolidates JFF's broad skills and expertise on these approaches into a unique offering. We partner with employers, government, educators, industry associations, and others to build and scale effective, high-quality programs. Visit https://www.jff.org/center.

TABLE OF CONTENTS

Acknowledgments

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Able-Disabled Advocacy
Ada Developers Academy
Adams County Workforce Development Board
AHIMA Foundation
Apprenti
Apprenticeship Carolina IT
Atlanta Workforce Development
Atlanta Technical College
Boise CodeWorks
Building Futures Rhode Island
CodeNation
Epicodus
Flatiron School
Focus HOPE
General Assembly
HOPE Project DC
iC Stars
JEVS Human Services
Kenzie Academy
LaunchCode
New Jersey Pre-Apprenticeship in Career
North Carolina Youth Apprenticeship
NPower
NuPaths
OpenTech LA
Per Scholas
Philadelphia Works
Resilient Coders
Sabio
Tech Elevator
TechHire WI and Forward Careers-WI
DCI TechHire
TechHire New Mexico
TechHire Rhode Island and Opportunity @ Work RI
Tech Talent Denver
TechRise
Techtonic Apprenticeship
The Door-TechBridge
Treehouse
Trident Technical College
UMOS TechHire
Vermont HITEC
Wisconsin Youth Apprenticeship IT Program
Year Up

Introduction

IT is a large, dynamic, and rapidly growing sector of the U.S. economy, one in which creativity and flexibility are prized and rewarded with high wages and skills that will yield longevity in careers as the workforce becomes increasingly tech driven. However, the highly skilled nature of these jobs, combined with employer preferences for postsecondary credentials and the challenges of navigating the volume of occupations and career pathways across industries, have limited access to entry-level IT positions for many workers including those without advanced degrees or previous experience in the IT sector. To varying levels of success, programs from boot camps, to postsecondary certificate programs, to community-based training have emerged to build new on-ramps into IT.

Pre-apprenticeship programs are one such on-ramp model that can be particularly beneficial to the IT sector. Employers are in search of a skilled workforce that is able to effectively communicate, problem-solve, and adapt quickly on the job. As a result, many are increasingly turning to apprenticeship and Registered Apprenticeship as talent development solutions. Registered Apprenticeships, often considered the gold standard of apprenticeship training, are workforce training models that combine paid on-the-job learning and classroom or online instruction to help a worker master the knowledge, skills, and competencies needed for career success, while helping employers develop talented workers. They are formally approved by either the U.S. Department of Labor's Office of Apprenticeship or a state apprenticeship agency. Pre-apprenticeship programs can provide a feeder into these highly skilled training opportunities, and attract and prepare a broader and more diverse labor force to the industry.

What Is Pre-Apprenticeship?

Pre-apprenticeship is a program or set of services that offers participants structured training opportunities to prepare them for entry into an apprenticeship or Registered Apprenticeship program. Unlike the U.S. Department of Labor's Registered Apprenticeships, there is no formal registration process for pre-apprenticeship programs at the federal level. However, some states including Pennsylvania, Ohio, Florida, and Wisconsin do register or formally recognized high quality pre-apprenticeships that meet certain standards.

The U.S. Department of Labor has outlined several essential elements for pre-apprenticeship in its Training and Employment Notice (TEN 13-12) and its Training and Employment Guidance Letter (TEGL 13-16). These elements include providing participants with meaningful work experience, essential skills and competencies, in-demand credentials that align with employer needs, and offering career navigation, mentorship, and supportive, wraparound services.

The purpose of this framework is to offer guidance to community-based organizations, training providers, employers, and other practitioners interested in developing a quality pre-apprenticeship program that is aligned with the specific needs of the IT industry and that advances equity in the workforce. It adapts the quality elements of JFF's Framework for a High-Quality Pre-Apprenticeship Program and provides IT-specific recommendations. These elements include:

Transparent entry and success requirements;

Alignment of skill development with local employer and apprenticeship demand;

Provision of industry-recognized credentials;

Development of skills through work-based learning;

Inclusion of academic and career exploration, as well as wraparound supports; and

Connections and transition into a Registered Apprenticeship.

This resource also spotlights several high-performing IT training programs. While not all of these are formal pre-apprenticeship programs, the best practices highlighted demonstrate the value and impact of incorporating pre-apprenticeship elements into overall program and training design.

It is important to note that there is a critical need to advance racial and social equity in our national systems, including workforce development. While elements of this framework can help programs support underserved populations and expand access to IT careers, pre-apprenticeships should ensure that they apply a strong lens of racial and social equity to all facets of their program design and training structure. Making this approach a core component of employer partnerships and embedding it into the provision of supportive wraparound services will help pre-apprenticeships increase access to career pathways for a more diverse worker population. Practitioners should also integrate their own best practices and understanding of how to do this in meaningful and effective ways that take into consideration the unique needs of the populations and communities they are serving.

COVID-19 Impacts and Considerations

The COVID-19 pandemic has dramatically changed the workforce and the ways that training across industries is designed and implemented. With the need for social distancing, training has been either put on hold or transitioned to a virtual setting, and pre-apprenticeship programs must adapt how they engage with and support their participants. Work-based learning activities and hands-on learning that are traditionally done in-person must be redesigned for remote settings, and a special emphasis needs to be placed on continued engagement and partnership with employers as they struggle to maintain their workforce.

While this has presented new challenges for providing participants with meaningful work experience and access to skill-building and social capital, it also comes with new opportunities for designing high-quality pre-apprenticeship programs in this sector. As other industries have dramatically reduced or paused their work, IT has demonstrated more resiliency in the face of COVID-19, and in these first few months has been able to keep its workforce employed and engaged. The shift to virtual learning and remote working has resulted in an increased demand for technology and for a skilled IT workforce to support this new reality.

For more strategies on responding to COVID-19, please visit https://www.jff.org/covid-19-our-shared-responsibility/.

Adapting High-Quality Pre-Apprenticeship for the IT Industry

1. Transparent Entry and Success Requirements

IT pre-apprenticeship programs should be made as accessible as possible for all participants interested in IT careers without compromising their ability to succeed after completing the program. In such a high-skill industry, this requires programs to determine how much they can achieve in a limited time to bridge the starting points of future IT professionals to the needs of employers. Pre-apprenticeships should begin by working with aligned Registered Apprenticeship programs and employers to identify the fundamental competencies and traits that are essential for beginning IT career pathways. From there, high-quality pre-apprenticeship programs should integrate program elements that address the technical and nontechnical challenges of entering the IT sector.

Pre-apprenticeship programs should clearly articulate entry requirements, including stipulations on any academic prerequisites, employability skills, and social-emotional skills.

The entry requirements that IT pre-apprenticeship programs communicate before enrollment should include eligibility requirements that define the target population, such as residency and age, as well as academic prerequisites, technical skills, and any other necessary qualifications.

Academic Requirements. Because many apprenticeships and other advanced training programs require higher literacy and numeracy proficiencies for entry, pre-apprenticeship programs must ensure that participants meet these standards by the end of their training. Pre-apprenticeships that

GED Attainment at JEVS

JEVS Human Services in Philadelphia offers the Project WOW (World of Work) program to assist 18-to-24-year-olds with obtaining a high school credential while participating in career pathway skills training. During the 24-week program, participants receive hands-on training at Orleans Technical College in the areas of building trades or computer technology. Technical training is paired with GED preparation delivered by a Project WOW academic facilitator. Participants in the computer technology track can earn an International Computer Driver's License certification as instruction develops introductory hardware, network, and software computer knowledge. The presence of Project WOW in the JEVS ecosystem of services also affords participants the opportunity to seamlessly transition into the JEVS IT Pre-Apprenticeship program as they continue working toward a high school credential.

focus on closing education gaps should clearly outline the reading and math proficiencies needed for entry, and should have a clear strategy in place to help participants make the necessary gains to progress into an apprenticeship or career pathway. Apprenticeships and employers also generally require a high school diploma or GED. A secondary credential should not be required for acceptance into a pre-apprenticeship program that is able to help participants earn these credentials while completing training. If a pre-apprenticeship program lacks the capacity or infrastructure to support attainment of a diploma or GED, either by providing the credential in-house or through a partnership with an external provider, it should emphasize a secondary credential as a requirement for enrollment.

Employability and Soft Skills. Given the rapid technological evolution of the IT sector and the competencies needed to advance within the industry, the most important employability skills for individuals entering an IT pre-apprenticeship program is adaptability and an openness to learning new skills. Pre-apprentices can then develop additional employability skills sought by IT employers such as effective communication, teamwork, and critical thinking in the context of IT careers during their training *(see section 2)*.

Technical Skills. Familiarity with IT hardware and software sets participants up for success in IT pre-apprenticeship programs. However, a lack of technical skills gained through formal training should not be a barrier to entry into an IT pre-apprenticeship. Prior technical knowledge gained through hobbyist exposure can help jump-start successful participation in an IT pre-apprenticeship program and help participants progress during the training program. IT pre-apprenticeship programs should advise participants

Articulating Apprenticeship Requirements at TranZed IT

TranZed IT apprentices develop talent for entry- and mid-level positions at tech and cyber companies. An abbreviated list of entry requirements offers an example of the kind of requirements that should be clear as pre-apprentices start their training:

Technical Requirements

- Demonstrate knowledge of PC hardware and networking
- Experience using and installing Microsoft Office
- A cursory knowledge of the OSI and TCP/IP model
- Familiarity with 802.11 protocol (Wi-Fi)
- Conceptual understanding of shared servers

Employability Skills

- Flexibility of work schedule and work location
- Excellent problem-solving ability
- Excellent communication skills, both written and oral
- Ability to follow precise and imprecise instructions
- Ability to learn quickly
- Time management/multitasking

during enrollment about the technical skills that will be developed through their training, as well as the requirements of aligned apprenticeships. Participants should receive advice on whether a pre-apprenticeship program will prepare them for direct entry into the workforce or if additional training is required for a pathway.

IT pre-apprenticeship programs should clearly articulate expectations for participation, such as self-management, persistence skills, and other success requirements. ***The high demands and skills of the jobs require that pre-apprenticeship programs assess candidate readiness, while avoiding a process that adds unnecessary burden.***

IT is a high-skill industry that expects workers to be self-directed, so high-quality pre-apprenticeship programs should both assess candidates for their readiness for successful participation and further develop those skills. Program recruitment and assessment strategies should align with the required employability skills (above) and should additionally incorporate a comprehensive approach to evaluate traits and skills needed for entry into the training program.

Information sessions and orientations engage interested participants and provide candidates with opportunities to self-assess readiness for training. Best practices include incorporating a variety of voices such as instructors, alumni, and employers to inform prospective participants of the expectations, resources, and benefits of attending and completing pre-apprenticeship.

Virtual Information Sessions at Sabio

The Sabio Coding Bootcamp in Los Angeles delivers 12-week training courses to prepare students for careers as software engineers. To familiarize prospective students with expectations of the program, training staff host weekly meet-and-greets via Zoom. During meet-and-greets, a short presentation about the program structure, job placement supports, and the cost is delivered before time is given for attendees to ask questions. Sabio instructors use these sessions is an early opportunity to engage candidates and clarify entry requirements.

Multistep applications are common among IT on-ramp training programs because of the high demands of the sector. Common activities include personal profile creation, pre-testing and assessments, and interviews. This allows programs to better gauge individual strengths and growth areas and identify needs across incoming cohorts. Multistep applications are also deployed by apprenticeship programs and employers, providing an opportunity to model the steps participants will experience when applying to future career opportunities. This strategy can be useful for evaluation and engagement, and pre-

apprenticeship programs should embed as many of these activities within the actual pre-apprenticeship training as possible while avoiding an extended application period that can discourage entry.

IT pre-apprenticeship programs should clearly articulate requirements for successful transition from the pre-apprenticeship program to at least one apprenticeship program, including skills, credentials, and other aspects that ensure access to stable employment (such as a driver's license, fees, drug testing, or GED). *The most common requirements for IT apprenticeships and employment are a secondary credential, prerequisite coursework, baseline technical knowledge, and targeted, relevant, industry-recognized credentials.*

IT pre-apprenticeship programs should be forward-thinking and begin preparing participants for the next step of their careers starting at enrollment. As with other sectors, best practices include incorporating career exploration into pre-enrollment work with interested participants and clearly articulating the industry-specific credentials required to enter an IT occupation *(see section 3)*.

IT pre-apprenticeship programs should also work with participants to understand all aspects of the application processes for apprenticeships and training programs, particularly technical demonstrations. Application segments such as problem-solving challenges and prerequisite coursework are common in IT and can create barriers to advancement if participants are not exposed to strategies for applying knowledge gained during pre-apprenticeship. To prepare participants for transitions, IT pre-apprenticeship programs can use case managers, coaches, or mentors to advise participants and prepare them to navigate technical demonstrations.

IT pre-apprenticeship programs should identify and flag for participants which requirements, such as physical capabilities or absence of specific criminal convictions, cannot be overcome through program supports, and should work with Registered Apprenticeship sponsors to add accessibility by removing these barriers whenever possible. *Because security is a core concern across the IT industry, many IT employers will not hire candidates who have a criminal record.*

As with any pre-apprenticeship program, IT pre-apprenticeships should clearly articulate any participant barriers that cannot be addressed by technical training or case management. Related to an industry-wide focus on cybersecurity, IT apprenticeships and early-career employment commonly require applicants to possess no felonies or misdemeanors of a violent nature and to have an ability to work in a drug-free work environment. High-quality pre-apprenticeships should designate staff to work with participants, the local justice systems, and employer and community partners to address barriers related to these requirements and pursue systemic advocacy supports. While outcomes may not be immediate, it is important to work toward more long-term equitable employment practices. This will serve to increase access to career pathway opportunities in the tech sector. Pre-apprenticeships should also explore IT jobs and pathways in other industries where employers are more open to working with and supporting workers with criminal records.

Preparing Participants for Training at TechHire New Mexico

TechHire sites in New Mexico offer paid IT training and career development support to individuals between the ages of 17 and 29. During enrollment into the program, participants must complete a "Core Score" soft skills assessment, and a score of 714 is required to meet the program training goals. Individuals who fall below this cutoff are automatically referred to an online soft-skills course delivered by Penn Foster to learn the foundational skills required by employers. Participants may retake the assessment after completion of the course. TechHire New Mexico is funded by a $4 million grant awarded by the U.S. Department of Labor's Employment and Training Administration; 100 percent of participant training costs are paid through the grant.

IT pre-apprenticeship programs should implement strategies to help participants address gaps in requirements for entry into an apprenticeship. ***Pre-apprenticeship programs are intended to be as accessible as possible, while the IT industry has higher barriers to entry than many other sectors. IT pre-apprenticeship programs should focus program design on apprenticeship and employment requirements that they are best positioned to bridge.***

As in all sectors, high-quality IT pre-apprenticeship programs should have clear strategies for helping participants evaluate their starting point and progress, identify gaps in their skills, and effectively close these gaps with additional academic and technical training. JFF does not recommend specific tools, but the Test for Adult Basic Education (TABE) and WorkKeys are among the most common for evaluating potential academic and technical skills.

Because of the high skill requirements in the industry, IT candidates may be more likely than in other sectors to require support in building foundational skills before entering a pre-apprenticeship as well as in preparation for transition to IT apprenticeship programs. High-quality pre-apprenticeships provide additional support for individuals who have demonstrated potential and growth yet fall short of requirement cutoffs, or they partner with another provider who can offer remediation and serve as a bridge into the pre-apprenticeship. Unlike other sectors where pre-apprenticeship often serves as the first step, IT pathways are more likely to benefit from on-ramps prior to pre-apprenticeship for academic skill building, digital literacy, or a basic introduction to technology.

2. Alignment with Skills Sought by Employers and High-Quality Apprenticeship Programs

Pre-apprenticeship programs should integrate in-demand technical and employability skills that prepare participants for IT apprenticeships, while also providing the foundation for longer-term career growth and development. This framework draws upon real-time job posting data to identify specific skills that are most important for new entrants to the IT field.[1] Because of their relevance for entry-level IT roles—and accessibility to individuals without a bachelor's degree—the framework focuses on skills relevant for IT support, cybersecurity, and web development pathways. IT pre-apprenticeships that prepare individuals for other IT pathways should conduct similar labor market analyses.

High-quality IT pre-apprenticeship programs should support participants in acquiring employability skills such as teamwork, written communication, problem solving, initiative, flexibility, and reliability. ***Many employability skills have broad relevance to employers hiring across the IT career pathways, mirroring those of other sectors but also including IT-specific skills such as creativity and attention to detail.***

Job postings in the IT sector reflect a demand for communication, teamwork, problem solving, planning, written communication, research, creativity, attention to detail, and organizational skills. Programs can leverage existing job-readiness training and contextualize it for the IT sector.

High-quality IT pre-apprenticeship programs should support participants in acquiring sufficient skills and academic credentials for entry into a high-quality apprenticeship or an entry-level job with advancement potential in the industry. ***Several technical skills are valued across the IT sector, but***

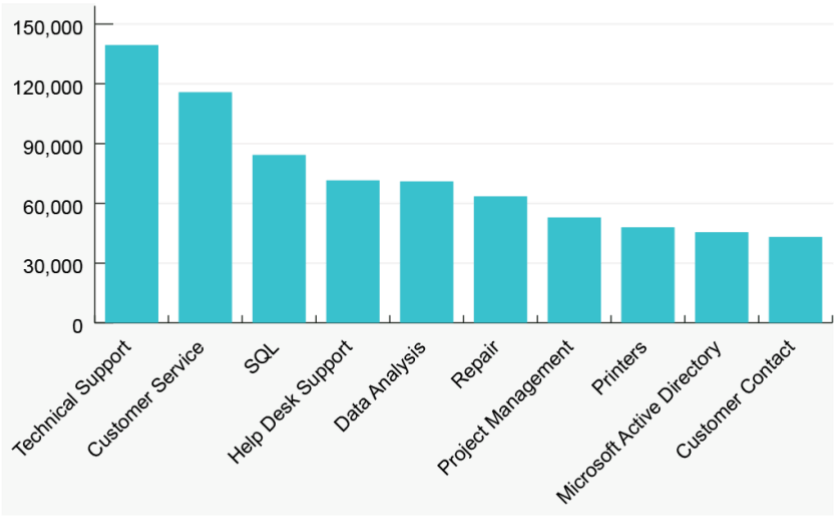
pre-apprenticeship programs should also teach skills aligned with IT support and service, cybersecurity, or programming and software careers.

The U.S. Department of Labor's Career OneStop Information Technology Competency Model introduces skills needed for growth and advancement within the IT industry. It provides a comprehensive overview of the foundational personal, academic, and workplace competencies for the industry, and illustrates how skill building should lead to the technology- and occupation-specific competencies.

Pre-apprenticeship programs should focus on ensuring that individuals gain industry-wide technical competencies. Job postings offer broad relevance across the sector by highlighting the skills that are most in demand: technical support, systems administration, help desk support, Microsoft Active Directory, repair, hardware/software installation, and Linux. In addition, most entry-level jobs also require specialized technical skills. Therefore, high-quality IT pre-apprenticeships should provide a broad introduction to these general skills while also introducing more advanced skills aligned with a specific pathway.

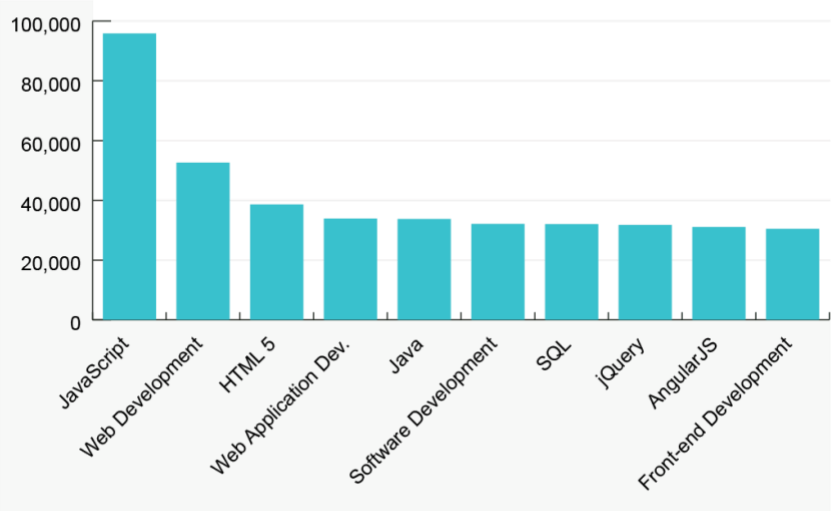
IT Support and Service. Approximately 1.9 million workers were employed nationwide in IT support and service jobs in 2018. Entry-level IT support roles—such as computer user support specialist and network support specialist—are accessible to individuals without a bachelor's degree, have strong wages,[2] and offer a path to advancement,[3] making them a strong match for pre-apprenticeship programs.[4] Key technical skills for IT support and service roles are highlighted in Figure 1.

Figure 1. Nationwide Employer-Demand for IT Support Skills, Based on Number of Job Postings



Source: Burning Glass Technologies (2019)

Figure 2. Nationwide Employer Demand for Programming Skills, Based on Number of Job Postings

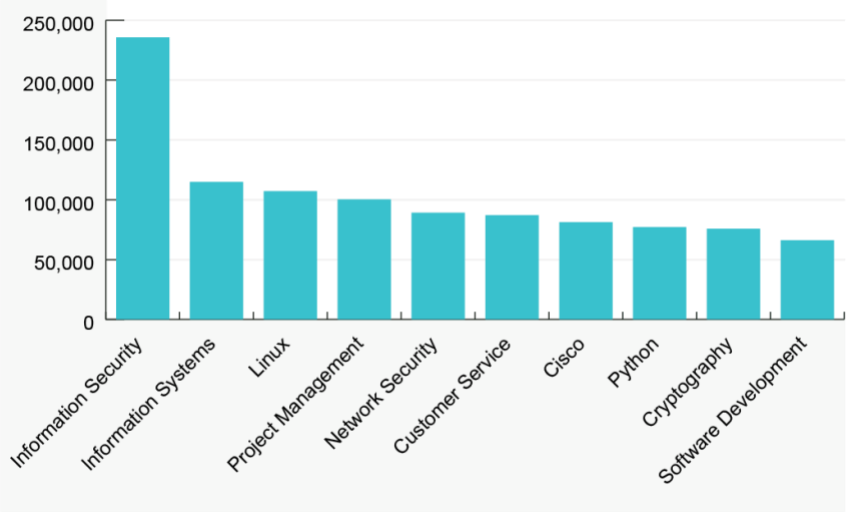


Source: Burning Glass Technologies (2019)

Programming and Software. For the programming and software pathway, the entry-point occupation is web developer, a role with a median salary of approximately $69,000. Around 30 percent of individuals in this occupation have a high school degree or some college. Pre-apprenticeship programs should build participants' exposure to and skills in programming languages, as indicated in Figure 2.

Cybersecurity Roles. Cybersecurity is a high-growth field that can be accessed through a range of IT pathways—including programming, IT support, and networking.[5] While cybersecurity jobs have historically favored bachelor's degrees, Registered Apprenticeship programs targeting roles such as cybersecurity analyst, computer forensics analyst, and secure software developer have emerged in recent years to help meet demand.[6] Cybersecurity roles are often hybrid; they require distinct skills and competencies, so cybersecurity pre-apprenticeship programs should build skill in areas such as information security, network security, information systems, and cryptography, while also introducing apprentices to programming languages such as Linux and Python *(see Figure 3)*.

Figure 3. Nationwide Employer Demand for Cybersecurity Skills, Based on Number of Job Postings



Source: Burning Glass Technologies (2019)

High-quality IT pre-apprenticeship programs align curriculum with a range of training and employment pathways. *They focus on a subsector of the industry—IT support and service, cybersecurity, or programming and software—rather than a single occupation.*

As discussed above, broad technical skills and employability skills are generally not sufficient for entry-level IT employment. Pre-apprenticeship programs should also lay the groundwork for higher-level technical competencies aligned with IT support and service, cybersecurity, or programming and development. Each of these subsectors offers a range of employment pathways while not overly limiting the career options of pre-apprenticeship graduates.

High-quality IT pre-apprenticeship programs design instruction and training to reach underserved populations. *IT pre-apprenticeship programs should draw on best practices for specific target populations regardless of industry sector.*

IT training programs that are designed to meet the unique needs of underserved populations will be the most effective at expanding equitable access to career pathways in the industry. Programs should incorporate promising practices to serve these participants. These could include providing additional services and supports, offering an ecosystem of community partnerships, applying a gender lens to training design, or using a Universal Design for Learning approach when developing curricula and classroom lessons.

Supporting Underserved Populations in Pre-Apprenticeship: Best Practices

- North Carolina Justice Center (for in-school youth)
- Center for Apprenticeship & Work-Based Learning (in-school and out of school youth)
- "Adding a Gender Lens to Nontraditional Jobs Training Programs" (women)
- "Apprenticeship and the Justice System" (justice-involved young people)
- "The UDL Guidelines" (Universal Design for Learning)

3. Culmination in One or More Industry-Recognized Credentials

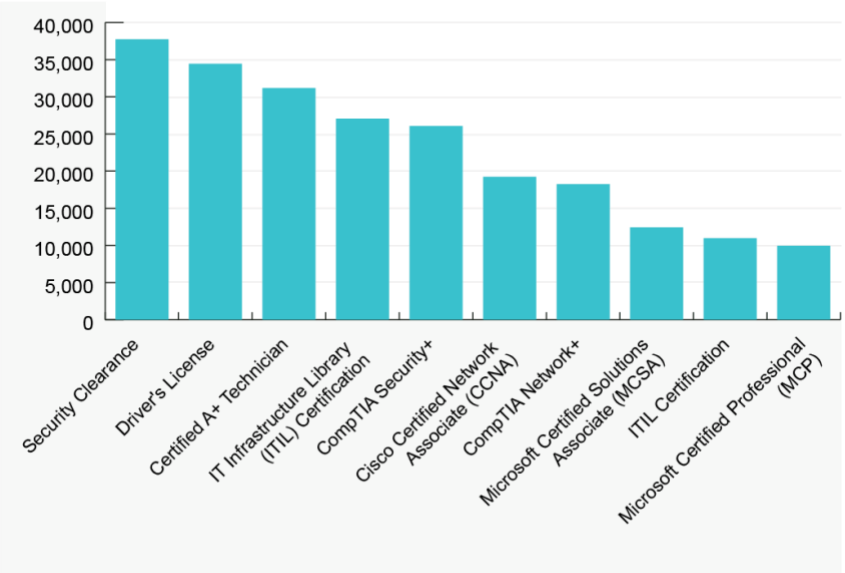
The IT sector has a robust credentialing ecosystem, and IT pre-apprenticeship programs and other entry-level IT job training programs commonly offer a suite of industry-recognized credentials. Many training programs provide participants with the option to earn two to three credentials, and that often drives much of the curriculum design. However, it is unclear whether this enthusiasm for credentials is matched by employers. Demand for industry-recognized credentials is currently mixed, with only about one-third of IT job postings requesting specific credentials.[7] Leading Registered Apprenticeship programs also do not tend to require credentials beyond a high school diploma. Regardless of whether credentials are required to enter the field, IT employers often upskill their workers with industry-recognized credentials.

The best IT pre-apprenticeship programs facilitate earning credentials that support direct entry into the workforce, are aligned with labor-market demand, and are validated by regional and/or national employers or industry associations.

Many IT credentials that are recognized by the industry can be incorporated into a pre-apprenticeship program, with the CompTIA A+ certification and a security clearance having the most value to IT employers.

In IT, industry associations and software/hardware vendors (e.g., Cisco, Microsoft) are key creators and validators of credentials. The CompTIA A+ certification is the most widely recognized and requested entry-level credential in the sector, and helps individuals build baseline skills and knowledge that are applicable across a wide range of career pathways in the sector, from IT support to programming.

Figure 4. Nationwide In-Demand IT Credentials, Based on Number of Job Postings



Source: Burning Glass Technologies (2019)

The ability to obtain a security clearance is the most sought-after IT credential and surprisingly important in roles across the sector, though it is particularly valued in cybersecurity. If possible, providing pre-apprentices with a security clearance could make them stand out in the labor market. Once security clearances are issued, there is a process for transferring them to a new employer, which pre-apprentices could pursue when entering a new job or moving on to an apprenticeship program.

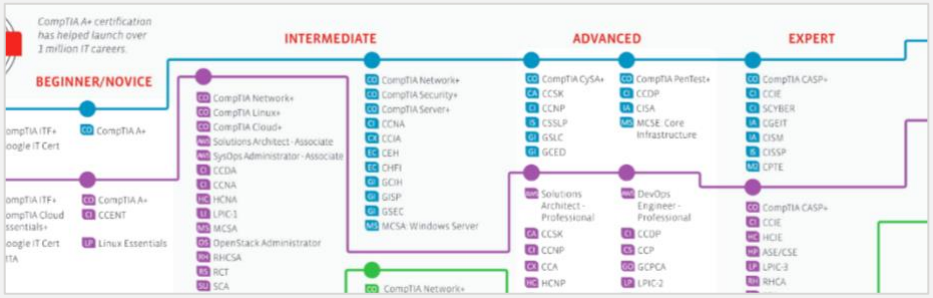
Credentials aligned with specific pathways within IT include the following:

- **IT Support and Service:** The CompTIA A+ certification is requested widely for entry-level IT support roles, with the CompTIA Network+ and CompTIA Security+ certifications also cited.
- **Cybersecurity:** Cyber-focused job postings typically place greater emphasis on the ability to obtain a security clearance and may also include the CompTIA Security+ and/or Certified Information Systems Security Professional (CISSP) credentials.
- **Programming:** Credentials are requested less frequently for programming roles, though the IT Infrastructure Library (ITIL) certification, Project Management certification, and CompTIA's Security+ certification are a few that are sought after by some employers.

IT pre-apprenticeship programs should facilitate earning credentials that are stackable and portable. *The CompTIA A+ certification provides a foundational certification that is designed to stack with a wide range of other IT credentials.*

Many IT employers are hesitant to commit to long-term training because of the field's quickly changing skills needs. Stackable credentials provide an effective way to support advancement within the sector by demonstrating growing skill and competency gains to employers.[8] Often, the CompTIA A+ certification is the first credential in a series. However, some programs are looking for a more baseline credential. The relatively new Google IT Support Professional Certificate and the CompTIA IT Fundamentals certification are aligned with the CompTIA A+ certification, and can be offered as an on-ramp to the CompTIA A+ content within a pre-apprenticeship program.

IT Certification Roadmap: *see the full roadmap here.*



Source: CompTIA, downloaded May 2020

When seeking to provide more targeted credentials, pre-apprenticeship programs should look to offer certifications, such as the Microsoft Certified Solutions or the Cisco Certified Network Associate certifications, that are tied to a specific vendor or platform. Because these vendors drive many credentials across the industry, they are simultaneously recognized as the industry standard and are therefore portable.

IT pre-apprenticeship programs should facilitate earning credentials that prepare participants or align with the skills identified for training and the curriculum. ***IT pre-apprenticeship programs can be built around the CompTIA A+ certification to teach baseline skills, while the more specialized technical skills may or may not align with a credential.***

As described above, many IT programs are built around the CompTIA A+ certification because of its foundational relevance across a range of pathways in the IT field, from networking to cybersecurity and programming. While many IT on-ramp training programs lead to multiple credentials, high-quality pre-apprenticeship programs should focus on in-demand skills as their top priority, and then only support the attainment of industry-recognized credentials that align with those skills. In the current market, employers ask for credentials less often than IT training programs provide them, which means that a credential focus can distract from the potential value of the curriculum.

IT pre-apprenticeship programs should embed preparation for earning industry-recognized credentials into the curriculum, including supports such as test delivery. ***Because many IT job candidates earn multiple industry-recognized credentials, certification costs add up and should be covered by the pre-apprenticeship program whenever possible.***

High-quality pre-apprenticeship programs should not only prepare participants to earn industry-recognized credentials, but should also include supports to facilitate obtaining the credential itself.

Pre-apprenticeship programs should support instructor training and certification to help ensure that instructors have mastered relevant content and are able to deliver it effectively to training participants. In some cases, an instructor must be certified by a validating agency. For example, CompTIA A+ instructors have to be CompTIA A+ certified in order to teach the course. In these cases, high-quality pre-apprenticeships should provide supports to instructors for such certification.

Pre-apprenticeship programs are also particularly helpful to participants when they defray the costs associated with examinations, which can be significant. The cost of obtaining industry-recognized credentials can surpass $1,000 when multiple credentials are required, or candidates don't pass an examination on the first try. As a baseline credential, CompTIA A+ certification costs $340 ($170 for each exam). Other common credentials range from $260 for Linux+ to $339 for CompTIA Security+, to as high as $700 for the CISSP. Educational vouchers and discounted rates for many of these certifications are available to training providers. Pre-apprenticeships should contact vendors directly to explore their options.

4. Development of Skills Through Hands-on Activities and Work-Based Learning

Work-based learning (WBL) is a crucial component of any successful pre-apprenticeship program, because it strengthens participant training and skills gains through application in a real-world setting. WBL is especially critical in IT because many employers require at least one year of experience in the IT sector as part of their hiring process. WBL can provide a way for individuals to build their work experience, gain essential skills *(see section 2)*, and build digital literacy through meaningful exposure to the hardware and software used in in-demand occupations. In addition, many IT employers are averse to long-term training because of the rapidly changing needs of the sector. Embedding WBL within a pre-apprenticeship program offers a shorter-term strategy for individuals to demonstrate their competency with in-demand skills to employers.

IT pre-apprenticeship programs should embed hands-on activities into the curriculum, including WBL or on-the-job learning, that are relevant to the target occupation. ***IT pre-apprenticeship programs should be creative in identifying hands-on and WBL opportunities, because they are not as widespread in IT as in many other sectors.***

WBL is particularly valuable in IT but hard to achieve, so pre-apprenticeships may have to rely on other hands-on activities to contextualize learning. Examples of effective WBL activities for the IT sector include internships, job shadows, mentoring, and service and volunteer projects. Service learning offers a way to provide real-world experience even without employers that are prepared to offer paid work-based learning. High-quality pre-apprenticeship programs should engage with employers to develop these activities to ensure that the skills training provided is in alignment with employer needs. To do this effectively, partnerships with employers and WBL providers should clearly identify the role that the partners will play, outline how skill gains will be documented and tracked, and include options for internships or other training placements.

Innovative Approaches to WBL: Able Disabled Advocacy

Able-Disabled Advocacy (A-DA) in San Diego employs a service model to offer WBL to its opportunity youth participants. Individuals engaged in the IT training track with their YouthBuild program volunteer with the local city government and community-based organizations to refurbish computers, which are then given to disadvantaged families. Through this activity, participants gain hardware and software skills that connect to in-demand occupations such as computer support and help desk specialist. It also builds social capital and expands their professional networks by allowing them to work alongside professionals in IT ultimately improving access to apprenticeships and meaningful jobs post-training, including A-DA's existing IT pre-apprenticeship and apprenticeship programs.

IT pre-apprenticeship programs should structure hands-on activities to make clear what skills are gained, how they are validated, and how they can be applied in a future career. ***In addition to best practices across sectors for skills validation, IT pre-apprentices can particularly benefit from the creation of portfolios and hack-a-thons.***

Pre-apprenticeship programs in IT should look to the best practices from across sectors in designing WBL activities. Programs can also consider how to supplement WBL or work around the limited opportunities to connect participants to meaningful IT work experience in this sector by adding reflective practices that help them identify how the skills they gain translate to a range of IT occupations. Examples of effective activities that hold particular value in IT include the creation of portfolios that track skill development and credential attainment, and talent-demonstration events such as hack-a-thons. Inviting employers to participate in these events as judges, or as mentors in other activities, can help them better understand the skills that pre-apprentices can bring to their companies.

IT pre-apprenticeship programs should structure hands-on activities in a classroom, worksite, or lab to be experiential, problem-based, and designed with input from employers and apprenticeship sponsors. ***IT pre-apprenticeship programs should draw on best practices for employer-driven, hands-on training designs regardless of industry sector.***

Internships for IT Success: Adams County Workforce Development Board

The Adams County Workforce and Business Center in Colorado works with the county's IT department, the Turing School of Software & Design, and employer partners to provide paid internships that include rotations through hardware, help desk, coding, and website administration. Internships provide an opportunity for participants to gain experience in real-world work settings while demonstrating their skills and expertise to employers. The ACWDB also subsidizes wages for each intern, making this a compelling strategy for employers. To date the program has placed participants with the county, the city, corporate employers, and community-based organizations.

Involving employers in the design of hands-on, problem-based, and experiential activities is particularly important in IT because many employers have concerns about skill and credential needs and the length of training participants engage in prior to entering the workforce. This can often result in employers using hiring proxies (like the requirement of a postsecondary degree for a job where the work does not actually require one) to select applicants instead of considering knowledge gained in programs such as pre-apprenticeships. By participating in the design and facilitation of these activities, employers can experience the value of the training and better understand the level of preparation it provides participants, which can ultimately remove barriers to the IT industry for a wider population of workers.

IT pre-apprenticeship programs should prioritize opportunities for WBL in which the participant completes meaningful job tasks in a workplace. ***WBL opportunities can be difficult to find among IT employers, but pre-apprenticeship programs can look to non-IT employers with IT needs as WBL hosts.***

IT employers sometimes trust work experience even more than credentials or degrees. Yet this creates a catch-22 where IT employers are hesitant to provide that first, valuable experience. Pre-apprenticeship programs may need to be creative to find employers who are willing to host WBL experiences such as internships. One place to start is by connecting to non-IT employers

that have significant IT needs, such as schools, local governments, finance and insurance companies, hospitals, and manufacturers. Training providers that offer pre-apprenticeships in multiple sectors can begin with employers in other industries that they already work with.

IT pre-apprenticeship programs should use WBL to develop participants' understanding of and ability to navigate company and industry culture, as well as specific position functions and workplace policies and procedures. *IT-focused WBL can help pre-apprentices understand how work cultures and careers differ between IT employers and non-IT employers that have IT jobs.*

Program Spotlight: Epicodus

Epicodus facilitates matchmaking between its coding students and local employers. The training program begins the process by having students rank companies based on the job descriptions employers provide. Based on those rankings, training staff assign up to eight students to interview with each employer after which, students re-rank their company preferences, and employers rank their candidate selections. Training staff then schedule worksite placements by matching employers and students as closely as possible to their top choice. This process helps participants develop a base-level understanding of different companies and employers, provides an opportunity to practice interview skills, and results in meaningful work-based learning activities that help them determine what career pathways might be the best fit for them.

The unique structure of the IT field, with a split between IT industry employers and employers from other sectors that contain IT departments and jobs, requires a different kind of introduction to, and exploration of, industry and company culture. High-quality pre-apprenticeship programs use WBL as a way to help participants experience the differences between IT employers and non-IT employers with IT needs. Programs can also use WBL to help participants understand the full range of IT careers available across IT and non-IT industries and how to fully access them. This is most effective when the WBL is coupled with meaningful career exploration and includes opportunities for participants to reflect on the activities they are doing and skills they are gaining, and connect their hands-on work to different occupations.

5. Offering of Academic, Career Exploration, and Wraparound Supports

Pre-apprenticeship programs are not only spaces to gain the technical knowledge needed for IT careers, but also essential spaces for participants to explore and identify their interests and career preferences. Exploration guided by career specialists and industry professionals can be invaluable to individuals entering the IT sector, particularly as the field of IT continues to grow and evolve, making it difficult to navigate. For example, cybersecurity jobs have expanded by 94 percent from 2013, compared to 30 percent growth for all IT jobs.[9] In addition, technical skills gained during training can translate to careers across numerous industries that individuals are less likely to identify on their own. Finally, the culture of the IT industry values self-direction, so pre-apprentices who enter the industry are unlikely to get robust career exploration or wraparound support from their new companies, supervisors, or peers to maximize their long-term success.

IT pre-apprenticeship programs should provide orientation to the industry and exposure to a range of occupations, career paths, wages, and information about job opportunities. ***In their career exposure activities, IT pre-apprenticeship programs should pay particular attention to the unique structure of IT occupations inside and outside the sector.***

Career Navigation Resources

- O*NET
- CareerOneStop
- CareerPathways
- College Greenlight
- Knack
- MyBestBets
- YOUniversityTV
- CareerExplorer
- CompTIA

High-quality pre-apprenticeship programs in IT should follow the best practices of career exploration from across sectors, including being grounded in local labor market information, incorporating self-assessments, and hosting panel discussions with industry professionals and company showcases. This is especially important in the IT sector, where employer-driven career navigation is uncommon. Programs should be mindful to incorporate activities that provide opportunities to engage with industry professionals at entry, mid, and advanced career points to help clarify pathways to senior positions and expose participants to areas of specialization within occupations. As mentioned above, individuals must also navigate a unique job landscape in which IT jobs are available both at IT companies and other companies with IT needs. High-quality pre-apprenticeship programs can help participants navigate the differences in career pathways to find the best short- and long-term matches for their careers. They can also

help orient participants to the range of workplace cultures and norms that exist across different employer types and better prepare them for success in their first job and beyond.

Each career pathway within IT is unique. IT support roles are typically more accessible to individuals without a bachelor's degree and can provide a foundational knowledge that can support a range of career pathways—from networking to development and cybersecurity—though earnings are lower. Programming occupations employ the most workers across the sector and typically offer higher salaries, but they tend to place greater emphasis on bachelor's degrees and higher-level skills such as coding.[10] Finally, cybersecurity occupations are experiencing significant growth and unmet employer demand. While they can be accessed from multiple entry points in the sector, long-term advancement typically requires a bachelor's degree and/or highly specialized credentials (e.g., the CISSP).

IT pre-apprenticeship programs should support exploration of postsecondary credential options aligned with career interests. ***IT pre-apprenticeship programs should draw on best practices for postsecondary alignment regardless of industry.***

IT is a sector where degrees hold significant value, at times more than industry-recognized credentials do, and so it is important for high-quality pre-apprenticeship programs to explore postsecondary education pathways alongside career pathways. This strategy can expand opportunities for participants to strengthen their ability to effectively connect to IT occupations, even if job placement is not their immediate next step.

Program Spotlight: i.c.stars

At Chicago-based i.c.stars, local tech leaders offer insights on current industry trends and their personal career journeys during "High Tea" talks. The hour-long conversations are held daily and offer participants the opportunity to network with guest speakers and engage in Q&A. In addition to the speaker series, i.c.stars recruits industry professionals to serve as volunteers in professional development roles working directly with participants:

- Career/resume coach
- Mock interviewer
- Business writing coach
- Entry-level resident mentor

Many community colleges offer credit for prior learning to individuals who have earned industry-recognized credentials, which is particularly valuable given the presence of those credentials within IT *(see section 3)*. For example, Blue Ridge Community College in Virginia awards three credits for the CompTIA A+ certification, while Carroll Community College in Maryland awards six. High-quality pre-apprenticeships should facilitate that credit award for

pre-apprentices who are interested in continuing on to a postsecondary degree. Pre-apprenticeships can also partner with community colleges that deliver credentials for credit as a way to meet their instructional needs and offer participants more opportunities for training and credential attainment. For example, community colleges around the country are now offering the Google IT Support Professional Certificate as either a credit course or credit articulation.

IT pre-apprenticeship programs should support participants in developing a career plan that identifies short- and long-term goals, including potential barriers and possible solutions. *IT pre-apprenticeship programs should draw on best practices for career plan development regardless of industry.*

IT differs from many other sectors in that it can be particularly difficult to determine what is needed to advance along a targeted career pathway or across occupational pathways. It is not uncommon for participants to become stuck in a specific job and not be able to move beyond it. To preempt this common pitfall, pre-apprenticeships must embed services that help participants create roadmaps from entry-level positions to senior IT positions that leverage education, training, and networking strategies. IT programs should look to best practices from high-quality pre-

Program Spotlight: General Assembly

The Outcomes program at General Assembly focuses on preparing students for their first job, or "outcome," post-graduation. The program offers career-readiness training, individualized path planning, and networking events aimed at helping students develop a job-search strategy during the technical training period. After graduation, students work one-on-one with a career coach to implement their search strategy and address challenges until the outcome, a job, is achieved.

GA career services overview:

- Network of 50 coaches
- Available to students in immersive courses
- Delivers Outcomes (job-readiness) curriculum from the start of training
- One-on-one career coaching support after graduation, until job is secured
- Coaching targets student accountability, search strategy, and motivation
- Students responsible for weekly networking, resume development, and technical skills building

GA Outcomes program focus:

- Application quality
- Networking
- Interview practice
- Time management
- Growth of technical skills

apprenticeships across sectors, including engaging career coaches, mentors, and alumni, and facilitating events with employers such as job fairs, service activities, or even program open houses.

IT pre-apprenticeship programs should provide wraparound supports such as tutoring and case management, including access to resources for child care, mental health, transportation, and housing. ***In addition to supports needed across sectors, IT pre-apprentices need robust academic support and access to computer hardware and software.***

While many other types of IT on-ramp training programs do not typically offer wraparound supports, high-quality pre-apprenticeship programs that serve underrepresented populations should address a range of needs such as child care, transportation, housing, and living expenses as a way of supporting persistence. Due to the highly technical and accelerated nature of IT training, academic supports that assist participants who are at risk of falling behind are particularly important. IT pre-apprenticeships can draw on many different best-practice models—from educational specialists providing customized assistance to cohort support for core academic content, to the provision of individual tutoring and extracurricular activities.

In addition to general case management and resource needs, IT pre-apprentices may also lack access to technology and materials needed to complete training. High-quality pre-apprenticeships should dedicate program resources, access Workforce Innovation and Opportunity Act supportive service funding, use philanthropic grants, or leverage employer partnerships to fund computer and software purchases for participants.

Program Spotlight: The Door/TechBridge

The Door/TechBridge training partnership is an effective on-ramp into the IT sector that includes many of the core elements of a high-quality IT pre-apprenticeship. The TechBridge program works specifically with young people ages 18 to 24 to provide them with contextualized IT literacy and numeracy instruction designed to raise math and reading to the 10th-grade level and with technical upskilling needed to enter into Per Scholas' 15-week IT Network Support training course.

Participants receive individual tutoring and coaching, have opportunities to contextualize and demonstrate skills gains, and engage in activities to cultivate essential interpersonal and soft skills. TechBridge provides wraparound services that support participant success and offers comprehensive career-exploration activities that help participants better understand the IT occupational landscape. Participants are paired with a case manager and career navigator, who support them through the five-week program and help them to connect their skills and interests to their long-term career goals. These staff continue to work with participants as they graduate into the Per Scholas program, providing ongoing career counseling and mentoring and remedial support and transition services as needed.

The TechBridge career exploration and wraparound support model is a strong example of how to effectively embed these program components into an IT training program. By prioritizing career and wraparound services, TechBridge helps participants cultivate the skills and proficiencies needed to successfully obtain the Google Professional Certificate, CompTIA A+, and Network+ through the Per Scholas training program. If TechBridge were an IT pre-apprenticeship, the training would integrate a supportive hand-off to a Registered Apprenticeship or other high-quality apprenticeship program.

6. Transition into a Registered Apprenticeship or Other High-Quality Apprenticeship Program

IT pre-apprenticeship programs should partner with industry, employers, unions, intermediaries, and the public workforce system to facilitate placements. ***It is important for pre-apprenticeships to understand the hesitancy of IT employers to hire candidates without traditional tech backgrounds, while also cultivating relationships with non-IT employers that have IT jobs as well as regional IT industry associations.***

As noted above, few IT employers host WBL opportunities or hire job candidates who lack traditional IT training. High-quality pre-apprenticeship programs should work to understand and address the various concerns or apprehensions of IT employers about these on-ramp programs while also focusing on building out partnerships with promising IT employers. Programs can start by cultivating industry partners that host WBL and career-exploration activities or contribute to training design, because that involvement may indicate a willingness to hire graduates for an apprenticeship or job. IT pre-apprenticeship programs can also reach out to regional IT industry associations operating in their area to expand the network of potential employers for apprenticeship or job placement.

Pre-apprenticeships can also benefit from prioritizing partnerships with non-IT employers that have IT jobs and apprenticeships. It can be easier to secure job placements with these entities due to their demonstrated willingness to engage with the apprenticeship system and to hire diverse job candidates. Similarly, smaller IT companies are attractive partners because they generally have a stronger track record than their larger counterparts of hiring a range of jobseekers with diverse training backgrounds and experiences and facilitating their career advancement.

Program Spotlight: Tech Talent Denver

The Tech Talent Denver sector partnership brings together a diverse group of over 40 industry and public partners to collectively solve sector challenges in a way that serves to attract, retain, and grow talent with a culture of diversity and innovation. These partnerships are collaborative and play a key role in informing overall best practices. Tech Talent Denver is also leveraging these relationships to develop WBL activities that will be facilitated by employer partners. The intentional engagement with both IT and non-IT employers helps to expand access to a wider range of IT jobs and career pathways while simultaneously addressing a variety of talent needs.

IT pre-apprenticeship programs should work with program sponsors to determine their form of selection preference for program graduates, such as guaranteed interviews or direct entry into a high-quality apprenticeship. *Where apprenticeship programs do not yet exist, align with the standards of leading national Registered Apprenticeships such as Apprenti and IBM, or with the Urban Institute competency-based framework for IT Registered Apprenticeships.*

Leading IT Registered Apprenticeship Programs

- Apprenti
- IBM
- TIRAP (Telecommunications Industry Registered Apprenticeship Program
- #YesWeCode
- Vermont HITEC Program
- New Mexico Information Technology Apprenticeship Program
- Interapt Coal to Coding

To find other RA opportunities, pre-apprenticeships should use the Apprenticeship.gov database and connect with their local Career OneStops.

Where relevant Registered Apprenticeships or other high-quality apprenticeships exist, IT pre-apprenticeship programs can follow the best practices of programs across sectors. Pre-apprenticeship programs formalize a partnership with sponsors confirming that their program equips participants with the technical and employability skills required to enter the apprenticeship. The form of the articulated agreement could vary but should include some benefit to pre-apprentices in the selection process.

Apprenticeship in the IT sector is still new and is evolving quickly. Programs can reach out to the federal Office of Apprenticeship or their state apprenticeship agency representative to identify where Registered Apprenticeship sponsors exist or where new programs are in the process of launching. Many pre-apprenticeship programs might be located in areas that do not yet have high-quality apprenticeships or might be preparing for IT pathways that lack such apprenticeships. In these cases, IT pre-apprenticeship programs can look to existing IT Registered Apprenticeships that are national leaders. Programs such as Apprenti and IBM, as well as the Urban Institute's competency-based apprenticeship frameworks for IT, set the sector standards and can help pre-apprenticeships match the technical skill requirements of IT Registered Apprenticeships that come to the community. While the relationship with an apprenticeship is generally what distinguishes a pre-apprenticeship program from other training on-ramps, pre-apprenticeship programs aligned with national sponsors will be well positioned to establish a local partnership as soon as a sponsor exists.

IT pre-apprenticeship programs should facilitate the provision of advanced standing when the curriculum of the pre-apprenticeship program overlaps with the apprenticeship program. ***IT pre-apprenticeship programs should draw on best practices for curriculum design leading to advanced standing regardless of industry.***

The same caveats hold true for IT pre-apprenticeships seeking advanced standing as with establishing relationships with Registered Apprenticeship sponsors for considering apprenticeship candidates. Many communities do not have relevant IT Registered Apprenticeship programs, but pre-apprenticeship programs can use the related instruction outlines of national leaders to design a curriculum likely to qualify for advanced standing. Ultimately, the local Registered Apprenticeship sponsor will be responsible for deciding whether to grant advanced standing to pre-apprenticeship graduates.

IT pre-apprenticeship programs should connect program graduates who do not enter an apprenticeship to a postsecondary education and training option, or to an employer in a related field for an interview. ***More pre-apprentices are likely to continue outside of the apprenticeship system in IT than other sectors, and four-year degrees remain highly valuable in the industry.***

While apprenticeships in the IT sector are growing, opportunities are still much more limited than in other industries, and degrees are still highly valued. Even where Registered Apprenticeship programs exist, not all pre-apprentices will want to continue on to an apprenticeship. IT pre-apprenticeship programs can maximize entrance to the sector and career advancement by providing clear connections to non-apprenticeship pathways in addition to RA. This includes aligning the program with postsecondary credit and cultivating employers to hire pre-apprentices into their entry-level jobs *(see section 5)*.

Conclusion

Pre-apprenticeship is a proven training model for expanding access to meaningful career pathways across industries. The quality skill development offered through employer-supported WBL and hands-on training—and the provision of wraparound services and supports, including career exploration, mentorship, and opportunities to build social capital—make pre-apprenticeship particularly beneficial to an industry such as IT, where experience and connections are highly coveted by employers.

The promising practices outlined in this framework can help both existing pre-apprenticeship programs and other training models strengthen their design and improve their alignment with the pre-apprenticeship model.

These elements are essential baseline components for all pre-apprenticeship programs, regardless of the industry focus or the population served. To be truly successful in creating high-quality pre-apprenticeship training, providers should pay special attention to specific needs of the populations and communities they are serving. For example, opportunity youth and justice-involved individuals face more systemic barriers to entry in the workforce, and so the inclusion of comprehensive career-exploration and wraparound services is crucial to supporting their long-term success. Additionally, pre-apprenticeship programs need to take into consideration the local labor market information and location and density of the communities in which they operate. Having access to resources and creating partnerships to build effective postsecondary and career pathways will look different in urban communities than it will in rural ones.

Below is a list of additional reading and resources that can help pre-apprenticeships further tailor their training to meet the needs of a diverse participant population:

- Pre-Apprenticeship: Pathways for Women into High-Wage Careers (U.S. Department of Labor, Employment & Training Administration)
- Principles for a High-Quality Pre-Apprenticeship: A Model to Advance Equity (CLASP)
- Cultivating Rural Talent through Apprenticeship (New America)
- Skilling Up: The Scope of Modern Apprenticeship (Urban Institute)
- Apprenticeship and the Justice System: Adapting a Proven Training Model to Serve People in Prison (Urban Institute)
- Preparing Opportunity Youth for the Future of Work (JFF)

- Connecting Apprenticeships to the Young People Who Need Them Most: The Role of Community-Based Organizations (JFF)
- Opportunity Works: Four Ways to Help Young Adults Find Pathways to Success (JFF)
- Universal Design for Learning Framework (CAST)

COVID-19 Resources:

- JFF's Equitable Recovery Hub
- "We Must Sustain Apprenticeship in a Post-Pandemic Downturn" (JFF)
- "This Crisis in Learning Requires Lasting Solutions" (JFF)
- Resources for Opportunity Youth Providers (JFF)
- National Association of Workforce Boards: Resource Center

Endnotes

1. All skills data cited in this section is drawn from 12-month nationwide data from Burning Glass Technologies, extracted by Sara Lamback from Labor/Insight in August 2019.
2. Computer user support specialists have a median salary of $51,000, and computer network support specialists have a median salary of $63,000, according to Emsi 2020 data.
3. Sara Lamback, Carol Gerwin, and Dan Restuccia, *When Is a Job Just a Job—and When Can It Launch a Career?* (Boston: JFF, 2018), https://www.jff.org/resources/when-job-just-joband-when-can-it-launch-career.
4. "Occupational Employment Statistics," 2018 wages, U.S. Department of Labor, Bureau of Labor Statistics, accessed July 16, 2020, https://www.bls.gov/oes/.
5. Burning Glass Technologies, CompTIA, the National Initiative for Cybersecurity Education (NICE), and Cyberseek Cybersecurity Career Pathway.
6. Matthew Sigelman, Scott Bittle, Will Markow, and Benjamin Francis, *The Hybrid Job Economy: How New Skills Are Rewriting the DNA of the Job Market* (Boston: Burning Glass Technologies, 2019), https://www.burning-glass.com/wp-content/uploads/hybrid_jobs_2019_final.pdf; National Institute of Standards and Technology, *Cybersecurity Apprenticeships* (Washington, DC: NIST, 2018), https://www.nist.gov/system/files/documents/2018/01/09/nice_apprenticeship_one_pager_oct_31_2017.pdf.
7. Burning Glass Technologies, 12-month nationwide analysis of IT roles; data extracted by Sara Lamback in August 2019.
8. Lamback et al., *When Is a Job Just a Job?*
9. Burning Glass Technologies, *Recruiting Watchers for the Virtual Walls: The State of Cybersecurity Hiring* (Boston: Burning Glass Technologies, 2019), https://www.burning-glass.com/wp-content/uploads/recruiting_watchers_cybersecurity_hiring.pdf.
10. Programming occupations employed 2.2 million individuals nationwide in 2018, while IT support roles employed 1.8 million workers, according to the U.S. Bureau of Labor Statistics. Because of their hybrid nature, cybersecurity roles span a broad range of occupations; however, recent estimates by (ISC)$_2$ placed the 2019 cybersecurity workforce at 805,000; see: (ISC)$_2$, *Strategies for Building and Growing Strong Cybersecurity Teams* (Clearwater, FL: (ISC)$_2$, 2019), https://www.isc2.org/-/media/ISC2/Research/2019-Cybersecurity-Workforce-Study/ISC2-Cybersecurity-Workforce-Study-2019.ashx?la=en&hash=1827084508A24DD75C60655E243EAC59ECDD4482.